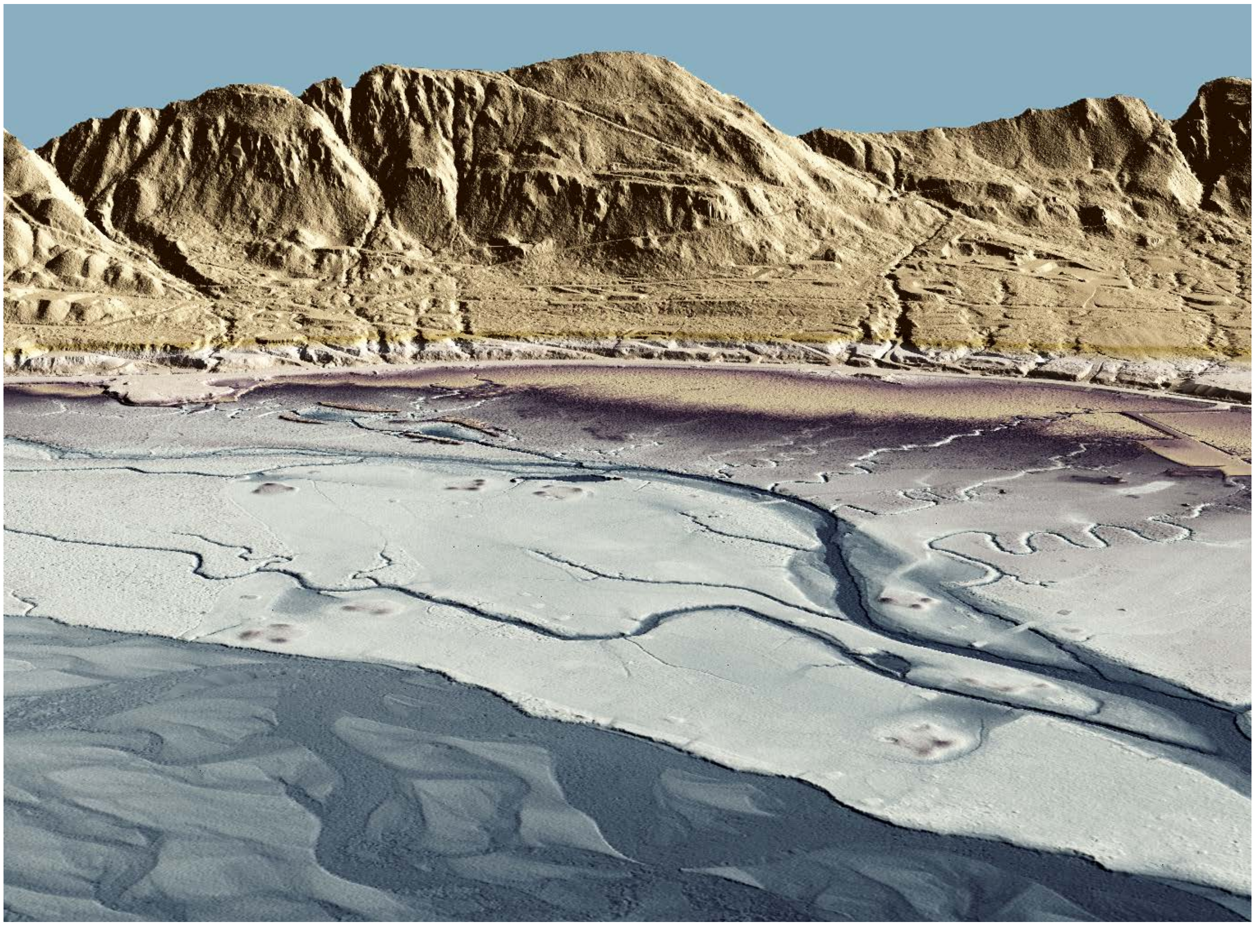
2018 ALASKA COASTAL MAPPING SUMMIT SUMMARY REPORT



Haines, Alaska. A look at the intricate braiding of tidal flats, looking north at the shoreline west of McClellan Flats. The image was created from the gridded LiDAR surface colored by elevation. Quantum Spatial

Final
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I. EXECUTIVE SUMMARY

On February 9, 2018 over one hundred subject matter experts gathered in Anchorage for the second Alaska Coastal Mapping Summit. This event, hosted by the Alaska Ocean Observing System (AOOS), the State of Alaska Department of Natural Resources (AK DNR), and the federal Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM), provided a forum to discuss the next steps for a coordinated approach to coastal mapping in Alaska.

Numerous real-world stories and planning scenarios made it apparent that reliable geospatial data underpins all responsible and economical decision-making for Alaska's coastal environments. Examples illustrated how coastal mapping is critical to the safety and livelihoods of residents, responsible resource extraction (mining, oil, gas, and timber), tourism, commercial fishing, subsistence, land and habitat management, and the development of local and international marine shipping routes. More than 30 of these detailed examples are included in the body and appendices of this summit report and the specific applications identified at the summit will drive development of the State's Coastal Mapping Strategic Plan.

Summit participants worked together to discuss strategies for identification and realistic prioritization of gaps in baseline geospatial data, namely imagery and seamless elevation surfaces that extend from inland areas to nearshore water and require auxiliary coastal mapping data, like tide station products or ground control. Meeting participants agreed that investments in Alaska coastal mapping should promote publicly accessible and authoritative products that address gaps critical to the safe navigation of vessels, infrastructure planning, flood and erosion mapping, emergency response, and environmental change detection.

Discussions throughout the day recognized that approaches, priorities, and objectives for mapping in Alaska's coastal zone require unique consideration of its extremely varied geomorphology, active earth processes, and remote setting. However, past success stories (e.g. 3D Elevation Program lidar project on the Yukon Delta), opportunities to pioneer new methods and technologies (e.g. advanced photogrammetric techniques or crowd-sourced bathymetry), and the existence of successful inter-agency bodies that recognize the importance of coastal mapping (e.g. the Alaska Mapping Executive Committee (AMEC), the Alaska Geospatial Council (AGC), and the ShoreZone Program) set a tone of optimism and opportunity about what can be achieved with this renewed commitment to statewide coordination.

To ensure that the substantive discussion from this meeting becomes a roadmap for coastal data acquisition in Alaska, the National Oceanic and Atmospheric Administration (NOAA), AOOS and the AGC have jointly funded a one-year Coastal Mapping Strategist position to spearhead compilation of an Alaska Coastal Mapping Strategic Plan. This Plan will incorporate many of the more than two dozen recommendations from this summit provided in the appendices to this report including; priorities and refresh rates for bathymetry, terrestrial elevation and imagery data; tiered, technology-neutral data specifications for different coastal environments; a data inventory with appropriate metrics; and an emphasis on demonstrated region-specific applications and anticipated future uses. Widespread and continued participation in the development of the Alaska Coastal Mapping Strategic Plan -- scheduled for draft release by December 2018 -- will be required to achieve an executable strategy that will include Alaska's many coastal mapping needs.

II. PARTICIPANTS

Approximately 100 individuals attended the summit, with 80 attending in person. Participants represented federal, state, and local governments; native corporations; non-governmental organizations; academia; and private sector organizations. The conference registration list with affiliations and contact information is available in the appendix of this report.

Figure 1: Alaska Coastal Mapping Summit, February 9, 2018, Anchorage, Alaska.

III. SUMMIT FORMAT & OBJECTIVES

The summit's broad purpose was to gather knowledge and strengthen Alaska's coastal mapping community as a follow up to the inaugural Alaska Coastal Mapping Summit held in June 2016. Three specific summit objectives were to: (1) distribute state and federal updates, (2) provide a forum for coastal mapping experts to present relevant work, and (3) host group discussions for exchange of ideas. One significant update was the introduction of a new **Coastal Mapping Strategist position**, funded by NOAA, AOOS, and AGC. This position is tasked with developing a feasible statewide Coastal Mapping Strategic Plan (CMSP) based on broad stakeholder input.

Twenty-two presentations were given in the morning, the majority as brief seven-minute lightning talks. In the afternoon, participants worked in small groups to address three discussion areas: (1) Stories that Speak, (2) Technologies and Specifications, and (3) Coordination and Collaboration. The full agenda, presentation PDFs and a digest of all group discussion notes organized by topic are available in the appendix of this report.

1. STATE AND FEDERAL UPDATE PRESENTATIONS

A. INTERAGENCY WORKING GROUP ON OCEAN AND COASTAL MAPPING (ASHLEY CHAPPELL, NOAA)

Chappell delivered a keynote speech on federal mandates and ongoing coordination strategies for coastal and ocean data acquisition, data management, and accessibility. She emphasized enabling as many applications as possible for each dataset: "**Map Once Use Many Times**."

The **3D Nation Study**, an effort to inventory national elevation data requirements and benefits, will be releasing a formal survey in 2018 and Alaska stakeholders are encouraged to participate. Chappell also introduced the **Alaska Coastal Mapping Strategist** part-time term position and the intent to develop a **Coastal Mapping Strategic Plan**. Lastly, Chappell conducted a brief tour of **SeaSketch**, an online mapping collaboration space, and highlighted some known upcoming plans and activities in Alaska.

B. ALASKA GEOSPATIAL COUNCIL (KEN WOODS, STATE OF ALASKA)

Woods provided an update on Alaska Geospatial Council (AGC) activities. Council members are senior executives from federal, state, local and tribal governments and academia working together to make current and accurate digital base maps widely accessible for Alaska. Several **technical working groups,** composed of local and regional representatives as well as subject matter experts from diverse governmental and nongovernmental entities, focus on datasets central to effective coastal mapping such as imagery, elevation, terrestrial hydrography, administrative boundaries, and wetlands. AGC is developing the **statewide geoportal** that will act as a data clearinghouse, metadata catalog, and central database for Alaska geospatial information.

C. DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS (JACQUELYN OVERBECK, STATE OF ALASKA)

Overbeck presented an in-progress report: **Alaska Coastal Mapping Data Gaps and Priorities for the Assessment of Coastal Flood and Erosion Hazards**. The report will be available at DGGS's Coastal Hazard Website (http://dggs.alaska.gov/sections/engineering/profiles/coastalhazards.html).

Changing ocean processes, permafrost thaw, reductions in sea ice concentration and extent, and relative sea level change contribute to coastal flooding and coastal erosion in Alaska. The report focuses on gaps in baseline datasets such as orthoimagery, topography, sea ice, bathymetry, waves, water levels, and tectonic motion models which are necessary elements to enable the forecasting and long-term modeling of coastal flooding and erosion.

D. FEDERAL CONTRACTING VEHICLES

UNITED STATES GEOLOGICAL SURVEY, NATIONAL MAP PROGRAM (BRIAN WRIGHT)
Wright gave an update on statewide activities to refresh the national elevation datasets in Alaska with Lidar and IfSAR data acquisition. Under annual United States Geological Survey **(USGS) Broad Agency Announcements (BAA)** for the **3D Elevation Program (3DEP)**, the USGS assists in coordinating partnerships that leverage USGS matching funds to update the **National Elevation Dataset Plan** for projects that typically begin one year in advance to identify as many partnerships as possible. The BAA contracting vehicle is open to any type of partner including private, public, government or non-profit entities. The **USGS Geospatial Products and Services Contract (GPSC)** suite of contracting services is available for use by both BAA and non-BAA projects. GPSC works with pre-approved small and large business vendors in a competitive qualification-based selection for elevation, remote sensing, and GIS services; this program charges 5% to cover project management and technical quality control services.

NOAA OFFICE FOR COASTAL MANAGEMENT (DAVE STEIN)
Stein described how the **Office for Coastal Management (OCM)** partners with many local, state, federal and other partners to collaboratively fund coastal geospatial projects that address coastal management issues. OCM offers a contracting vehicle for coastal geospatial data acquisition, GIS services, and thematic mapping by competitively-selected business vendors. Contracting services include project management, quality assurance and quality control; this program charges 2%, which includes technical support from NOAA staff. No OCM liaison is physically located in Alaska, and partnerships to date are primarily outside of Alaska, but remote projects are possible and a memorandum of understanding can typically be established in two to three months. More information on this contracting mechanism can be found on the OCM website (coast.noaa.gov/idiq/geospatial.html).

2. ALASKA COASTAL MAPPING PRESENTATIONS

The summit included 15 additional presentations from public and private entities with different types of expertise relevant to mapping Alaska's coastal areas. Presentation themes included recent and upcoming coastal and nearshore data acquisition projects; the utility of using a variety of technologies and sensors including satellites, topo-bathymetric lidar and aerial photos for coastal projects; and data collection challenges associated with Alaska's remoteness and short weather windows. The summit's full agenda and PDF versions of all presentations are available in the appendix of this report.

Presentations and Speakers:

- Hydrographic Charting Activities in Alaska (Bart Buesseler, NOAA)
- NOAA's Coastal Mapping Program (Mike Aslaksen, NOAA)
- National Park Service Coastal Mapping Operations 2017-2018 (Tahzy Jones, NPS)
- Statewide Threat Assessment (Wendy Shaw, Denali Commission)
- Wave and Hydrodynamic Modeling within the Nearshore Beaufort Sea (Warren Horowitz, BOEM)
- U.S. Coast Guard Seventeenth District Brief (Dave Seris, USCG)
- Coastal Resilience and Adaptation Workshops (Karen Murphy, USFWS)
- Lidar Data Collection in the Yukon-Kuskokwim Delta, Alaska (John Gerhard, Woolpert)
- Shoreline Verification with Unmanned Aerial Systems (Tim Smith, TerraSond)
- Topo-Bathymetric Lidar - Flash Talk (Russ Faux, Quantum)
- Coastal Water Clarity in Alaska (Rick Stumpf, NOAA)
- Technology Integrations for Coastal Mapping Success (Rada Khadjinova, Fugro)
- Satellite Imagery for Coastal Mapping (Drew Hopwood, GeoNorth Information Systems)
- ShoreZone Coastal Imaging and Habitat Mapping in Alaska (Sarah Cook, Coastal and Ocean Resources)
- Two Hundred Billion Pixels of Digital Coastal Paradise: Mapping a Mile Wide Swath of Alaska's West Coast at 10-20 CM GSD with Fodar (Matt Nolan, Fairbanks Fodar)

3. GROUP DISCUSSIONS FOR EXCHANGE OF IDEAS

The summit's afternoon schedule was dedicated to small (4-15 person) group discussions in order to strengthen the collaborative community and gather knowledge to inform Alaska's upcoming Coastal Mapping Strategic Plan. Each discussion session began with a brief introduction by an experienced member of Alaska's coastal mapping community. Every group had a dedicated note-taker and addressed the same set of questions over the course of three themed discussion sessions: (1) Stories that Speak, (2) Technologies and Specifications, and (3) Coordination and Collaboration. Groups were invited to pick specific questions for discussion or branch into other conversations related to the session theme. A complete list of the discussion questions that were distributed to participants in advance of the summit is included in the appendix of this report.

(1) **Stories that Speak** focused on the value of coastal geospatial data in Alaska. This session allowed participants to meet one another and to identify specific, contemporary stories that illustrate the real-world need for coastal geospatial data products.
(2) **Technologies and Specifications** explored the potential for testing and using emerging technologies in Alaska in conjunction with technology-neutral discussions about data quality specifications and requirements such as refresh rates and tide coordination.
(3) **Coordination and Collaboration** concentrated on strategies for working between agencies and across sectors, strategies for working with existing State and Federal coordination programs, and required next steps to achieve coastal mapping objectives.

IV. DISCUSSION SESSION HIGHLIGHTS

Selected highlights from each of the three discussion sessions are described below. These excerpts are representative of the broad scope of topics and ideas that were exchanged in the discussion portion of the summit; a comprehensive digest compiled from notes taken by each group is available in the appendix of this report.

1. STORIES THAT SPEAK

This theme centered on stories in which geospatial data, or lack of geospatial data, makes an impact on real life situations. Most group conversations focused on specific instances, locations or stories that reflect the benefits of good geospatial data and examples of harm or loss attributed to a lack of data. In the complete digest, content is organized into the following categories:

- Successes
- Examples of Under-Mapped Area Issues
- Applied Data Uses
- Known Barriers
- Strategies for Success
- Opportunities for Success

A. SUCCESSES

Successful geospatial data acquisition projects occur regularly in Alaska, ranging in size from Statewide IfSAR collection to small aerial Imagery in Anchorage community parks. During the summit, the Yukon-Kuskokwim Lidar data collection was highlighted as a successful project funded by a variety of partners.

3DEP LIDAR COLLECTION ON THE YUKON-KUSKOKWIM DELTA

The collaborative 2016 Yukon-Kuskokwim area lidar project is addressed in multiple sections of this report.

Lidar data collection across a large swath of the coastal zone was conducted through a **USGS 3DEP** contract with Woolpert and Kodiak Mapping with regional partners (**USFWS, AOOS, NRCS, FEMA, AKDNR**) represented through the **Western Alaska LCC**. The data are publicly available through the **DGGS Elevation Data Portal** (http://elevation.alaska.gov) and will also be available on the USGS site soon.

These data benefit multiple applications, including change studies, resource management, trail planning, and assistance in the potential move of the community of Newtok to its new location Mertarvik.

EMMONAK

Lidar data were used near Emmonak for a channel migration study conducted by **DGGS** and funded by the **Federal Emergency Management Agency (FEMA) Cooperative Technical Partners** program. The study produced rates of shoreline change that show where channel migration has impacted the area surrounding Emmonak since 1950. Shoreline positions were also projected to 2020, 2025, and 2030 for near-term community and state planning. The written report is available at http://doi.org/10.14509/29858 and data can be viewed in the Alaska Shoreline Change Tool http://maps.dggs.alaska.gov/shoreline/.

Figure 2: Emmonak delineated shorelines, including shoreline derived from 2016 Lidar data. Image courtesy of J. Overbeck, State of Alaska DGGS.

MERTARVIK

The **Alaska Native Tribal Health Consortium** and the **Denali Commission** were early users of the lidar data in order to assist the community of Newtok, an Alaska Native village experiencing rapid erosion. Data were used for siting, community planning, and engineering design of Mertarvik, for community relocation.

Figure 3: Heavy equipment loading the last seasonal barge in Mertarvik, after completion of the beach road to the barge landing. Photo taken by Robert Lundell, Alaska Department of Transportation, 2009.

HOOPER BAY

Near Hooper Bay, lidar data were compared to 2015 photogrammetric digital surface models (DSMs) in a research poster presented by **DGGS** at the **2016 American Geophysical Union Fall Meeting**. Differences in the two elevation datasets were compared based on vegetation and surface type. This type of research and comparison leads to greater understanding of how elevation from photogrammetric DSMs can be utilized.

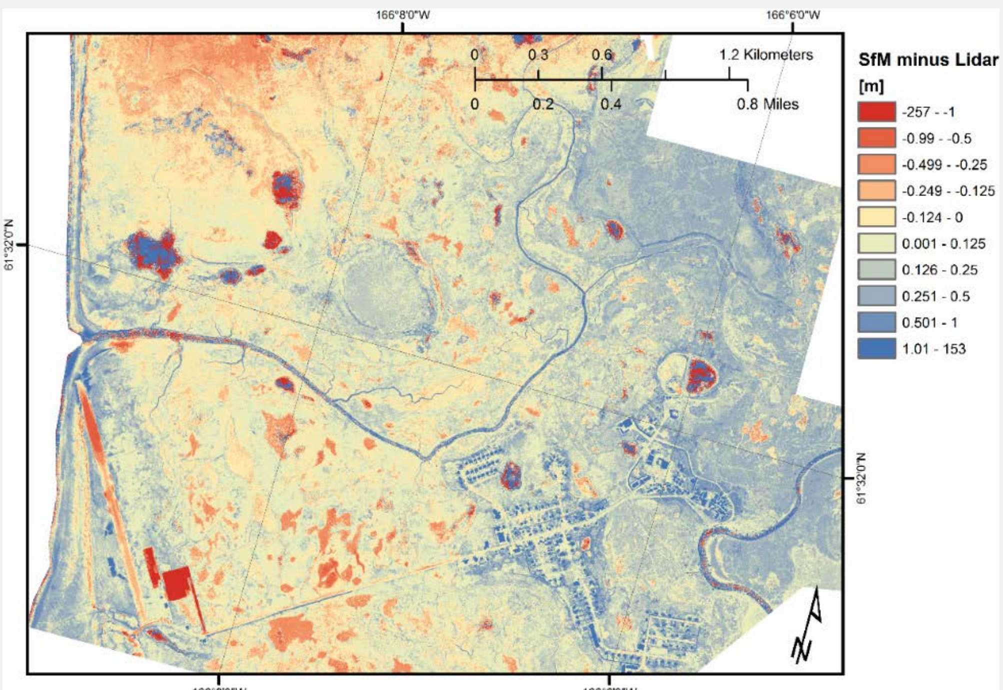

Figure 4: Difference in photogrammetrically-derived (SfM; 2015) and Lidar (2016) elevations near Hooper Bay, AK. Image courtesy of J. Overbeck, State of Alaska DGGS.

B. EXAMPLES OF UNDER-MAPPED AREA ISSUES: MARITIME OPERATIONS

The safe navigation of maritime vessels is dependent on accurate nautical charts created from modern bathymetry. In Alaska, however, many charts need updating. This is particularly true in the Arctic region where some soundings date back to the work of Captain Cook in the 18th century.

WESTERN ALASKA BARGE OPERATIONS
As most communities in Western Alaska are not connected to the road system, nearly all goods and supplies, including fuel, are distributed by barges. Due to dynamic shoaling on coastal deltas, rivers, and inland lakes in Western Alaska, some vessel operators experience "bump and go" groundings while transiting these poorly charted waterways. As the sandbars in these regions are soft and forgiving, the U.S. Coast Guard can exclude certain groundings from the casualty reporting requirements in 46 CFR 4.05, however, the potential for any type of grounding affects operational costs in the form of delays, heavier design criteria, and additional maintenance for vessels. Delays arise from padding operational windows with extra time to account for uncertainty in water levels, deployment of smaller scouting skiffs, and waiting for favorable winds, tides, or currents.

Figure 5: Cargo barge operations on the Kuskokwim River. Photo taken by M. Kumle, 2010.

RECENT LARGE VESSEL GROUNDINGS

In contrast to the soft bottom groundings described above, two recent reported groundings referenced in the **USCG Port Access Route Study Report** (https://www.regulations.gov/document?D=USCG-2014-0941-0040) highlight the risks of navigating inadequately charted areas and are summarized below. While these incidents did not result in any pollution or injuries, considering the limited response capabilities in the region any grounding could rapidly escalate to a potentially catastrophic situation. Appendix H of the USCG Port Access Route Study analyzes USCG reported marine casualties in the Bering Sea from 2005-2016 and is included in the of this report.

- **Report Casualty #132:** In 2015, the M/V Fenica, with a draft of 27 feet, grounded near Dutch Harbor while operating in a nearshore area most recently surveyed in 1935. NOAA was able to rapidly conduct a response survey in the area using modern technology and found the shallowest depth to be 22.5 feet rather than the previously charted 31.5 feet. This discrepancy was due to the limitations of the survey equipment in use at the time, and similar discrepancies can be expected in other survey areas of this vintage.
- **Report Casualty #142:** In 2016, the oil tanker Ebony grounded near Nunivak Island while carrying 11 million gallons of fuel. The vessel's maximum draft at the time was 37.3 feet, and well within the charted depth of 54 feet. Following the grounding, examination into the source data for the area revealed an "unknown" source, indicating the data was likely part of the Alaska Purchase in 1867 and represented the best data Russia had available at the time.

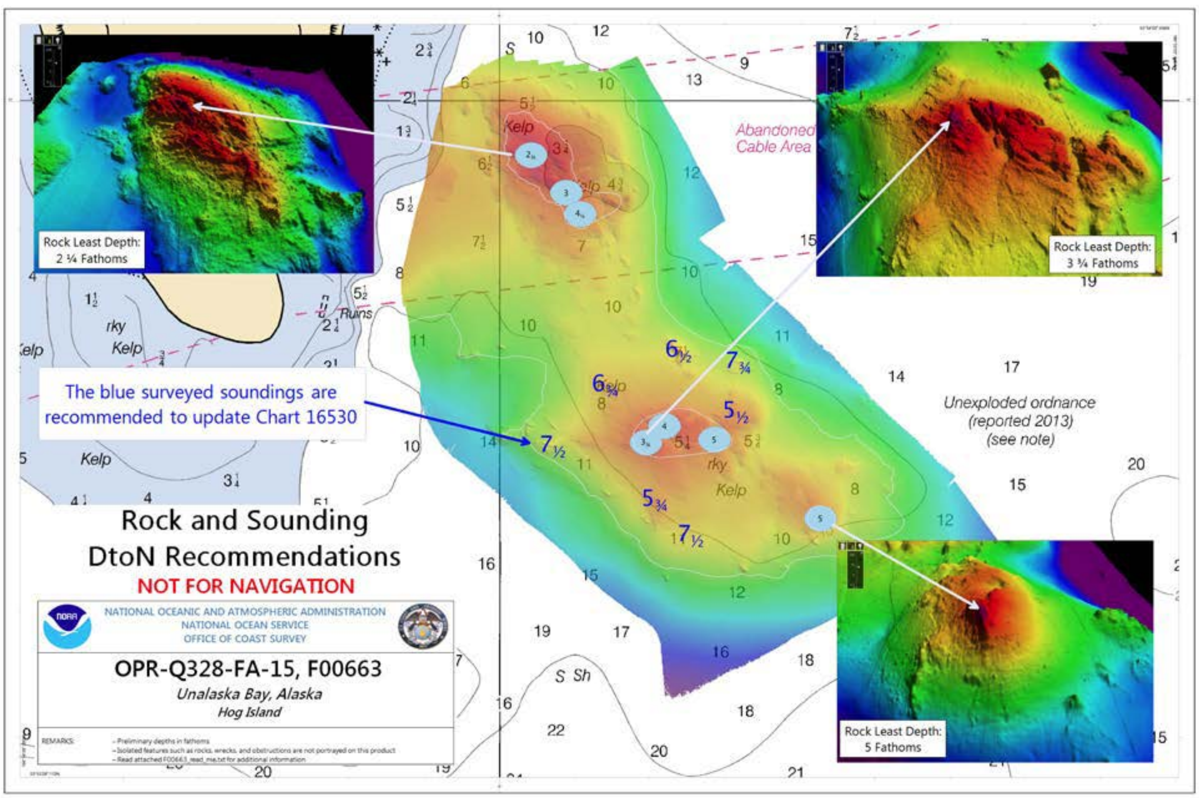

Figure 6: Example of modern multi-beam survey report finding previously uncharted dangers to navigation. From USCG Port Access Route Study Report.

LIMITED UNITED STATES COAST GUARD PRESENCE IN BRISTOL BAY

Bristol Bay is one of Alaska's most productive commercial fishing grounds, with millions of salmon harvested every year and yet this area is not patrolled regularly by the United States Coast Guard (USCG) due to a complex mix of challenges including the quality of current hydrographic data and charting information. The USCG is concerned about the safety of mariners operating in the area, and the congestion caused by a highly competitive seasonal fishery. The limited availability of soundings, tides, currents, and charting information increases the risk of operating USCG vessels in Bristol Bay, and hinders their capability to establish an enforcement presence to ensure the safety of all vessels operating in the area.

Figure 7: 2009 Egegik, Bristol Bay fishing vessels, photo credit Warner Lew, Icicle Seafoods. Note the muddy wakes from fishing in such shallow water.

C. APPLIED DATA USES: ONSHORE EXAMPLES

Moving onshore, geospatial data at the transition from sea to land is necessary for assessing coastal flood and erosion hazards, designing mitigation structures for coastal geohazards, and defining land use and ownership boundaries. As Overbeck's opening presentation stated; accurate topography/bathymetry; current and historical imagery; and vertical datums, all essential for flood and erosion mapping, forecasting, and mitigation; are not available for many communities in Western Alaska.

EROSION HAZARDS - SHISHMAREF
Coastal erosion is occurring in many Western Alaska communities with widespread consequences. Erosion is impacting community infrastructure such as buildings, schools, water treatment plants, landfills, and private homes, as well as traditional and cultural resources. Recent reductions in the duration of offshore and shorefast ice allow coastal storm water surges and waves to develop. The shorter shorefast ice season leaves coastal areas unprotected from fall and winter storms that can erode large portions of shoreline. Permafrost near the coast is especially susceptible to erosion with increased exposure to above freezing temperatures and wave action. In 2017, the community of Shishmaref (approximately 600 people) experienced a coastal storm during ice-free conditions which eroded the only access road to the landfill.  **Figure 8: Erosion at the landfill access road, photo taken by the Native Village of Shishmaref after November 2017 storm.**

FLOOD HAZARDS - GOLOVIN

Communities in western Alaska are subject to coastal flooding from storms originating in the Bering Sea. **NOAA National Weather Service (NWS)** provides coastal flood forecasts for this region. Since of the NWS began incorporating DGGS color-indexed maps for flood-vulnerable communities (http://www.dggs.alaska.gov/pubs/id/29719) into forecast decision support and forecast language has become localized in communities where maps are available. At Golovin local community leaders, the NWS, and DGGS have been using color-indexed maps to give advance notice of the timing and potential impact of flooding in the community. The community has responded by building a temporary flood berm each time a storm is forecast to exceed local elevations. The community also provides feedback on the observed flood level, so that the accuracy of the flood forecast model can be assessed.

These color-indexed maps require (1) high resolution elevation data (< 2 m ground sample distance), (2) vertical datum transformations from tidal to land-based datums (e.g. mean lower low water to NAVD88), (3) local community infrastructure names and locations, (4) elevations of past flood events, and (5) elevations of modelled flood events based on return interval. Maps are publicly available where these data exist, however this only covers 13 of 60 coastal communities.

Figure 9: Schematic of color-indexed elevations as they relate to local topography, beaches, and coastal infrastructure. Image courtesy of J. Overbeck, State of Alaska DGGS.

FLOOD HAZARDS - CAPE LISBURNE

Many areas in Alaska, especially in northern and western Alaska, are low lying and subject to inundation by coastal flooding.

The Cape Lisburne airstrip in Northwest Alaska on the **Chukchi Sea** is known to completely flood during storm events. A local survey company, JOA Surveys, LLC, was involved in the response to re-establish airport survey control benchmarks after a flood event completely covered the airstrip.

Figure 10: Cape Lisburne airstrip during flood event in 2002 or 2003, photo courtesy of Cape Lisburne staff. Runway light near the bow of the skiff is three feet in height.

RELOCATION PLANNING - MERTARVIK

Coastal communities are already responding to erosion by relocations, selective expansion locations, building mitigation structures, and monitoring; however, without adequate data, efforts are delayed or conducted with inadequate data which limits their resilience to future events. Due to erosion, the community of Newtok has selected to relocate to a site that is under development, Mertarvik. During site development, a barge landing was chosen and developed without collecting bathymetry. Upon completion, the site was found to be too shallow for barge traffic, and a new site was constructed. By constructing the barge landing without adequate coastal mapping, the project incurred an additional $400,000 in costs and was delayed by three months.

Beyond the economic costs of community relocations there are greater losses to culture through the loss of individuals properties and archeological sites due to erosion and/or flooding. Communities need data to sustain planning on a greater than 50-year time scale.

Figure 11: Mertarvik original barge ramp sinking in the mudflats. Photo taken in 2009 by R. Lundell, State of Alaska Department of Transportation.

2. TECHNOLOGIES & SPECIFICATIONS

This topic focused on current and emerging technologies that could be used in Alaska to fill coastal mapping data gaps. Alaska's wide range of environmental conditions and remoteness allow for the testing of technologies under a variety of extreme conditions. Technology-neutral discussions about data specifications were also a central discussion topic. Several of the topics that were most prominent in the group discussions are summarized below. In the complete digest, content is organized into the following categories:

- Specifications
- Types of Elevation Data Needed
- Data Formats and Standards Coordination
- Water Levels and Tide Coordinated Data
- Emerging Technologies
- Test Locations
- Community Needs/Priority Locations
- Refresh Rates
- Elements of the Coastal Mapping Strategy

A. NATIONAL STANDARDS

Summit participants discussed how meeting national data standards can be more expensive in Alaska than in other areas of the U.S. due to remoteness, lack of ground control, lack of water level infrastructure, and unpredictable weather patterns. Participants indicated that data use considerations should drive data quality specifications, while remaining technology-neutral. This approach will maximize the opportunity for project managers to select the most appropriate or economic approach and allow emerging technologies to compete with traditional geospatial data collection techniques. Additionally, participants recognized that tighter specifications are required in some locations due to population, area use, economics, and ecological significance.

GPS CHECKPOINT REQUIREMENTS IN REMOTE AREAS

In the Yukon-Kuskokwim lidar project summarized in the 'Stories that Speak' Section, a slight adjustment of the checkpoint specification from "regular" to "reasonable" spacing was key to this project's success and feasibility in both costs and timeline. The adjustment enabled checkpoints to be distributed in accessible areas rather than in a rigid grid pattern, thus eliminating the need for excessive helicopter use and delays arising from special access permitting. The change is estimated to have saved the project well over $100K in the final budget and significantly increased the feasibility of project completion in a single season. Data that were assessed for quality control, were not degraded from QL2 requirements and have sufficiently met stakeholder needs for all known uses.

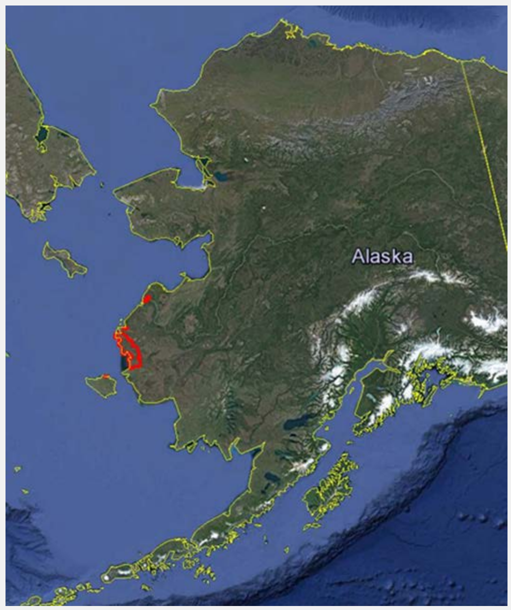

Figure 12: Footprint of 2016 Yukon-Kuskokwim Delta Lidar Project. Image courtesy of Woolpert.

ONSHORE DATA COLLECTION WINDOWS: LEAF FREE AND SNOW COVER

Standards for aerial imagery and lidar typically include seasonal stipulations such as "no snow cover" and "leaves to be absent from deciduous trees." While there are data quality justifications for these standards, the snow free and leaf free spring or fall periods in Alaska are short and collection at these times is further complicated by rapidly changing daylight hours and complex weather windows. It can be very costly to get equipment and people on site to wait for optimal conditions. While data coverage and quality may be marginally impacted, extending data collection further into shoulder seasons could reduce project costs.

B. EMERGING TECHNOLOGIES

Summit participants discussed the potential for using and testing emerging technologies in Alaska.

SATELLITE-DERIVED BATHYMETRY
Satellite-derived bathymetry (SDB) has the potential to provide shallow water bathymetric data over large coastal regions. Multiple forms of this technological approach have advanced in the past decade, however, there are still limitations in resolution, absolute vertical accuracy, and lack of effectiveness in turbid water. In 2015 NOAA created provisional Electronic Navigational Charts (ENCs) using satellite data for the turbid Yukon River and Yukon Delta, an area known for its changing shoals and coastline. The charts do not include bathymetric soundings, rather they contain shoreline and approximate shoals derived from satellite data. NOAA is aiming to update these products annually. This approach provides mariners and barges that frequent this area more up-to-date information than previously available at a fraction of the cost of a traditional ship-based sonar hydrographic survey. More information on this project can be found at https://landsat.gsfc.nasa.gov/satellite-images-are-source-for-first-of-its-kind-charts-of-alaskas-yukon-river/ and http://ccom.unh.edu/publications/yukon-river-prototype-electronic-charts-using-satellite-derived-bathymetry. Continued experimentation with SDB by NOAA and others, including evaluating new SDB technologies, experimenting with successful methodologies in different environments and comparison testing with ship-based sonar surveys may yield new options for Alaska coastal mapping.

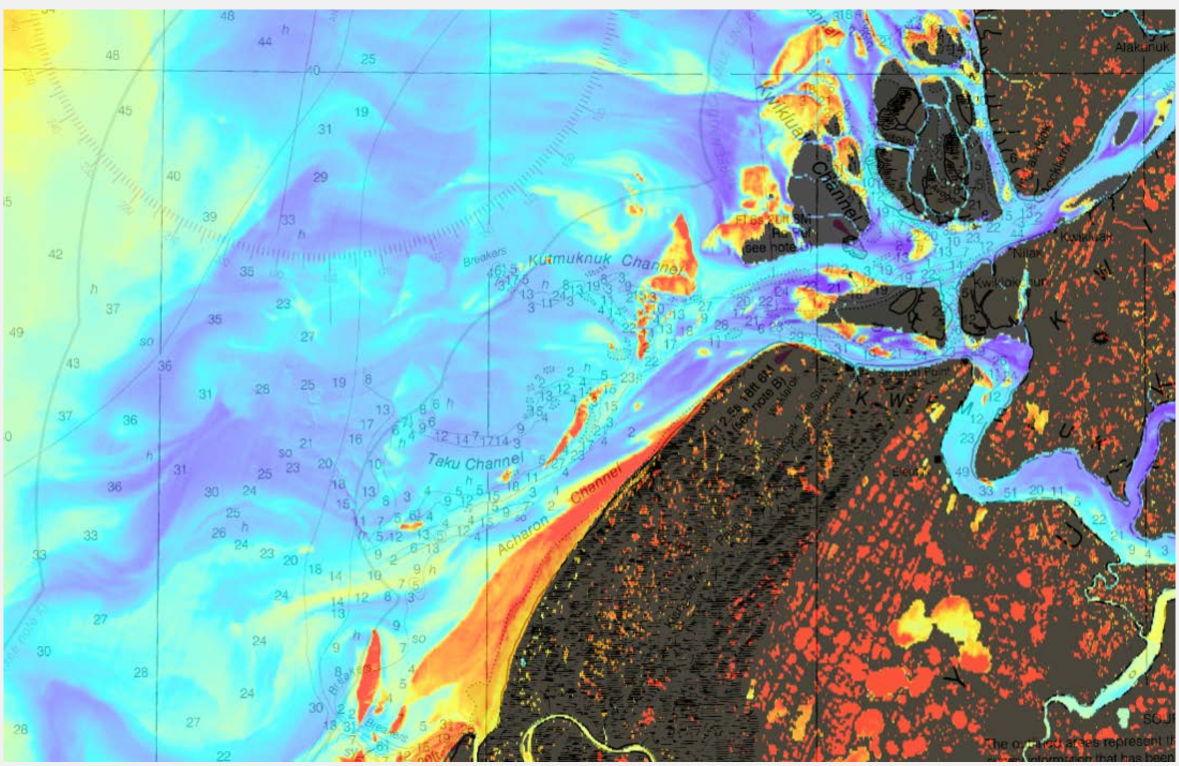

Figure 13: Experimental satellite derived bathymetry product on the Yukon Delta overlaid onto Chart 16240. Image courtesy of NOAA Coast Survey.

PHOTOGRAMMETRICALLY DERIVED DIGITAL SURFACE MODELS

Lidar is the primary technology presently used in the Continental United States (CONUS) for the collection of elevation data to support production of high resolution digital terrain models (DTMs) and DSMs. DSMs are elevation models that include above-ground features like vegetation or houses; whereas DTMs represent the bare earth.

DSMs can also be produced using modern photogrammetric techniques, such as Structure-from-Motion (SfM). DSMs generated with photogrammetry over unvegetated and undeveloped terrain, such as beaches, are equivalent to DTMs, and DTM algorithms may be used on photogrammetric point clouds to remove large structures from built environments. However, photogrammetric point clouds do not possess the same multi-return characteristics of lidar point clouds in vegetated areas or where small discrete features like power lines are present.

SfM is becoming a popular and relatively inexpensive method for producing DSMs for projects when lidar is cost-prohibitive due to project size, location or other factors. An increasing number of projects in Alaska are utilizing this methodology, but to ensure the data can be correctly geospatially referenced and have multiple uses, accuracy and data quality should be recorded by the data producer in a standard fashion. Existing elevation data standards, such as those used for lidar and IfSAR, are not directly transferable and could be modernized. Participants brainstormed methods to better communicate data quality/accuracy by separating elevation datasets into categories based on how they were collected, when they were served to the public and with more consistent and descriptive metadata. It was noted that without adequate metadata and outreach, users accustomed to elevation data from lidar may misinterpret this data type and its associated use limitations, such as reduced potential for descriptive point cloud classification.

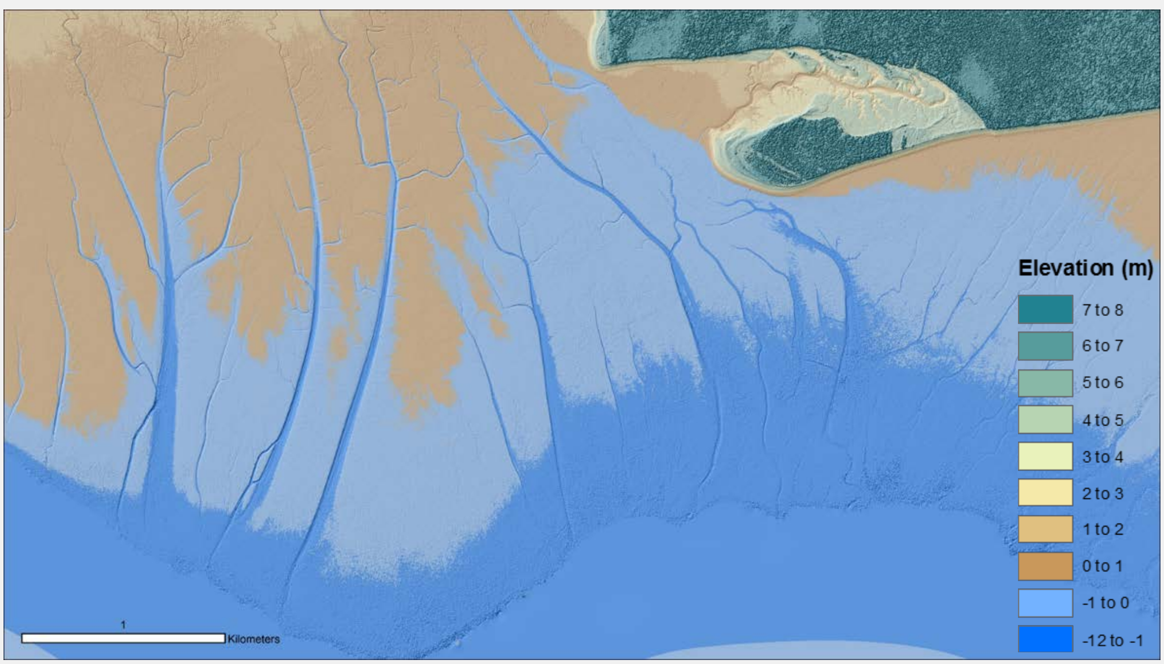

Figure 14: SfM elevation map of Cook Inlet tidal mudflat area. Image courtesy of T. Jones, National Park Service.

DRONES
The use of drones for mapping has been increasing as both platforms and mapping technologies evolve. Drones have advantages over traditional methods (manned ships or aircraft) including being more portable for use in remote areas and more cost effective for smaller areas that require high resolution data. There is also the potential to train local or regional personnel in the operation of drones for areas that need frequent re-survey. In these cases, resulting product accuracy can be controlled by establishing local control checkpoints which are included in each data collection effort. Battery life limitations are especially challenging for drone use in Alaska during very cold temperatures. Airspace restrictions, including around national parks and protected areas, further limit some aerial drone use. Projects using drones must still be evaluated for cost efficiency against the ready availability of marine vessels and aircraft in Alaska which often make traditional collection platforms more affordable. As drones establish their place in the mapping toolbox, we anticipate Alaska serving as an important test-bed; for example, the lack of man-made features in Alaska's Aleutian Islands served as a useful NASA field site for developing vision-based localization and navigation algorithms for Unmanned Aerial Vehicles.

3. COORDINATION & COLLABORATION

This topic focused on the opportunities to enhance coordination and collaboration across government agencies and with non-government entities. Several of the topics that were most prominent in the group discussions are summarized below. In the complete digest, content is organized into the following categories:

- Coordination
- Communications
- Working with the Private Sector
- Crowdsourcing Data
- Potential Leveraging of Coastal Mapping Activities for Other States
- Next Steps/Road Map Strategy Document
- 3D Nation Survey

A. SUCCESSFUL DATA ACQUISITION PROGRAM EXAMPLES

Participants discussed different programs and program models which have been successful for data acquisition in Alaska.

3DEP
The 3DEP program was noted as a highly successful model in Alaska due to the initial cost-benefit analysis, economy of scale, the Federal USGS matching funds for selected projects, and the interagency leadership of the Alaska Mapping Executive Council. 3DEP has resulted in the near-completion of replacing decades old, 60-meter resolution elevation data with contemporary 5-meter resolution IfSAR data statewide through ongoing and opportunistic partnerships. Areas still in need of data acquisition include Kodiak, areas around the Yukon-Kuskokwim Delta, parts of the Alaska Peninsula, the Aleutians and other remote islands. More recently, 3DEP has also supported some lidar projects around the state. The focus on identifying as many partners as prudent for any particular project has resulted in larger areas of data acquisition reducing the relative cost of project mobilization and decreasing the data acquisition cost per area. Matching funds from the USGS are a key incentive for partners to work with the 3DEP program. Additionally, the 3DEP competition period enables advanced project planning, which greatly enhances project success within Alaska's limited field season. Lastly, having a dedicated USGS liaison in Alaska familiar with local and federal agencies promotes program participation through personal connections with interested parties, ensuring the continued success of this program.

SHOREZONE
Another program with success garnering ongoing financial support specifically related to coastal mapping is ShoreZone. Like the 3DEP program, ShoreZone has been flexible enough to accept funds from a variety of partners. The flexibility to receive funds as they become available and more independently plan data acquisition missions based on an overarching plan to cover the state, has proven to be a successful model. Public availability of data and name recognition also encourages participation and funding of new acquisitions through this program.

B. CROWDSOURCING DATA

Participants discussed the potential for crowdsourcing and community-led projects as mapping technologies become more portable and digital connectivity increases. Most importantly, for crowdsourced geospatial data to be usable by others, it needs to adhere to base standards and undergo some type of control. Implementing methods or programs to provide data acquisition and metadata documentation guidelines, provide standardized quality control on datasets, and the identification of a data hosting platform are keys to successful crowdsourced data integration. Additionally, community relationships and reliable communication must be established and maintained for crowdsourcing data acquisition programs to be successful. In one example Olex, a company out of Norway, has created a model for crowdsourcing bathymetric data collection. Olex operates as a global bathymetry database in which users submit their data and in exchange they gain access to the contents of the shared database. For this type of system to be successful it must have significant consumer participation, standardized equipment, a tested methodology, and a desirable data-hosting service.

C. ACCESS, QUALITY CONTROL, UNIFORMITY AND METADATA

Summit participants discussed how data sharing can be enhanced with published guidelines, standardized access, quality control, and data uniformity. Published guidelines for data acquisition that cross federal and state agencies can make it easier for project collaboration and the collection of additional items that increase data applications. Many summit participants said that a regulated data access point with data standards and quality control measures would be useful for evaluating where data is already available. Reliability and consistency in data format, something often set at the contracting phase, was also cited as important, particularly for authoritative data. Lastly, standardized quality control measures for metadata will greatly enhance the usability and application of datasets.

ELEVATION DATA PORTAL
The State of Alaska Elevation Portal (https://elevation.alaska.gov/) is an example of data hosting specific to Alaska.

ALASKA GEOSPATIAL COUNCIL GEOPORTAL
The AGC Portal technical working group is tasked with developing a geoportal that will provide a statewide data access point for geospatial data. The geoportal will serve as a catalog for geospatial data holdings throughout the state, providing links to current datasets hosted by various agencies, as well as, hosting capabilities for data not hosted elsewhere. Datasets will include elevation, imagery, and many other thematic layers indexed and searchable with a standardized metadata library for easy data discovery and access. For updated information on the geoportal and to learn more about the AGC Portal technical working group, visit the AGC website: http://agc.dnr.alaska.gov/geoportal.html.

V. CONCLUSION

The 2018 Alaska Coastal Mapping Summit met all stated objectives of the meeting through highly-targeted presentations with numerous updates and in-depth discussions of coastal mapping in Alaska that laid the groundwork for the next step of developing a Coastal Mapping Strategic Plan under the guidance of the new Coastal Mapping Strategist.

The tables below contain notable feedback from the 2016 Alaska Coastal Mapping Summit, the corresponding actions implemented to improve the 2018 summit, and solicited participant feedback from the 2018 summit.

Table 1: 2016 summit participant feedback and corresponding 2018 summit actions.

2016 Suggestions	2018 Implementation Actions
Keep presentations short, less than 15 min.	Most talks were limited to 7 minutes, with the exceptions of the keynote speaker in the morning and the closing remarks speaker.
Provide coffee and snacks and social mixer after the event	Private industry partners were successfully solicited for food, beverage, and social mixer sponsorships.
Make agenda available in advance	Draft agenda emailed to registrants nearly two weeks before summit. Updated agenda emailed before the conference.
Have presentations in the morning and discussions in the afternoon	Implemented.
Provide discussion session questions in advance	Discussion session questions emailed to registrants nearly two weeks before summit.
Pre-designate discussion group moderators/notetakers	Online registration included a question for in-person participants to volunteer to be a group discussion moderator/notetaker. Selected moderators/notetakers were emailed instructions ahead of the summit.
Keep discussion groups small, 8-10 people	Registrants were assigned to groups ahead of the summit that dispersed participants from the same agencies/companies into different groups. During the summit, groups were combined to maintain adequate group size and account for participants who were not able to attend the entire summit.
Longer discussion periods	Discussion periods were scheduled for one hour, inclusive of a short (5-10 min) topic introduction and a short (10 min) large group discussion that shared one or two notable items from willing groups with the entire audience.
More specific questions for discussion periods	Discussion sessions were organized by topic and a list of 7-8 specific questions were formulated for each. Groups were not required to address all questions and were free to select a few questions and/or were encouraged to discuss additional related questions as the group deemed fit. The goal was to provide adequate brain teaser questions while allowing for discussions to evolve naturally. Additionally, during summit planning, some interested parties from past summits were solicited for discussion topics and questions. Lastly, online summit registration asked participants to enter any questions or topics they wanted included in the discussion sessions.
Compile a summit report with executive summary to sustain and facilitate continued discussion.	This summit report generation was included in summit budget/planning.

Table 2: 2018 summit participant feedback.

2018 Summit Feedback
Positive Feedback: • The location was perfect. • The agenda/schedule were kept on track the entire time. • The distribution of lightning rounds and breakout sessions worked well, as it kept participants more engaged. • There was a good mix of user perspectives and technology overviews. • Selection of beverages and healthy snacks was good.
Areas for Improvements: • Ask group leaders to bring laptops or tablets to record notes and email notes to summit organizers. • Put a short break between each 'round' of lightning talks. • Host an "icebreaker" social event the night before the conference. • Each summit should also report on the previous year's efforts.

Next Steps Recommendations:
• Formal in-state stakeholder survey
  o Identify user groups of coastal datasets
  o Document how these groups use coastal datasets
  o Determine where and at what refresh rate data is most urgently needed
  o Provide clarity on available budgets in order to develop funding framework
• Technology focused survey to data providers
  o Understand what technologies are available and under development
  o Determine advantages/disadvantages of each
• Develop working groups for
  o Acquisition needs & opportunities
  o Data availability for use in coastal planning & resiliency
• Create timelines and completion dates that are assigned to identified goals/actions discussed during the summit, to keep the momentum going.
• Make this summit an annual event.

VI. CRITICAL ELEMENTS FOR MOVING FORWARD

Over the remainder of 2018, several elements and milestones exist to keep the coastal mapping agenda moving forward. Upcoming activity will focus on the development of specific actions to support the development of the Coastal Mapping Strategic Plan; these concrete next steps will be based on the recommendations from summit participants.

1. ENCOURAGE RIGOROUS RESPONSE TO 3D NATION SURVEY

3D Nation Survey, sponsored by the National Oceanic and Atmospheric Administration (NOAA) Office of Coast Survey (OCS) and the U.S. Geological Survey (USGS), will be coming out soon. Responses from identified Alaska native, state, and local agencies will be solicited and compiled to access Alaska's identified need and desired base specifications for seamless topographic and bathymetric data that are in line with demonstrated business uses and associated benefits. Additional federal, not-for-profit, and private sector survey participants will also be selected at the national level. Additional information is available at:

https://my.usgs.gov/confluence/display/3DNationStudy/3D+Nation+Requirements+and+Benefits+Study

2. SUPPORT COASTAL MAPPING STRATEGIST POSITION

The Coastal Mapping Strategist is a part time, term position that will take the lead role in preparing the Coastal Mapping Strategic Plan; this position is presently funded to remain active until the end of the calendar year. In the coming months, the strategist will work to define and execute the actions necessary to act upon the recommendations from summit participants. Stakeholders are encouraged to remain in contact with, continue to provide input and feedback to, and respond to questions from the Coastal Mapping Strategist to ensure that a comprehensive strategy is developed.

3. COORDINATE WITH OTHER REGIONS

Other states and regions are also prioritizing coastal mapping and developing strategic data acquisition plans independently and in coordination with the 3D Nation survey. Communications and coordination with other states such as Florida, which is at approximately the same stage in the process as Alaska, is anticipated to be particularly beneficial to both states.

4. REPORT AT UPCOMING FEDERAL MEETINGS IN ALASKA

Participation and presentation of the summit outcomes at several upcoming federal meetings will raise awareness about Alaska's specific data needs and the increased in-state coordination now focused on coastal mapping.

A. NOAA HYDROGRAPHIC SERVICE REVIEW PANEL (HSRP)

NOAA’s Hydrographic Service Review Panel (HSRP) will hold a meeting on August 28-30, 2018 (2.5 days) in Juneau, AK. This external panel advises the NOAA Administrator on matters pertaining to safe, efficient and environmentally sound maritime transportation and navigation products, data, and services. The HSRP also has a working group on "Emerging Arctic Priorities." Among probable discussion at the Summer 2018 meeting will be items pertaining to the Arctic maritime frontier, Alaska observational data gaps, and the 3D Nation Survey. The meeting will be open to the public and public comments are encouraged in person or in writing in advance of the meeting. There will be a webinar for remote attendees where pre-registration is requested at https://attendee.gotowebinar.com/register/3898703691780313857. Additional information will be available at: https://www.nauticalcharts.noaa.gov/hsrp/hsrp.htm.

B. ALASKA MAPPING EXECUTIVE COMMITTEE (AMEC)

In August 2018, the Alaska Mapping Executive Committee (AMEC) will meet in closed session the same week as the HSRP in Juneau, Alaska. AMEC Members are executive level managers from nearly two dozen federal and state agencies. Members serve to coordinate critical mapping activities in Alaska and collaborate with the AGC to provide accurate, current and accessible statewide base map products. AMEC has worked in the past to secure financial resources to complete Alaska topographic mapping, and a newly broadened tactical plan now supports the expansion of this effort to compile coastal and nearshore mapping requirements and ongoing activities in Alaska by location, quality-level, partner, capacity, feasibility, and refresh-rate. These will be used to develop a long-term strategy for prioritizing coastal mapping activities and acquiring high-resolution lidar elevation datasets for select areas. AMEC forms yearly plans for data acquisition in Alaska.

5. DEVELOP COASTAL MAPPING STRATEGIC PLAN

Most importantly, the development of a feasible statewide coastal mapping strategy will be key to defining shared goals, improving coordination, and gaining support and funds. The Coastal Mapping Strategist, supported through AOOS, NOAA and AKDNR, will be primarily responsible for strategic plan development. The involvement of as many stakeholders as possible (AGC, AMEC, federal and state liaisons, native corporations, NGOs, the private sector, and academia) is an important goal in ensuring that the defined strategy reflects all user needs. Recommendations from summit participants will be used to define next steps for making this coordination occur.

The strategy will include bathymetry, terrestrial elevation data, and imagery priorities extending from approximately 30m in water depth to land subject to flooding within 1 km of tidally influenced water (an initial focus zone that may be further refined as the plan develops). This long-term strategy is intended to present an achievable, statewide roadmap for data collection over the next ten years with inclusion of additional considerations such as defining refresh rates according to rate of change and/or land use. A selective or tiered data specification matrix will be technology neutral, customized to specific physical environments, and reflective of current and future area uses. Recommended mapping activities will benefit a variety of user groups in the spirit of “map once, use many times”. The strategy will outline specific recommendations and next step action items. Lastly, the document will be a ‘living document’ to facilitate updates as Alaska coastal mapping needs evolve.

APPENDIX

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