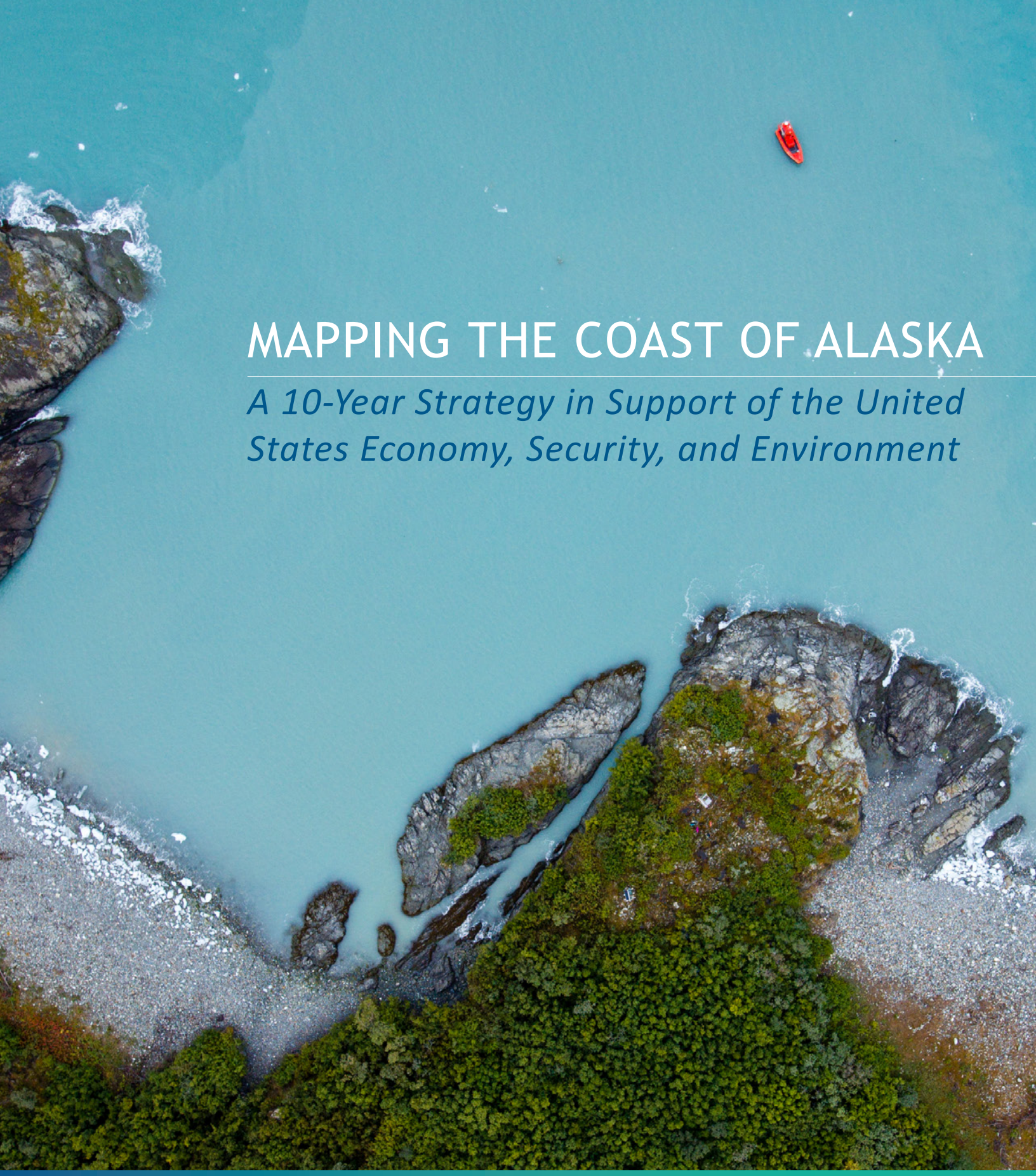


MAPPING THE COAST OF ALASKA

A 10-Year Strategy in Support of the United States Economy, Security, and Environment

ALASKA MAPPING Executive Committee

AOOS Alaska Ocean Observing System

USGS

June 2020

Sitka, Alaska. Credit: U.S. Army Corps of Engineers

Coastal mapping priorities are defined in this Alaska coastal mapping strategy as:

- elevation data collected above and below the water surface, specifically topography and nearshore bathymetry,
- orthorectified aerial imagery,
- the linear demarcation of the shoreline, specifically shoreline vector, and
- the supporting positional control required for accuracy.

The focus of this strategy is on the coastal and nearshore areas that can be mapped with airborne and satellite remote sensing, roughly 2 miles landward to the seaward extinction depth of these optical technologies.

Front cover image: Haenke Island, Alaska. Credit: Lt. Cmdr. Damian Manda

This document was updated on 8/4/2020 to reflect the correct number of Alaska gaps in the National Water Level Observing Network, p. 7.

Executive Summary

Alaska's 66,000 miles of Arctic and sub-Arctic shorelines constitute a tremendous strategic, economic, and ecological resource to the Nation. Accurate and contemporary mapping of Alaska's coastal and nearshore regions is critical to informed use of these vast resources, maritime domain awareness, safeguarding of the health and security of coastal communities, and strengthening of the Blue Economy.

The November 2019 ***Presidential Memorandum on Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore of Alaska*** calls for the National Oceanic and Atmospheric Administration (NOAA), the State of Alaska, and the Alaska Mapping Executive Committee (AMEC) to develop an Alaska coastal mapping strategy. The Alaska Coastal Mapping Strategy (Strategy) builds on decades of effort to modernize Alaska's geospatial infrastructure, including AMEC's creation in 2012, and envisions an Alaska that in 2030 possesses seamless coastal mapping data.

AMEC, co-chaired by the United States Geological Survey and NOAA, recently completed the first statewide acquisition of terrestrial elevation data at consistent standards and specifications. With this achievement, there is now opportunity to channel momentum toward strategic mapping of Alaska's coasts and nearshore waters. New efforts to map the coast will meet critical needs for coastal mapping data, including bolstering the shipping and fishing economy through safer maritime navigation, ensuring more resilient coastal economies through flood and wave impact modeling, data-driven coastal infrastructure development, improved emergency planning, and more effective community management plans.

This Strategy also aligns with AMEC's other statewide mapping priorities, including imagery, elevation, terrestrial hydrography, and airborne gravity, and implementation of this Strategy will benefit from close coordination with these priorities. In addition, by promoting collaboration and coordination with Federal and State agencies, academia, and the private sector, this Strategy seeks to leverage partnerships to ensure success.

Subject to the availability of appropriations, implementing the Alaska Coastal Mapping Strategy would yield significant upgrades to Alaska's geospatial framework and mapping of the coastal zone by 2030. Products derived from topographic, nearshore bathymetric, and orthoimagery data, including the Alaska shoreline, would vastly improve life, safety, and economic opportunities for Alaska residents and the Nation.

The Alaska Coastal Mapping Strategy defines four goals to guide near-term action, including acquiring priority coastal mapping datasets over the next five years, and the remainder by 2030:

Goal 1: Build on Existing Mapping Partnerships to Meet Alaska's Coastal Mapping Needs

Goal 2: Expand Coastal Data Collection to Deliver the Priority Geospatial Products Stakeholders Require

Goal 3: Leverage Innovation in Mapping Technology Development

Goal 4: Conduct Strategic Communications to Promote Widespread Stakeholder Engagement

Introduction

Alaska has the longest coastline in the Nation, spanning the Pacific and Arctic Oceans, the Gulf of Alaska, and the Bering, Chukchi, and Beaufort Seas. The State's 66,000 miles of shoreline and coastal ecosystems are geologically complex and diverse, including glacial fjords, 52 active volcanoes, a delta that is 12 times larger than the Mississippi Delta, inlets, bays, parks, and refuges. These coasts have a long history as places of subsistence, Indigenous culture, and economic opportunity for many Alaskans. They are also known for their hazardous weather and challenging ocean conditions.

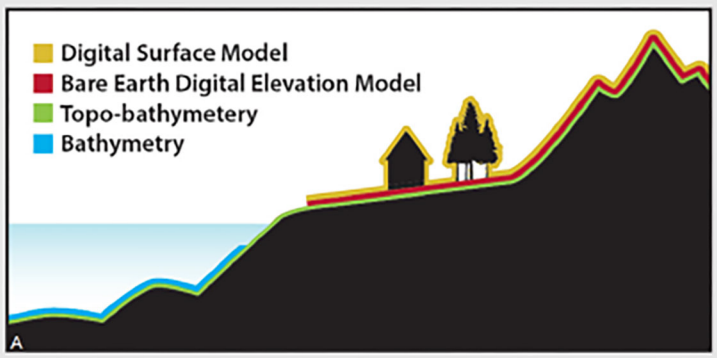
Informed decisions in the coastal zone depend heavily on accurate and up-to-date coastal mapping data. Alaska, however, has large gaps in its tidally referenced elevation and imagery data coverage. The State's supporting geospatial positioning framework is also deficient. Gaps in Alaska's water level station network and spatial reference system do not enable an accurate and reliable vertical datum transformation tool (VDatum), which is necessary to efficiently acquire and merge topographic and bathymetric datasets.

Unlike many other states, Alaska does not have integrated and seamless topobathymetric elevation data connecting nearshore waters to upland terrain. Nor does it have the coastal data that is foundational to sustainable fisheries management, energy and mineral resource development, safe maritime operations, understanding of earth system dynamics, and other scientific research.

Given the State's diverse coastline, Alaska's lack of mapping data is particularly challenging considering the longstanding threats of tsunami and earthquake, or the frequent hazards of extreme weather, storm surge, sea ice retreat and coastal erosion. Environmental and economic decisions must be made every day in Alaska without the data-enhanced benefit of reliable situational awareness. Alaska, however, will be able to utilize and strengthen existing partnerships and policies to collaboratively develop and implement a comprehensive mapping strategy for its shoreline and nearshore waters.

Background

The November 2019 ***Presidential Memorandum on Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore***



Digital Surface Model (DSM) – a three-dimensional surface that follows the tops of buildings, trees, and other vegetation.

Bare Earth Digital Elevation Model (DEM) – a three-dimensional surface that follows the ground surface, excluding buildings, treetops, and vegetation.

Seamless Topobathymetry – a three-dimensional surface that includes both under water bathymetry (depths) and onshore topography (land elevations) with no data gaps at the land/water interface or tidal zone.

Bathymetry – the measurement of water depth in oceans, sea, or other bodies of water. Often represented as a three-dimensional surface of the seafloor.

Orthoimagery – aerial photographs or satellite images that have been geometrically corrected ("orthorectified") to fit the earth's irregular surfaces such that the scale is uniform and the image has the same lack of distortion as a map.

Shoreline Vector – a derived line separating offshore from onshore areas. Most commonly aligned with the official or estimated Mean High Water position.

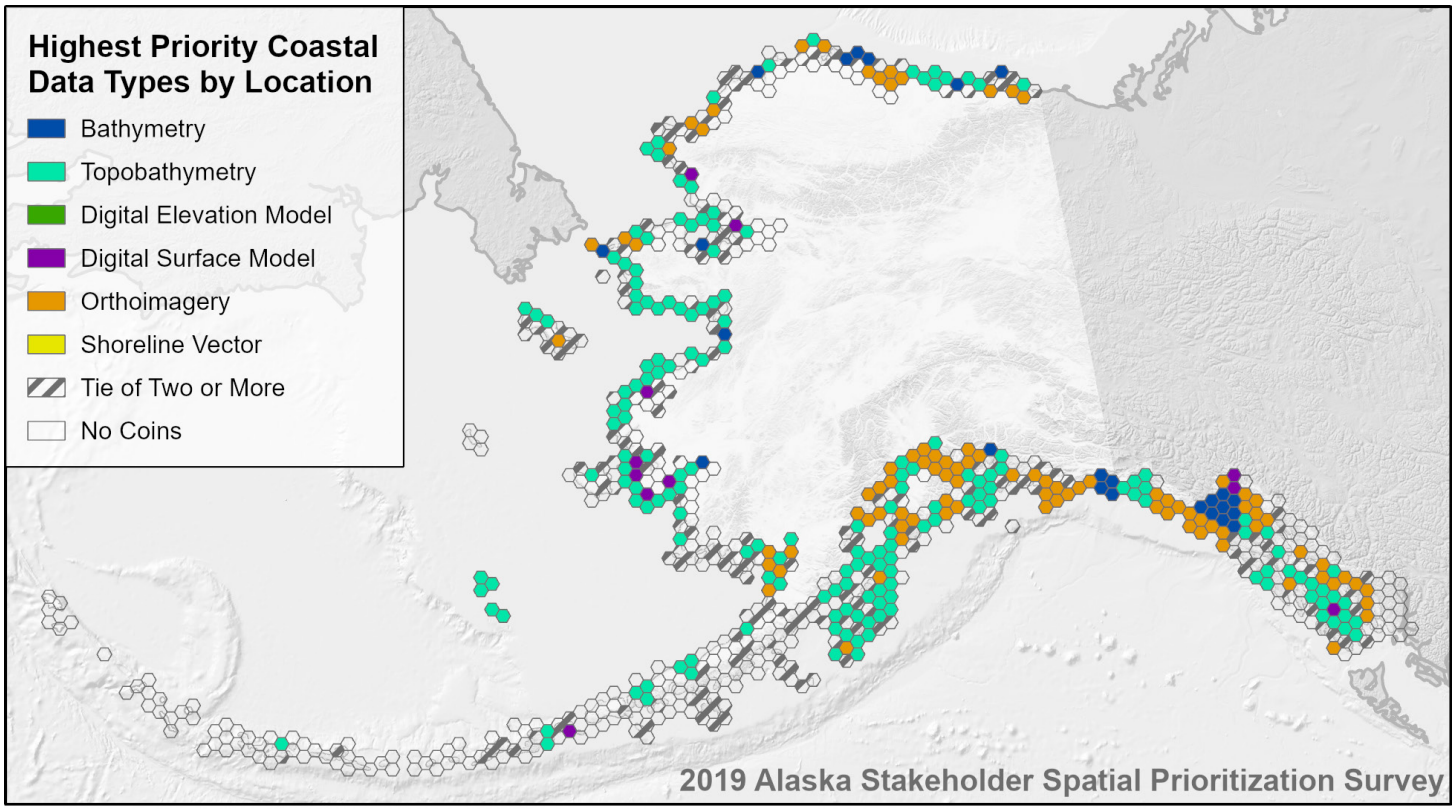


Figure from a 2019 assessment of Alaska stakeholder priorities for mapping data at the coast. Participating stakeholders were a representative body asked to identify their highest priority mapping data needs and locations. Objective 1.2 of this Strategy would refine and revalidate stakeholder mapping needs to ensure that identified priorities reflect broader stakeholder input.

of Alaska directs the creation of an Alaska Coastal Mapping Strategy, stating:

- It is the policy of the United States to act boldly to safeguard our future prosperity, health, and national security through ocean mapping, exploration, and characterization.
- Completed mapping is especially lacking for Alaska and for the Alaskan Arctic, which lack the comprehensive shoreline and nearshore maps available for much of the rest of the Nation.
- The National Oceanic and Atmospheric Administration (NOAA) will coordinate with the State of Alaska and the Alaska Mapping Executive Committee (AMEC) on a strategy to map the shoreline and nearshore of Alaska.

In 2019, the State of Alaska, NOAA, and the Alaska Ocean Observing System (AOOS) followed two Alaska Coastal Mapping Summits with an effort to inventory existing data for suitability in coastal applications, and to collect Alaska regional coastal mapping priorities using a GIS-based tool. The assessment of existing onshore, tidal, and nearshore areas revealed that 86 percent of the Alaska coastline is deficient in mapping data needed for critical coastal zone applications. AMEC, a consortium of Federal and State agencies with shared goals for Alaska mapping, added coastal topography and bathymetry to its priority areas in May 2019. Appendix A includes short summaries of AMEC agency coastal mapping mandates and interests.

In addition to the Presidential Memorandum, Federal and State legislative mandates, agency missions, and initiatives support the development of an Alaska coastal mapping strategy.

Such directives include:

- The Ocean and Coastal Mapping Integration Act of 2009,
- The 3D Nation vision of a United States with seamless elevations from mountain peaks to ocean trenches,
- The Blue Economy's coastal-dependent growth opportunities,
- Alaska Geospatial Council (AGC) goals for shared effort to modernize Alaska's geospatial data,
- The Federal Interagency Working Group on Ocean

and Coastal Mapping's (IWG-OCM) national coastal mapping strategy and elevation data standards,
- The Geospatial Data Act of 2018 directives on data standards, acquisition and access, and
- Agency missions reliant on coastal mapping data such as NOAA's coastal and navigation safety programs, the Department of the Interior agencies and bureaus with science and management responsibilities in Alaska, the U.S. Army Corps of Engineers' (USACE) navigation and flood risk management programs, the State of Alaska's Department of Natural Resources, and AOOS, among others.

Vision

This Strategy envisions an Alaska that in 2030 possesses seamless coastal mapping data. This vision translates into near-term goals for action, including acquiring priority coastal mapping datasets over the next 5 years, and the remainder of Alaskan shoreline datasets by 2030.

Goals and Objectives

Because mapping coverage of Alaska's coasts lags far behind other coastal states in the United States, new efforts to map the coast must fit the needs of many users, provide for strategic implementation, and promote collaboration from many entities. Alaska's coastal and ocean mapping needs are not limited solely to airborne and satellite-based remote sensing. Therefore, this Strategy describes a method to achieve topographic, bathymetric and orthoimagery coverage of the coastal zone by 2030. Shallow water acoustic bathymetry beyond the extinction depth of optical sensors is also a high priority for Alaska. However, for consistency purposes, acquisition of this dataset is scheduled to be captured in the National Ocean Mapping, Exploration and Characterization Strategy (NOMEC), a second plan developed pursuant to the Presidential Memorandum.

Goal 1: Build on Existing Mapping Partnerships to Meet Alaska's Coastal Mapping Needs

This Strategy builds on prior collaboration and coordination across Federal and State agencies, academia, and the private sector.

Objective 1.1: Establish a Team for Alaska Coastal Mapping Implementation

Coordination is critical to making geospatial data collection a priority and to successfully implementing this Strategy. Working with many different State and Federal agencies over a 10-year period, AMEC utilized this model for coordinated mapping with the Interferometric Synthetic Aperture Radar (IfSAR) terrestrial mapping program. Currently, AMEC agencies have the opportunity to implement lessons learned from the IfSAR acquisition program into this Alaska Coastal Mapping Strategy. In 2018, NOAA became a co-chair of AMEC with the United States Geological Survey (USGS), and the charter was revised

Utqiagvik, Alaska. Credit: NASA

Utqiagvik, Alaska. Credit: NOAA

to include a focus on coastal mapping. NOAA stands ready to lead and execute this Strategy with USGS and AMEC partners, the State-led AGC, and the IWG-OCM.

Approach: NOAA and AMEC created a Coastal Mapping Subcommittee at the May 2020 AMEC meeting. This subcommittee will be responsible for the coordination and development of an Implementation Plan for the Alaska Coastal Mapping Strategy (Implementation Plan).

Objective 1.2: Refine Stakeholder Mapping Priorities, Costs, and Data Standards

The 2019 assessment of existing coastal data quality, coverage and gaps, and the Alaska coastal mapping prioritization survey were conducted prior to the release of the Presidential Memorandum. Survey participants included over 40 representatives from federal, state and local agency liaisons, Native corporations and associations, non-profit and professional organizations, and academia. The input from these studies will be the foundation on which to build mapping requirements as they represent the direct needs of the coastal communities and industries that will benefit from the acquisition of new coastal mapping data. Broader mapping studies, including the 3D Nation Elevation Requirements and Benefits Study, will also be used to inform requirements and data standards in the Implementation Plan.

Scientists collect tidal staff shots on an Arctic beach north of Wales, Alaska on a rare calm, clear day. Looking north towards the Arctic Ocean, with the RV Qualifier 105 in the background. Credit: Andrew Orthmann, Terrasond

Approach: Recent user assessments and data studies will be analyzed to refine and define stakeholder needs in the region. Requirements, costs and data standards will be validated through engagement with stakeholders, AMEC members, and AGC representatives to inform the Implementation Plan.

Objective 1.3: Cost-Effectively Resource the Alaska Coastal Mapping Implementation Plan

As with IfSAR, acquisition resources comprised of contributions from Federal agencies, State and local entities, and academia will have more impact and can leverage acquisition efficiencies. For example, Federal geospatial contract vehicles with high funding ceilings, such as the NOAA Shoreline Mapping, Hydrographic Services and Coastal Geospatial Services Contracts, and the USGS Geospatial Product and Services Contracts are available for use in a coordinated mapping campaign. In addition, the USACE's Joint Airborne Lidar Bathymetry Technical Center of Expertise may also contribute to this Strategy. The role of the private sector is important as well; private sector participation contributed to IfSAR's success, from managing data collections, data merges, quality assurance, and data acquisition.

Approach: While the cost of mapping Alaska's coast is significant, there are cost savings and efficiencies in combining resources and energy to achieve common goals. Agreements and contracts between agencies and external partners may contribute to this process. The Coastal Mapping Subcommittee will explore these mechanisms in preparation to implement the Strategy.

Objective 1.4: Integration with Complementary AMEC Mapping Priorities

AMEC presently facilitates the acquisition of multiple statewide mapping priorities that geographically intersect with Alaska's coastal and nearshore areas, including imagery, elevation, terrestrial hydrography, and airborne gravity. Requirements for wetland and vegetation mapping and targeted geophysical data are under consideration as possible future AMEC priorities. Implementation of this Strategy will benefit from close coordination with complementary implementation strategies. For example, alignment with the terrestrial hydrography priority will advance implementation of NOAA's National Water Model, a hydrologic modeling framework that simulates observed and forecasted streamflows in Alaska.

Approach: The Coastal Mapping Subcommittee will factor complementary AMEC mapping priority acquisition plans into implementation, including strategic timing of data collection or processing, combined requirements in coastal and nearshore areas, and leveraged resources and capabilities.

Goal 2: Expand Coastal Data Collection to Deliver the Priority Geospatial Products Stakeholders Require

Mapping the Alaska coast is challenging. However, utilizing targeted and coordinated data collections will potentially reduce overall costs and improve the cost-to-benefit ratio of expanded mapping activities. Data acquisition also depends heavily on improvements to the positioning framework, which is a prerequisite to seamlessly integrate data on the coast.

Objective 2.1: Execute a Flexible Alaska Coastal Mapping Campaign

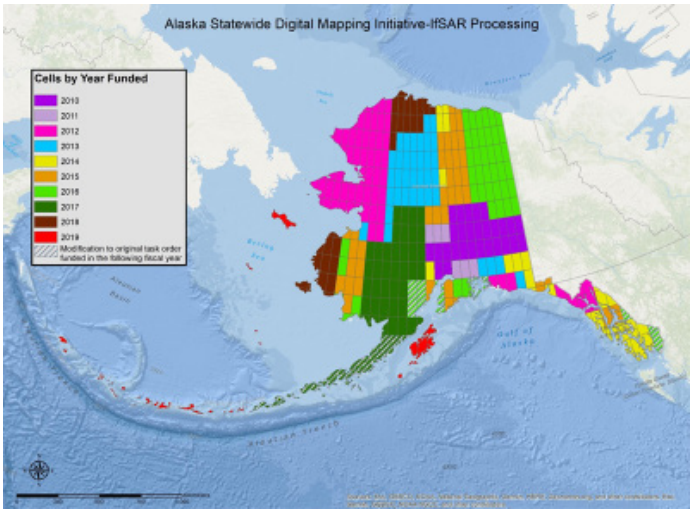
The Implementation Plan will follow the IfSAR framework of clearly delineating priority areas into manageable acquisition targets of appropriate scope, scale, timing, and cost. This is a key step to coordinated acquisition. The Implementation Plan will factor in existing data coverage and quality to achieve complete mapping coverage of Alaska coasts with topobathymetric lidar or orthoimagery before 2030.

Flexibility to move among stakeholder priority areas is essential, as both Alaska's fluctuating weather conditions and indigenous food security measures will dictate where mapping efforts can be most effective. National data standards and best practices will be used, as required by the Geospatial Data Act of 2018. Periodic analysis of acquired data should also be considered, as these datasets have shorter lifespans due to the continually changing nature of shoreline and coastal areas

Approach: Acquisition of comprehensive coastal mapping data will follow a trackable yet flexible approach to map manageable segments of Alaska's coastline.

Objective 2.2: Upgrade Alaska National Spatial Reference System Components to Support Mapping Data Acquisition

Integrating nearshore bathymetric and topographic data at the coast would be improved by enhancements to the National Spatial Reference System in Alaska. These could include collection of



Alaska IfSAR campaign mapping 1-degree cell completion, by funding year. Credit: Dewberry

airborne gravity data to update and monitor the Alaska/Arctic geoid for centimeter level positioning accuracy; filling the 32 identified Alaska gaps in the National Water Level Observing Network (NWLON); co-locating existing water level stations with Continuously Operating Reference Stations (CORS); and building VDatum models to seamlessly link topographic and bathymetric datasets together. VDatum enables users to convert data from different horizontal and vertical references to a common system, making it easier to integrate diverse datasets. In places where traditional tide gauges cannot be easily installed and maintained -- like Arctic Alaska -- temporary gauging can help verify the accuracy of VDatum in offshore areas.

Approach: The AMEC will examine options for filling the 32 identified Alaska NWLON gaps, co-locating existing water level stations with CORS, and building VDatum models in Alaska to gain efficiencies by seamlessly linking topographic and bathymetric datasets for inclusion in the Implementation Plan.

Objective 2.3: Produce and Disseminate Key Datasets and Products from Alaska Coastal Mapping Data

The acquisition of new and accurate coastal mapping data will inspire a generation of improved and derivative datasets. For example, NOAA's shoreline mapping products for the National Shoreline and Continuously Updated Shoreline Product (CUSP) could be updated to create a new shoreline vector for use in nautical charting, providing greater certainty in boundary and jurisdictional definitions, and shoreline

change monitoring. Other products that would benefit from new topographic and bathymetric data include NOAA's tsunami models and the first USGS Coastal National Elevation Database (CoNED) models for Alaska. These digital elevation products support inundation forecasts and sediment transport models. Accurate mapping data will also help to improve Alaska terrestrial hydrography efforts and wetlands inventory in coastal low relief areas, among many other uses.

The State of Alaska, NOAA, and AMEC partners are committed to ensuring that data is readily available to the public, with quality metadata following ISO 19115 standards. The State actively maintains a public elevation portal for viewing and downloading elevation datasets. The State is also building a public orthoimagery portal to host current and historic orthoimagery for viewing and downloading. NOAA hosts topographic, bathymetric, and orthoimagery coastal mapping data at the National Centers for Environmental Information and Digital Coast. USGS and NOAA also manage elevation data reporting at the United States Interagency Elevation Inventory.

Approach: Key coastal datasets will be updated and made available to the public. Existing data delivery portals and frameworks within the State of Alaska and among Federal agencies will be used to distribute these new data and models.

Goal 3: Leverage Innovation in Mapping Technology Development

Remote sensing technology, from aircraft and satellite-based systems to sonar and unmanned platforms, will continue to improve, thereby reducing time and cost to acquire data in challenging coastal and nearshore areas.

Objective 3.1: Upgrade Alaska Climatology Tool for Smart Application of Satellite and Airborne Lidar Bathymetry

Satellite-derived bathymetry (SDB) and bathymetric lidar rely on reflected light and laser penetration of the water column. Acquisition of these datasets are therefore more successful during times of high water clarity. NOAA's climatology tool uses satellite image records to identify patterns in time and space that enable more successful SDB and bathymetric lidar acquisitions. Using satellites to coordinate the timing of nearshore bathymetric data may result in more frequent and effective acquisitions, decreasing cost and improving quality.

Approach: The State of Alaska, the National Aeronautics and Space Administration (NASA), USGS, USACE, and NOAA will assess the feasibility of upgrading the NOAA-developed water clarity climatology tool to add a real-time component for Alaska based on satellite imagery and other remote sensing sources.

Objective 3.2: Monitor and Test New Technologies for Acquisition Efficiencies

Across the globe, mapping efforts are benefitting from rapid technological advancements in sensor technology, platforms, processing, and inferencing. Satellites such as WorldView-3 and ICESat-2 have demonstrated their potential. However, they need to be incorporated into routine operations in places where they are most effective. Unmanned systems are also of interest as force multipliers, particularly at sea to augment data collection, increase safety, and reduce risk in Alaska's remote or extreme environments. The State is a willing partner to test out new technologies, particularly in unique and tough Alaska environments with the benefit of local community on-the-ground knowledge.

Approach: The Coastal Mapping Subcommittee members will monitor commercial and academic research and testing for potential implementation

The ASV C-Worker 5 moves in to survey close to shore along the Alaska Peninsula. The wreck of the MV *Oduna*, a 422' steel steam ship lost in heavy seas in 1965, is on the shore nearby. Cape Pankof, Alaska Peninsula, June 2018. Credit: Andrew Orthmann, Terrasond

into coastal mapping operations. Technology demonstration pilot projects will test and evaluate new methods and platforms for suitability and feasibility in meeting mapping requirements.

Goal 4: Conduct Strategic Communications to Promote Widespread Stakeholder Engagement

Communication between Federal and State agencies, boroughs, Alaska Native Organizations (to include Alaska Tribes, Alaska Native Corporations, Alaska Native Consortia, and Alaska Native Co-Management Organizations), and other key stakeholders was critical in the development of the Alaska Coastal Mapping Strategy, and will be equally critical for its successful implementation. Sustained engagement is necessary to confirm that coastal mapping efforts meet user needs and to incorporate new requirements. Special consideration will be given to Alaska Native Organizations in order to minimize potential conflicts with food security practices and cultural activities. For example, mapping, exploration, and characterization activities will avoid bowhead whale migration and other important subsistence time periods.

Objective 4.1: Strengthen Stakeholder Communications to Grow Participation in the Alaska Coastal Mapping Campaign

Multiple forums and governance structures exist for communicating with stakeholders and the public. NOAA, the State, USGS, and AOOS are funding an Alaska coastal strategist, housed under AGC, to supply technical guidance to parties interested in their own coastal mapping data acquisitions, to update state priorities as data are collected, and to actively seek partnerships for potential data acquisitions. Promoting this Strategy, its implementation, and subsequent data acquisitions will require collaboration from all of the partners.

Approach: The Coastal Mapping Subcommittee will leverage AMEC, the AGC, the Alaska Coastal Strategist, coastal mapping summits, and other regional mapping gatherings to provide information on the Strategy, its progress, distribution mechanisms, and potential applications. This approach commenced during the May 2020 AMEC Meeting and will continue with a later Coastal Mapping Summit.

Objective 4.2: Use Online Tools and Technologies to Communicate Plans and Performance

Transparency in the execution of this Strategy will be essential in building trust and ensuring coordination across the broader Alaska mapping community and sustaining support with the public. Providing clear and frequent information, in a consistent manner, about the mapping effort will promote transparency and bi-lateral dialogue with the stakeholder community.

Approach: The AGC will host online interactive maps of spatial prioritization results and assessments of existing data. The State of Alaska will host performance measurement and progress tracking against priorities and plans as additional datasets are collected. In addition, plans and priorities will be shared through the IWG-OCM's Federal United States mapping coordination site, available at fedmap.seasketch.org.

Conclusion

For Alaska, coastal mapping data are critical for a multitude of reasons, including informed management of coastal lands and Alaska Native trust resources; safe navigation in an ice-diminished Arctic; and responsible resource and energy exploration. Community resilience to coastal hazards such as flooding, erosion, and tsunami begins with mapping data to establish baseline conditions and model change. Alaska's Federal, State, regional, tribal, academic and private sector partners have the opportunity and ability to take a targeted, collaborative, and innovative approach to comprehensive Alaska coastal mapping with this Alaska Coastal Mapping Strategy. The return on investment is apparent with the vast potential for improvements to life, safety, and economic opportunities that will accrue to Alaska and the Nation from a solid coastal mapping foundation.

Kodiak Island, Alaska. Credit: NOAA

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Appendix A: AMEC Agency Alaska Coastal Interests and Mandates

Alaska Department of Natural Resources (AK DNR)
The AK DNR mission is to develop, conserve, and maximize the use of Alaska's natural resources consistent with the public interest. Coastal mapping is critical to carrying out this mission in the coastal zone to support the safety and livelihoods of Alaska residents, responsible resource extraction (mining, oil, gas, and timber), tourism, and land and habitat management. AK DNR participates in the Alaska Mapping Executive Committee and leads the Alaska Geospatial Council.

AK DNR is home to the Division of Geological & Geophysical Surveys (DGGS) which conducts activities to fill coastal mapping data gaps in order to determine the potential of Alaskan land for production of metals, minerals, fuels, and geothermal resources, the locations and supplies of groundwater and construction material, and the potential geologic hazards to buildings, roads, bridges, and other installations and structures (Alaska Statute 41.08.020). DGGS works collaboratively with other state, federal, and non-federal partners to fill gaps in coastal mapping data, through the development of the Alaska Coastal Mapping Strategic Plan and Implementation Plan, and the water level datasets that support seamless topobathymetric data collection efforts, through Alaska Water Level Watch. DGGS conducts on-the-ground and remote sensing mapping activities and provides public access to mapping data and tools, including the Alaska Elevation Portal (http://elevation.alaska. gov/).

Alaska Ocean Observing System (AOOS)
AOOS is the Alaska regional component of the national Integrated Ocean Observing System (IOOS). Its mission is to provide ocean and coastal information to meet stakeholder needs at both regional and national levels. AOOS starts with the needs of users of Alaska's coasts and oceans as the first step in identifying its programmatic priorities. This is done using a variety of activities: coordinating State, Federal, local and private interests at a regional level; identifying gaps in existing ocean observing activities and data, making recommendations for needed enhancements to both Federal and non-Federal assets, and filling gaps when appropriate; increasing efficiencies and usefulness of existing ocean observing activities and data for a wider variety of users by integrating and visualizing data, and convening and facilitating networks of stakeholders to address common issues and leverage activities.

AOOS supports the largest federally certified regional data center in Alaska and provides ocean and coastal data along four broad themes: improving maritime safety (including support for search and rescue and oil spill response operations); responding to coastal hazards (in particular, coastal flooding and erosion); tracking climate and ecosystem changes; and responding to water quality needs (including ocean acidification and harmful algal blooms). AOOS leads or co-leads the Alaska Ocean Acidification Network, the Alaska Harmful Algal Bloom Network, and the Alaska Water Level Watch network. The Alaska Water Level Watch is facilitated by AOOS with support from the Alaska Department of Natural Resources, NOAA, USGS, and other state, federal, and local partners. Its goal is to integrate water level data from a variety of sources to improve flooding and storm surge forecasts as well as to plan for future responses to erosion and coastal flooding by affected communities and agency managers. Coastal mapping is a key component of this effort in Alaska, and AOOS has been a main partner in the effort to develop a coastal mapping strategy for the state.

Bureau of Land Management (BLM)
The BLM not only manages some of Alaska's great historical sites but also is a part of the state's history with its survey, oil and gas, mining, and land transfer programs from coast to coast. To manage public lands, the BLM prepares land-use plans, also known as Resource Management Plans. These plans serve as blueprints for keeping public landscapes healthy and productive for multiple-use. BLM Alaska manages more surface and subsurface acres than any other state with BLM-managed lands. This includes approximately 70 million surface acres and 220 million subsurface acres (Federal mineral estate) in a state with a landmass equivalent to about one-fifth of the entire contiguous United States. Systems such as the Alaska Spatial Data Management System provide access to BLM-Alaska land record documents, reports, and GIS data, including land conveyance cases, master title and survey plats, leases, permits, federal mining claims, and easements for many waterfronts.

Bureau of Ocean Energy Management (BOEM)
BOEM is responsible for managing the development of the Nation's offshore energy and mineral resources in an environmentally and economically sustainable way. To do so effectively, understanding the physical environment is critical, leading BOEM scientists to incorporate bathymetry data, topobathymetry data, and orthoimagery data into map products and models for decision making. BOEM has the authority through the Outer Continental Shelf Lands Act to manage lands seaward of the Submerged Lands Act Boundary (SLAB, also known as the state seaward boundary) and does so by using the available National Baseline data to depict that boundary where it has not been otherwise fixed by decree of the U.S. Supreme Court. Baseline points and bay/river closing lines are ambulatory and change with coastal erosion and accretion. These are the most seaward points along the Nation's shoreline, e.g., those that would be used to determine the Alaska 3 nautical mile SLAB, where it remains ambulatory. From BOEM's perspective, if the priority areas and subsequent leasing/permitting interests and program planning are focused on areas that do not have the most up to date baseline, then the Submerged Lands Act coastline is in question and needs to be addressed. Another priority for

BOEM is to utilize these datasets for effectively identifying seep sites and other hydrocarbon indicators.

In support of Section 3 of the Presidential Memorandum, BOEM will focus on the identification of priority areas, and requirements for characterization of these areas. The relevant priority regions for BOEM are areas that are:

- Unmapped or mapped, but to an insufficient resolution for BOEM-related resource identification, evaluation, economic and risk analysis, and to a standard sufficient to allow regulatory oversight and environmental analyses (e.g. through the National Environmental Policy Act) for-compliant characterization of that resource and associated environmental and cultural features. ("Resource" includes conventional energy, renewable energy, and offshore marine mineral potential and potentially impacted sensitive biological and cultural resources). Areas with higher resource potential will be given higher priority.
- At least somewhat likely to experience extractive/impactful activities in the near to medium term.
- Areas with high resource potential will be defined as priority areas. They must be mapped to a standard sufficient to allow the characterization of that resource and associated environmental and cultural features.

BOEM is a partner in the development of the strategy for mapping the shoreline and nearshore areas of Alaska, as well as the strategy for mapping the Exclusive Economic Zone. BOEM advocates that both efforts are coordinated for consistent data parameters and requirements across the region. BOEM provides program management, quality assurance, and quality control capabilities through its Environmental Studies Program and Office of Strategic Resource's Geospatial Services Division. Through the implementation of this strategy, BOEM will continue partnering with USGS, NOAA and others to effectively leverage combined resources to map, explore, and characterize seabed habitats and resources, including sand, gravel, and critical minerals, while ensuring datasets are collected with multiple end-user purposes in mind.

Environmental Protection Agency (EPA)
EPA's mission is to protect human health and the environment working under the authorities of an array of statutes to ensure that Americans have clean air, land and water. To accomplish this mission, EPA develops and enforces regulations, provides grants to states and other partners, conducts research to solve environmental problems, works in partnership with other organizations, and conducts educational activities. EPA's Alaska activities that rely on shoreline and nearshore mapping include response to oil and other chemical spills; environmental review of proposed projects under National Environmental Protection Act (NEPA), Clean Air Act, and other authorities; permitting and compliance under Clean Air Act, Clean Water Act (CWA), and other authorities; and research and technical assistance to communities facing challenges such as food insecurity and infrastructure failures associated with diminishing sea ice and increasing coastal erosion.

- Nearshore mapping helps EPA carry out statutory responsibilities regulating disposal of materials in ocean waters under the Marine Protection, Research, and Sanctuaries Act (MPRSA), also known as the Ocean Dumping Act. The mapping of the baseline in these nearshore coastal areas is critical for jurisdictional determinations that relate to EPA's regulatory role in designating, managing, and monitoring ocean disposal sites.
- The CWA § 404 establishes a program to regulate the discharge of dredged or fill material into waters of the United States. Both the EPA and the U.S. Army Corps of Engineers co-administer the program and the roles and responsibilities differ in scope. Of key interest to EPA for this mapping effort is its role in determining scope of geographic jurisdiction and applicability of exemptions.
- The EPA has been leading a project to expand the Local Environmental Observer Network, a tool that allows local practitioners of traditional knowledge to capture and share environmental observations and changes with other Arctic nations. These observations are turned into data points and help remote Arctic communities communicate with one another and with experts in universities and governments. They can also be used by industry and other stakeholders to understand the current weather and climatic situations in coastal areas where monitoring data is sparse.

Federal Emergency Management Agency (FEMA)
FEMA conducts hazard analyses and mapping studies to produce Flood Insurance Rate Maps (FIRMs) and other products that inform local coastal communities and residents about their risk of flood and other natural hazards. Over the past several years, FEMA has been evaluating and updating flood maps along the populated U.S. coastlines, in close collaboration with other federal agencies, states, local communities, nonprofits and academia, and the private sector. Through collaboration with these partners, FEMA has developed advanced methodologies for determining the flood risk along the coast, which are used to update the FIRMs. FEMA has also developed several programs to support flood hazard analysis specific to coastal conditions, including the Coastal Hazard Analysis Modeling Program, RUNUP software, and Wave Height Analysis for Flood Insurance Studies.

Several factors can affect the flood and other coastal hazard risks. For instance, changes in coastal development and land use can change the way coastal flooding impacts a community. FEMA strives to maintain the most accurate flood and hazard maps possible, using the best data resources available. Advances in technology and data availability will continue to improve how FEMA evaluates flood and other coastal hazard risks.

National Aeronautics and Space Administration (NASA)
NASA develops innovative airborne and satellite remote sensing technology, modeling, and analysis tools to better understand the Earth as an integrated system for societal benefit. NASA maps coastal regions as part of its ocean observing and modeling strategy, delivering long-term data records relevant to physical oceanography, biogeochemical sciences, and atmospheric science. Satellite remote sensing offers the advantage of frequent repeat measurements at regional scales, thereby complementing ship-based *in situ* and airborne platforms. The repeat observations allow the understanding of the integrated ocean system and time-varying physical properties and how they change from daily to seasonal and annual time scales. When the observations are combined with coupled ocean circulation, atmospheric circulation, and transport models, they provide important information on coastal processes at the surface and within the water column, including surface/atmosphere water and energy exchanges, biogeochemical, and ecological cycles, and on regional weather and climate.

Over the past 50 years, NASA's ocean remote sensing and mapping have involved the full suite of multispectral optical, thermal, and radar technologies. The wide variety of science data products derived from these missions are validated using ship and airborne platforms. NASA satellite missions are frequently executed with partner agencies, including NOAA, the USGS, and international partners. Mission priorities are guided, in part, by the National Academy of Sciences Decadal Surveys for Earth Science and Applications from Space. Observations from past and current missions that have contributed specifically to coastal and nearshore bathymetric mapping include the Landsat series, ICESat-2, and JASON satellite missions, and the airborne Operation IceBridge. In addition to the above missions, research at several NASA centers continues to investigate new variations of multispectral, LIDAR and radar technologies for deeper bathymetric penetration and imaging. NASA will continue to facilitate access to any current and new technological capabilities to support the Presidential Memorandum Strategy on Ocean and Coastal Mapping.

The NASA Earth Science Data and Information System with U.S. and international partners supports the processing, archiving, documenting, and distributing data from past and current Earth-observing satellites and field measurement programs, promoting open sharing with the general public. It further provides various browsers and software that facilitate access and visualization of mission and modeled data.

National Geospatial-Intelligence Agency (NGA)
With approximately 40% of the U.S. population living in coastal communities along the nation's shorelines, accurately analyzing, mapping, preparing for, and mitigating the flood hazards in these areas is critical to addressing the threat of hurricanes, tropical storms, and sea-level rise. The NGA provides resources and FEMA guidance materials for coastal flood hazard analysis and mapping, as well as mitigation, preparedness, and recovery information on reducing coastal hazard risk. Map resources are intended for mapping professionals and contractors and hazard mitigation planners. NGA delivers world-class geospatial intelligence that provides a decisive advantage to policymakers, warfighters, intelligence professionals, and first responders.

Anyone who sails a U.S. ship, flies a U.S. aircraft, makes national policy decisions, fights wars, locates targets, responds to natural disasters, or even navigates with a cellphone relies on NGA. Geospatial intelligence (GEOINT) is the exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities on the Earth. GEOINT consists of imagery, imagery intelligence, and geospatial data.

National Oceanic and Atmospheric Administration (NOAA)
NOAA's Integrated Ocean and Coastal Mapping program leads the acquisition and management of ocean and coastal mapping data to get the most value from data acquisitions. The program has recently contributed to the development of this strategic plan and has hosted the Alaska Coastal Mapping Summits to date. Continued investment in a local facilitator to carry out this strategic plan is critical to its success over the next five years. NOAA also has multiple offices with mapping missions, which include collecting topobathymetry, bathymetry, and orthoimagery in coastal regions. The primary offices of the National Ocean Service include the Office of Coast Survey, which is responsible for surveying and producing navigation charts and the Integrated Ocean Observing System (IOOS), which leads implementation and administration of observing systems in partnership with other federal and local agencies. The National Geodetic Survey (NGS) collects pre- and post- event orthoimagery data in response to disastrous flooding from hurricanes and storms, and more recently conducts shoreline mapping. In recent years, NGS has also collected baseline orthoimagery for large sections of the Alaska coast. The Office for Coastal Management (OCM) supports coastal zone management through collecting and providing coastal mapping data to the public. OCM has also contributed to recent major coastal mapping initiatives through cooperation with Alaska Department of Natural Resources, North Slope Bureau, and NOAA's Center for Operational Oceanographic Products and Services in Alaska's North Slope, Bristol Bay, Western Alaska, and St. Lawrence island areas by utilizing the OCM Coastal Geospatial Contract program. This program not only provides an efficient avenue for NOAA to direct internal funds towards significant mapping goals, but can host collaborative approaches to mapping by ingesting funds from outside NOAA, including from local, state, and other federal partners. The contracting service includes project management, quality assurance, and quality control.

NOAA is a critical partner in mapping Alaska's coastal zone. Many different offices within NOAA have the capacity to assist in directing mapping priorities, collect mapping data, and facilitate investments from other partners. The National Weather Service's use of accurate mapping is essential for accurate coastal flood and tsunami warnings in coastal Alaska. NOAA will continue to work with the State to connect with stakeholders, prioritize coastal mapping in Alaska, and direct coastal mapping funds.

National Park Service (NPS)
Of the 17 National Park System units in Alaska that the NPS manages, 11 collectively contain more than 3,600 miles of Alaska coastal shoreline. These parks were established to preserve their beauty, national significance, and natural and cultural legacy for the American people. NPS conserves and protects a variety of resources such as reefs, kelp forests, glaciers, estuaries, beaches, wetlands, abundant wildlife, coastal formations, historical and cultural sites, and more. Multiple federal laws require the service to protect these resources against threats from inside and outside of park administrative boundaries, including the NPS Organic Act and other statutes governing protection and management of public lands and natural and cultural resources. Common threats to NPS coastal resources include anthropogenic influences of overfishing, ocean acidification, changing climate, marine debris, erosion, invasive species, and unsustainable recreational demand. To address these concerns, the NPS has adopted priorities and strategies that increase the agency's organizational and scientific capacity focused on ocean and coastal issues, including a national benthic and topobathymetric mapping priority. These priorities and strategies rely on geospatial and scientific data created with the use of mapping technologies (i.e., topographic LIDAR, orthometric imagery, bathymetric data, etc.), and data that must be up to date, accurate, and adhere to national data standards. These data are important management tools because they equip parks to:

- protect natural and cultural resources
- better prepare and manage for natural hazards, change, and disturbance
- prioritize response and restoration

NPS's participation in interagency coastal mapping initiatives, coastal mapping strategy development, and coastal data collection is therefore vital to achieving the NPS' statutory mandate to conserve these coastal resources.

National Science Foundation (NSF)
The National Geospatial-Intelligence Agency and the National Science Foundation publicly released new 3-D topographic maps of Alaska in support of a White House Arctic initiative to inform better decision-making in the Arctic. The models are based on 2-meter resolution images captured by DigitalGlobe commercial satellites. This technology is significant in polar mapping because it allows for more thorough coverage of the Arctic than did traditional imagery collection by aircraft, which is limited in the inhospitable and remote polar region. The models also provide critical data and context for decisions related to climate resilience, land management, sustainable development, safe recreation, and scientific research. With the Arctic region experiencing some of the most rapid and profound changes in the world, staying involved in the most up-to-date mapping solutions is critical.

Projects funded by NSF have brought together a unique set of national assets, including the White House Office of Science and Technology Policy, NGA, the Polar Geospatial Center at the University of Minnesota, University of Illinois, Ohio State University and Cornell University, and many others. Teams from NGA and NSF worked with these partners to launch an unclassified, open Arctic portal where the Digital Elevation Model (DEM) and emerging information is available to the public. Esri, a geographic information system provider, hosts the site. The public website hosts Webmaps, map viewers, other DEM exploratory tools, nautical charts, sailing directions and infographics, and a downloadable Pan-Arctic map with mission-specific data layers.

United States Arctic Research Commission (USARC)
USARC is an independent federal agency created by the Arctic Research and Policy Act of 1984. It is a presidentially appointed advisory body. As required by law, USARC releases, to the President and Congress, a biennial "Report on the Goals and Objectives for Arctic Research," which regularly emphasizes the importance and value of mapping of Arctic waters and lands, especially those in Alaska. The Commission also develops and recommends an integrated national Arctic research policy and builds cooperative links in Arctic research within the federal government, with the State of Alaska, and with international partners. The law also requires the Commission to report to Congress on the progress of the Executive Branch in reaching goals set by the Commission and on their adoption by the Interagency Arctic Research Policy Committee (IARPC). For more information, visit https://www.arctic.gov

United States Army Corp of Engineers (USACE) Coastal Mapping Program/Joint Airborne LIDAR Bathymetry Technical Center of Expertise (JALBTCX)
JALBTCX is a partnership among the U.S. Army Corps of Engineers, the U.S. Naval Oceanographic Office, NOAA, and the USGS. The JALBTCX and USACE National Coastal Mapping Program are responsible for collecting topobathymetric LIDAR along the ocean and lake coastlines of the continental U.S. on a five-year rotating cycle (which does not include Alaska). In 2016, JALBTCX recognized an opportunity to take advantage of regular operations that resulted in a JALBTCX aircraft transiting over Alaska. In 2018 and 2019, JALBTCX directed resources to collect topobathymetric LIDAR at 13 Alaska communities over the two-year period. These collections

are the only publicly available topobathymetric data collections completed in Alaska in the last decade. JALBTCX will continue to coordinate and communicate with the State program regarding topobathymetric LIDAR data collection priorities.

United States Coast Guard (USCG)
The Coast Guard maintains the "signposts" and "traffic signals" (more than 50,000 Federal aids to navigation, including buoys, lighthouses, beacons, and radio-navigation signals) on the nation's waterways. In addition, it operates Vessel Traffic Services in key ports and waterways to coordinate the safe movement of commercial vessels. The Coast Guard 17th District encompasses all 3,853,500 sq miles of Alaska and includes its 66,000 miles of shoreline. The United States placed its first aids to navigation in Alaskan waters in 1884. Today the Coast Guard actively maintains more than 1,300 Federal aids to navigation in the District 17th and works towards its mission to ensure our Nation's maritime safety, security, and stewardship. Coast Guard missions include drug interdiction, defense readiness, migrant interdiction, coastal security, marine safety, aids to navigation, living marine resources, marine environmental protection, and ice operations.

United States Department of Agriculture (USDA) - Natural Resources Conservation Service (NRCS)
As a member of the National Cooperative Soil Survey, NRCS is the lead Federal agency for mapping and interpreting our nation's soil resources, including in our coastal zone areas. NRCS supports rigorous scientific content from field data gathering and research, diverse and uniquely effective partnerships, and modern techniques to produce spatial and tabular seamless soil surveys as well as the timely distribution of the data to all users. NRCS knows that more refined and detailed scientifically based coastal zone soil mapping, data, and interpretations are achievable. With vast improvements to remotely sensed data including LIDAR, aerial photography and topobathy, much of the spatial, coastal updates can be remotely assessed and verified with minimal time in the field. This collaborative, goal-oriented mapping will not only address the soil data needs of conservation planners and engineers, but it will also confront emerging issues such as climate change, coastal resiliency, estuary restoration, small and large-scale watershed use planning, and environmental literacy. Baseline coastal zone soil survey data is already guiding the protection, conservation, and management of our nearshore coastal waters and natural resources. The NRCS Snow Survey Program provides mountain snowpack data and streamflow forecasts for the western United States and Alaska. Common applications of snow survey products include water supply management, flood control, climate modeling, conservation planning, and recreation. NRCS is also the lead federal agency for implementing conservation solutions to protect natural resources on private lands, including those found along coastal zones. Voluntary conservation solutions offer more resilient landscapes, healthier soils, clean and abundant water, and thriving communities to help feed a growing world.

United States Department of Agriculture - United States Forest Service (USFS)
There is a strong need for a technical strategy in Alaska for delineating key shorelines and mapping the intertidal zone. Marine shorelines are critically important to the Forest Service as they serve as legal ownership boundaries and regulatory reference points. Precisely mapped shorelines are important for subsistence, estuary, forest, fish, and wildlife management. Accurately mapped shorelines are key to ecological monitoring and long-term planning and are essential reference layers for ecological research. The National Hydrography Dataset (NHD) and Watershed Boundary Dataset are the authoritative datasets used by the Forest Service for representing the nation's surface waters, drainage networks, and related features, including rivers, streams, canals, lakes, ponds, glaciers, coastlines, dams, and stream gages.

As a framework dataset for the Alaska Region, an accurate, updated shoreline will contribute to all of the Forest Service Strategic Goals, including:

- Sustaining our nation's forests and grasslands through increased knowledge in restoration and forest management
- Delivering benefits to the public by making the data publicly available through the NHD
- Applying knowledge globally by providing a repeatable methodology to share with our interagency and public partners
- Excelling as a high-performing agency by providing the most up-to-date information to our staff as they carry out the work of the programs.

Portions of the shoreline along Alaska Region Forests have been mapped by NOAA. Yet there are still large areas of low accuracy shoreline. For example, over the Tongass National Forest roughly one-third of the mean high water shoreline contained in the NHD comes from a patchwork of 1:63,360 USGS/FS Topo quadrangle shorelines and air photo interpretation derived from source data, dating as far back as the 1930s. The outdated shorelines are in stark contrast with the segments of shoreline that have been updated with modern technology, including LIDAR- derived and NOAA coastal bathymetric survey shorelines.

United States Department of Transportation (USDOT)
USDOT and the Alaska Department of Transportation and Public Facilities (AK DOT&PF) work together to implement evolving Federal requirements and the new directives in the Fixing America's Surface Transportation (FAST) Act. An effective implementation of these

requirements includes having accurate coastline input through mapping. AK DOT&PF is developing and continuously improving an accessible, accurate, and controlled inventory of public roadway features and linear coordinates for the Roadway Data System network. The network, a linear referencing system, will meet Federal and State requirements as well as the expanded needs of mandatory data programs within the department. To improve and expand Geographic Information System services, mapping, database management, web applications, training and technical/graphic assistance in support of DOT&PF's core business areas. NOAA regularly partners with the USDOT on state road projects through USDOT's Regional Offices. USDOT's regional offices track projects in collaboration with State DOTs and could potentially provide information that supports planning for current and future coastal restoration opportunities.

United States Fish and Wildlife Service (USFWS)
The USFWS has trust responsibility for the many resources that are found in Alaska's coastal zone. The coastal zone contains National Wildlife Refuges, migratory bird habitats, Endangered Species Act critical habitats, fisheries habitats, wetlands, and more. A complete framework of data from elevation and imagery to hydrography and wetlands is necessary to conduct planning efforts for future responsible management of resources. The FWS is the steward of the National Wetlands Inventory (NWI) data and is targeting completion of a statewide inventory. The program has contributed funding to numerous coastal zone imagery and elevation data collection projects in the past decade. Collaboration for data collection between the NWI program and the Coastal Mapping technical subcommittee will be essential for furthering the mission of both programs.

United States Geological Survey (USGS)
USGS includes coastal areas in its mapping missions in the form of onshore elevation data, bathymetry data, topobathymetric data, and orthoimagery data. The USGS has two main contracting vehicles: the Broad Agency Announcements (BAA) for the 3D Elevation Program (3DEP) and the Geospatial Products and Services Contract (GPSC). The BAA offers collecting up to 50% additional data as a match for elevation data acquisition. In addition, GPSC offers a suite of contracting services to both BAA and non-BAA projects. There have been several BAA LIDAR data collections in Alaska's coastal areas in recent years. USGS will continue to work with the State to promote the awareness of the 3DEP program while connecting partners and communicating data gaps, with a goal to execute at least one coastal project per year in Alaska through BAA or other partnership processes.

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Alaska Mapping Executive Committee Agencies:

Department of Agriculture
Department of Defense
Department of Homeland Security
Department of Interior
Department of Transportation
Environmental Protection Agency
Executive of the Office of the President, Office of Management and Budget
Executive of the Office of the President, Office of Science and Technology Policy
Federal Aviation Administration
Federal Emergency Management Agency
National Geospatial-Intelligence Agency
National Oceanic and Atmospheric Administration
National Science Foundation
United States Northern Command
United States Forest Service
United States Army Corps of Engineers
United States Geological Survey
United States Bureau of Land Management
United States Bureau of Ocean and Energy Management
United States Fish and Wildlife Service
United States National Park Service
State of Alaska, as determined under the leadership of the Governor's Office

For questions and more information, please contact Alaska Coastal Strategist Marta.Kumle@alaska.gov.

Kodiak Island, Alaska. Credit: NOAA