2022 Alaska Coastal and Ocean Mapping Summit Report

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In partnership with
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Executive Summary

Recognizing the value of coastal and ocean mapping data and products to enhance our future prosperity, health, and national security, on November 19, 2019, a Presidential Memorandum titled "Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore of Alaska" was issued. The memorandum directed federal agencies to prepare a national strategy for mapping, exploring, and characterizing the Exclusive Economic Zone of the United States (U.S. EEZ) and prepare a strategy for mapping the Arctic and Sub-Arctic Shoreline and Nearshore of Alaska. These directives led to the following two strategies and associated implementation plans in 2020-2021:

1. National Strategy for Mapping, Exploring, and Characterizing the U.S. Exclusive Economic Zone (NOMEC)

2. A Strategy for Mapping the Arctic and Sub-Arctic Shoreline and Nearshore of Alaska (ACMS)

On November 16 and 17, 2022, the 2022 Alaska Coastal and Ocean Mapping Summit convened virtually to discuss the latest efforts to advance ACMS and NOMEC. Approximately 280 people registered for the mapping summit, 185 people attended, and 57 people presented. Participants represented federal, tribal, state, and local governments; native corporations; non-governmental organizations; academia; and private sector organizations.

The summit was the fifth in a series going back to 2016. For 2022, the summit presenters spoke about Alaska mapping updates and plans; collaboration methods; technology advancements; and potential opportunities to progress our mapping goals.

This summary report is organized by day and concludes with a section of key takeaways to capture potential next steps. While detailed further in this report, some themes associated with the key takeaways include:

- Coastal and ocean mapping continues to be important;
- Funding is limited relative to the scope of work;
- Mapping and data sharing involving multiple stakeholders are key;
- User knowledge about data, processing, and products could be improved; and
- Collaborators are sometimes confused by numerous planning tools that do not agree, demonstrating the need for centralized data storage and strong coordination.

The appendices in this report include an abbreviations and acronyms list, agenda, polling results, and compilation of helpful web links that were shared during the summit.

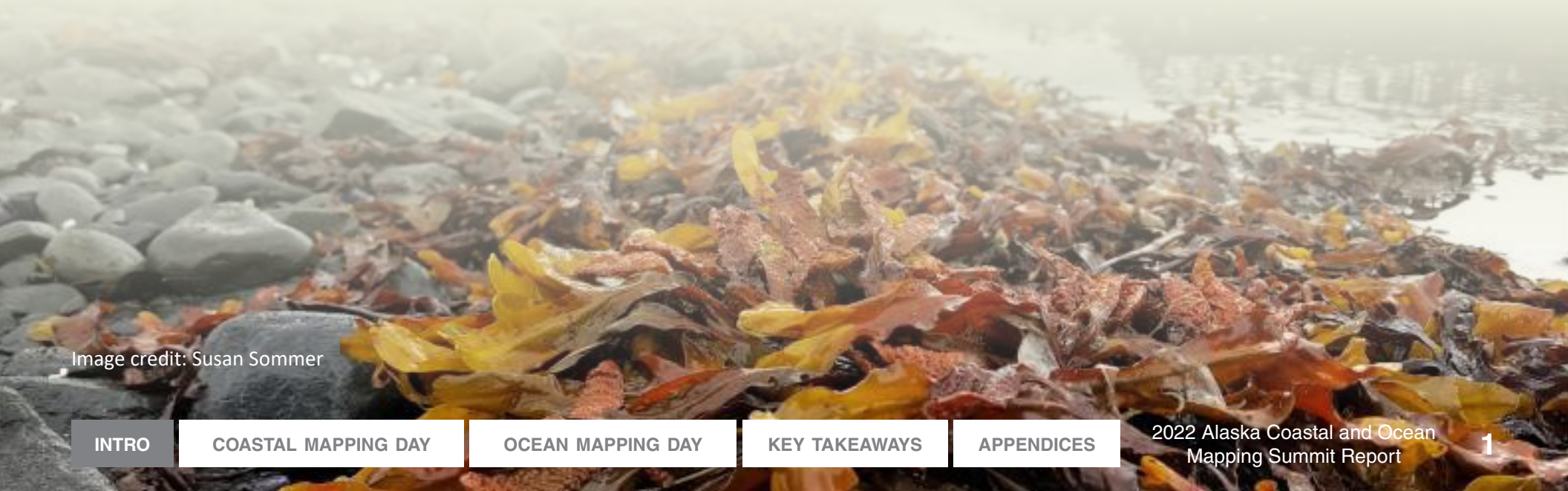


Image credit: Susan Sommer

Summit Format and Objectives

The Alaska Coastal and Ocean Mapping Summit was held virtually over two days on November 16-17, 2022. The event was Alaska's fifth mapping summit and focused on the latest efforts to advance ACMS and NOMEC.

Day 1 focused on the ACMS and associated implementation plan. The day opened with an inspirational talk about Florida's Coastal Mapping Program. The agenda for the coastal day included a series of panels covering Alaska Mapping Executive Committee-Coastal Subcommittee agency mapping updates; 2022 Typhoon Merbok efforts; the latest in airborne and satellite mapping technology developments; and the path forward to progress the ACMS.

Day 2 focused on the NOMEC Strategy and associated implementation plan. The day opened with an inspirational talk about Canada's Ocean Protection Plan. The agenda for the ocean day included a series of panels covering Seascape Alaska mapping updates; mapping vessels of opportunity; data, products, and processing; and collaboration and planning. Participants were asked a series of poll questions throughout the day.

This report is organized by day and concludes with a section of key takeaways to capture potential next steps. The appendices include an abbreviations and acronyms list, agenda, polling results, and compilation of helpful web links that were shared during the summit.

The related slides and pre-recorded videos can be found at https://agc-coastal-soa-dnr.hub.arcgis.com/pages/aksummit and https://iocm.noaa.gov/projects/regional-activities.html#Alaska.

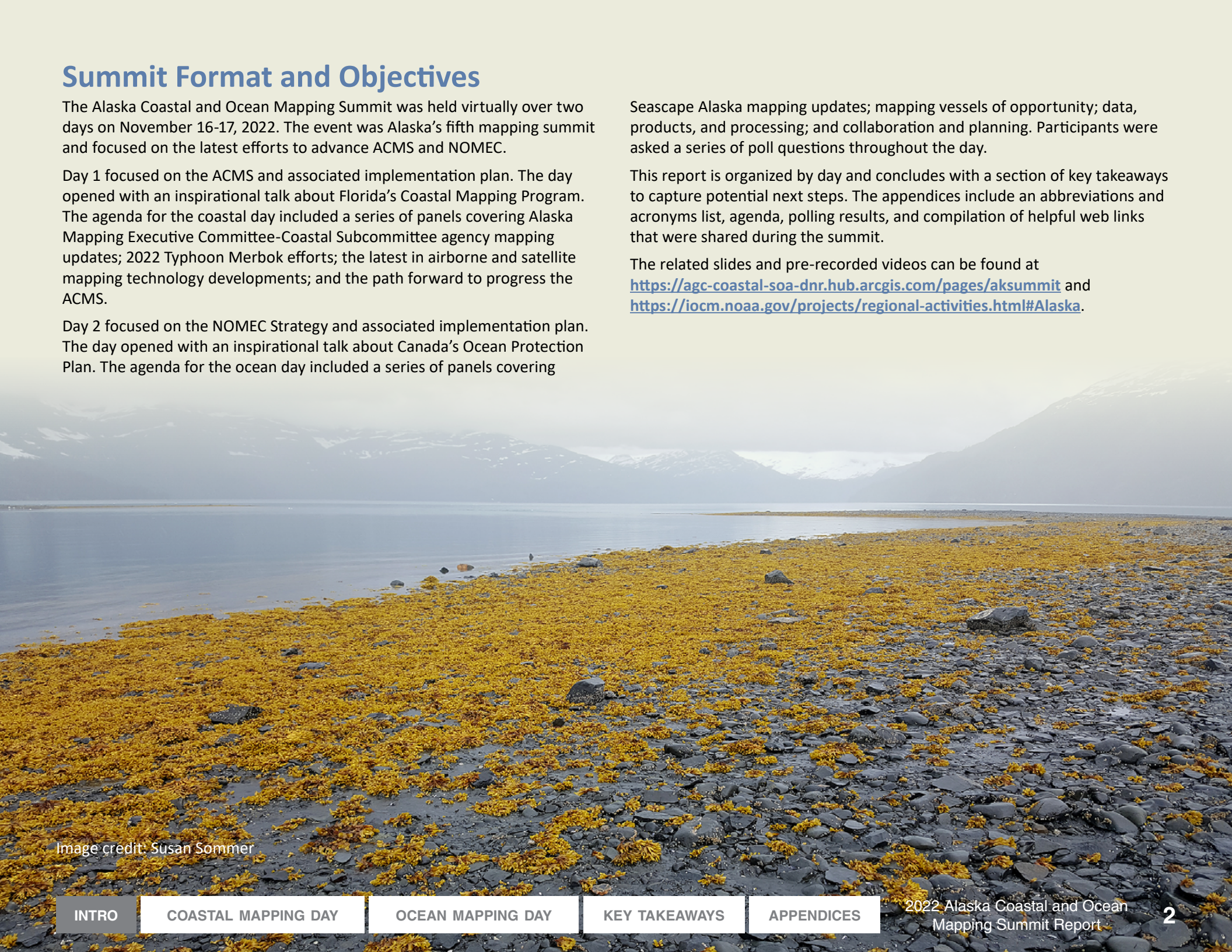


Image credit: Susan Sommer

Coastal Mapping Day

The Summit began with Nadine Doiron, NOAA Digital Coast Fellow assigned to the Alaska Geospatial Office (AGO), welcoming participants and introducing opening remarks from U.S. Senator Dan Sullivan. Dr. Rob Thieler, Director of the U.S. Geological Survey (USGS) Woods Hole Coastal and Marine Science Center and co-chair of the NOMEC Council, delivered a welcome address. Dr. Thieler spoke of the shared goals of the ACMS and NOMEC Strategy – both focused on achieving comprehensive mapping for the coastal, nearshore, and offshore areas of Alaska in support of various functions, including coastal and ocean hazards analysis. He described how the NOMEC Council and the Alaska Mapping Executive Committee-Coastal Subcommittee (AMEC-CS) collaborate to deliver equitable access to current and accurate mapping data.

Keynote – Alaska Geospatial Council Update

Dr. Leslie Jones, Geospatial Information Officer for the Alaska Geospatial Office (AGO) and AMEC-CS co-chair, spoke about AGO's goals and initiatives. The AGO develops Alaska's spatial data infrastructure and provides coordination and leadership through the Alaska Geospatial Council (AGC), an independent volunteer-based advisory council, where all stakeholders can join coastal and ocean mapping activities to properly build a complete and sustainable spatial data infrastructure for Alaska and the Nation. Alongside the AMEC-CS, the AGC is the co-lead for some of the goals and objectives within the ACMS Implementation Plan, including leveraging mapping technology innovation and promoting widespread stakeholder engagement. Strong regional and local coordination in Alaska is key to achieving these goals. Within the AGC, there are 10 technical working groups, which serve as diverse stakeholder pathways for engagement.

A priority of the ACMS Implementation Plan is the development of Statewide Vertical Datum (VDatum). Statewide VDatum is imperative for the accurate collection and use of geospatial data along the coast and in applications such as flood and sea level inundation mapping, the engineering and design of coastal protection projects, and infrastructure investments. VDatum in Alaska minimally requires tidal datum determination and associated geodetic observations at 40 priority gauge sites as well as ingestion of these data into the NOAA tides and currents database. Additionally, GNSS observations on tidal benchmarks, shoreline delineation and nearshore bathymetry are initial inputs in model development for statewide modeling of sea surface topography and tidal datum grids for public integration into VDatum tools. VDatum in Alaska is presently proceeding at a steady rate of completion in 2028. With the recent earmark directed to the AGO through NOAA's National Geodetic Survey (NGS), the AGO will fund the remaining 26-gauge sites to advance the delivery of Statewide VDatum. With the collaborative efforts of AGO and NOAA, the completion year will advance to 2024.

The AGO is also supporting a lidar mapping project for underserved and threatened communities, funded through the Federal Emergency Management Agency (FEMA). This project will collect topographic lidar data across a minimum of 19 communities previously identified as environmentally threatened communities in the 2019 Statewide Threat Assessment. These are interior, riverine communities that do not have previously collected lidar or baseline data for monitoring change. Lidar will also be collected over 7 communities with levees, providing critical data to support the evaluation of Alaska levee conditions along the coastline.

Keynote – Florida Coastal Mapping Program

Cheryl Hapke, from the University of Southern Florida, and Nicole Raineault, from the Florida Institute of Oceanography, provided an overview of the Florida Coastal Mapping Program (FCMaP).

FCMaP is a coordinating body of Federal and State agencies and institutions. It promotes and facilitates the collection and dissemination of Florida coastal seafloor data to fill priority areas and gaps within 10 years. This program benefits aquaculture, environment, tourism, research, safety, fisheries, energy, and sand resources.

FCMaP formed in 2017 and began by compiling an inventory of existing coastal seafloor mapping data and populating a portal with footprints and metadata. In 2018, FCMaP held its first stakeholder workshop, which led to the decision to undertake a statewide prioritization study. An online participatory GIS tool was developed and five regional workshops were held around Florida. In 2020, FCMaP created an Esri Hub site to showcase the inventory and prioritization results via an accessible story map. In 2021, the Florida Legislature awarded $100M to the Florida Department of Environmental Protection (FDEP) for seafloor mapping. FDEP is planning to map first with topobathy lidar and then use multibeam echosounders to map the remaining areas. At this time, no mapping initiatives have begun.

Looking ahead, FCMaP will be holding its annual summit this year and will hire a program coordinator to aid in carrying out the strategic plan including increased community engagement and coordination. Summit topics will

include mapping status and mapping plans, including the state initiative, and feature discussions about crowdsourced bathymetry, deep-water mapping, and storm response.

Questions

To Cheryl Hapke – Thank you for the presentation, it's great to see the efforts between AK and FL side-by-side. I'd like to know whether and how the $100M investment from the State of Florida is being leveraged? And whether there are any other entities contributing mapping dollars in partnership?
We had a lot of interest in our stakeholder group, including the larger mapping companies. These mapping vendors really championed this idea and advocated heavily, in simple terms, about the importance of this effort to our elected officials in Tallahassee. So it was really their lobbyists who ultimately led to this funding success.

To Cheryl Hapke – It's great to see all this progress in Florida. You didn't speak about how the $100M was added to the state budget. Can you talk about that? Seems like there must have been a charismatic champion!
Multiple charismatic champions were certainly very helpful!

SESSION 1: Coastal Subcommittee Agency Mapping Updates

Within the session on AMEC-CS agency mapping updates, we heard from seven speakers who spoke about the past year, next year's plans, and future opportunities for mapping in Alaska using airborne and satellite-based technologies.

NOAA Office for Coastal Management

Jacquelyn Overbeck, Alaska Regional Geospatial Coordinator at NOAA's Office for Coastal Management (OCM), serves as the technical advisor on baseline coastal mapping, geospatial data for coastal management, and Digital Coast. Jaci also facilitates access to OCM services and engages with stakeholders on coastal management geospatial needs, including coordinating post-Typhoon Merbok data collection.

OCM is updating high-resolution land cover mapping data across the Nation, plus snow and ice for Alaska. OCM will produce a 1-m resolution product of Alaska for local, tribal, municipal, regional, state, and federal governments. Collaborations with NOAA and the AGO are focused on extracting building footprints for the entire state.

NOAA's Digital Coast hosts data, tools, and training to help communities address coastal issues. It contains a data access viewer for lidar and imagery from the Alaska coastal mapping activities. Digital Coast also offers training on how to access and use the data. Work is underway to expand the utility of Digital Coast for Alaskans.

OCM also operates the Coastal Geospatial Services contract vehicle, which can assist with lidar and imagery data acquisition, among many other things.

NOAA is co-leading a project called "Expanding and Connecting Tribal-Led Climate Change Capacity to Serve Indigenous Community Needs in Alaska," which will establish a director of Tribal climate change initiatives position at the Alaska Native Tribal Health Consortium (ANTHC). This effort will assess adaptation activities in Alaska, formulate and launch an Alaska Tribal Climate Change Advisory Group, and lead Tribal review and publication of Unmet Needs of Environmentally Threatened Alaska Native Villages report.

State of Alaska Mapping Updates

Autumn Poisson, from the Alaska Division of Geological and Geophysical Surveys (DGGS) Coastal Hazards Program, gave several updates.

With the Alaska Division of Mining, Land, and Water (DMLW) and USGS, DGGS supported Typhoon Merbok response efforts by collecting high water marks, coastal profile measurements, and photographic evidence of flooding and erosion, where available. AGO has posted the imagery, and DGGS has posted survey data from the event. Additionally, DGGS is hosting a community flooding, erosion, and permafrost risk assessment tool, which shows the status of work performed by DGGS and others in each of the communities.

DGGS led field mapping in the Yukon-Kuskokwim Delta and Northwest Arctic region in Summer 2022. They collected UAS imagery/DSM, ground control points, single-beam bathymetry, historical flood points, and coastal erosion profiles, and installed/replaced water level sensors.

DGGS is involved in the National Coastal Resilience Fund funded by the National Fish and Wildlife Foundation in partnership with ANTHC. DGGS collected LiDAR data over Kwigillingok and Kipnuk. One of the major outcomes of this work is to develop flood assessments in over 30 villages. Several assessments have been published to the DGGS website.

Future DGGS plans include visiting Point Lay, Utqiagvik and Wainwright next Summer to begin community engagement and install some critical monitoring equipment, including Global Navigation Satellite System reflectometry (GNSS-R); creating additional color index maps for North Slope communities; and starting an erosion and permafrost degradation project in Kaktovik. DGGS continues to work with the Alaska Water Level Watch, which is funded by AOOS to support the National Water Level Observation Network to fill in gaps for real-time water level monitoring in western Alaska.

U.S. Geological Survey

Ann Gibbs, from the USGS Pacific Coastal and Marine Science Center (USGS-PCMSC), and Brian Wright, the USGS National Map Liaison for Alaska, provided mapping updates.

In FY22, USDA Natural Resource Conservation Service (USDA-NRCS) contracted QL2 topographic lidar for 14 Western communities utilizing the USGS Geospatial Product Service contract vehicle. Via the Alaska Mapping Initiative, USGS contracted QL1 topographic lidar data of Ketchikan, Petersburg, Sitka, Juneau, Yakutat, and Mount Edgecumbe in FY22. Ketchikan and Petersburg were acquired prior to the end of the collection season. Coordinated low tide collection is listed within the contract specifications.

USGS-PCMSC continues to orthorectify circa-1950s black and white aerial photographs and 1980s color infrared Alaska High Altitude Photography in Norton Sound using a 4-D SfM photogrammetric technique, with time as the 4th dimension. Images from the different decades are processed together resulting in co-registered imagery with improved precision compared to individually processed orthoimagery. Overall accuracy is also improved by using ground control derived from available 2015-16 Fairbanks Fodar photography or recent MAXAR satellite imagery. Regional shoreline change rate statistics for Norton Sound are anticipated to be published by the end of the calendar year.

USGS-PCMSC also published a collection of orthoimagery and elevation data from Icy Cape to Cape Prince of Wales acquired in 2016. The data release includes RGB orthoimagery, digital surface model, and SfM point cloud. Data can be accessed at https://www.usgs.gov/media/images/data-icy-cape-cape-prince-wales.

Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX)

Jennifer Wozencraft, JALBTCX Director and National Coastal Mapping Program Manager at the U.S. Army Corps of Engineers (USACE), provided an update on program activities in Alaska. Over an approximate mile-wide swath, JALBTCX collects high resolution aerial photography and hyperspectral imagery at 1m resolution using Coastal Zone Mapping Imaging Lidar (CZMIL), which is the 3rd generation coastal mapping and charting system developed for JALBTCX. It includes a green laser system capable of collecting bathymetry in up to 60 meters of depth below the water surface. The primary limitation of this technology is turbidity in the water column. This is also a low flying system roughly 400-meter altitude which causes logical limitations especially in Alaska where landscape topography adjacent to shoreline is higher than the aircraft can safely fly.

From July 1 to September 13, 2022, JALBTCX mapped 14 areas in 11 weeks: Homer, Port Clarence, Nome, Mikkelsen Bay, Kotzebue, Deering, Wales, Tin City, Chefornak, Quinhagak, Seward, Lowell Creek, and Sumner Strait. The projects covered 18 full flight days and 5 transit days. They were impacted by weather for 35 days. Six areas were planned for 2022, but not flown: Kaktovik, St. Paul Island, Pilot Point, Chignik, Sand Point, and Atka.

JALBTCX is also collaborating on data, products, partnerships, and capacity building with the University of Alaska Fairbanks and the Alaska Center for Energy and Power.

U.S. Fish and Wildlife Service

Regional Wetlands Coordinator Sydney Thielke spoke about the Statewide National Wetlands Inventory (NWI) Program and AGC Wetlands Technical Working Group. The USFWS is the federal agency tasked with providing public access to the location and type of wetlands and deep-water habitats.

The NWI coverage for Alaska is currently only 45% complete. NWI data are vital to support the National Environmental Protection Act, infrastructure, climate change models, and prioritize habitats related to flood mitigation and storm surge. Overall, these data provide a better statewide understanding of where the National Wetlands are.

In terms of NWI production and availability, USFWS is currently working in the coastal zone while prior focus was on the interior and Arctic Alaska. Recently, projects have been absorbed to update the west coast such as the Yukon Kuskokwim Delta, EVOS Phase 1, Aleutians, and Seward Peninsula. One of the most recent published datasets is the Lower Kuskokwim region. Most of the data are accessible via the NWI Wetlands Mapper interface as web services. You can also download data and print maps.

The next steps for NWI are working with stakeholders to fund projects across data gaps for the Bristol Bay region, National Park Service (NPS) lands, and State lands. The goal is to complete and publish NWI products across the state by 2029.

USFWS has also purchased a new aircraft for imagery acquisition and plans to hire a new Alaska Refuges Remote Sensing Coordinator.

Recently, the USFWS has acquired a Lucint12 Camera System for smaller, project level imagery acquisitions. The camera system contains nine different sensors and is currently mounted to a Super Cub but can also be mounted on a Cessna 206 to extend the reach from base or expand the area of acquisition.

NOAA Coastal Mapping Program

Stephen White, from the Remote Sensing Division (RSD) of NOAA's National Geodetic Survey (NGS), provided updates on the NOAA Coastal Mapping Program. NGS' mission is to define, maintain, and provide access to the National Spatial Reference System. RSD has three primary mapping programs – Aeronautical Survey, Coastal Mapping Program, and Emergency Response. The Coastal Mapping Program has a congressional mandate to conduct remote sensing surveys of coastal regions of the United States and its possessions for demarcating the nation's legal coastline. Goals of this program include providing the Nation with accurate, consistent, and up-to-date national shoreline data. To accomplish these goals, RSD uses lidar, digital cameras, high resolution satellites, and unmanned aircraft systems (UAS).

In 2022, to support nautical charting, RSD updated the shoreline for the Port of Dutch Harbor and Sitka Cruise Terminal. RSD has also been supporting hydrographic surveys by collecting nearshore topobathy lidar in the year prior to ship operations. Although the pandemic has slowed additional work, RSD did acquire a new camera system, a Digital Sensor System (DSS) V6, with two 150MP RGB cameras and two 100MP NIR cameras that capture nadir and oblique orientations. The camera system was used for an emergency response post Hurricane Ian.

Another important initiative that will be hugely beneficial to coastal mapping in Alaska is the recent push to make Statewide VDatum operational. RSD and Dewberry have been partnering to ensure coordination among AMEC-CS member agencies in support of the ACMS.

NOAA SatBathy Tool (beta) Update

Gretchen Imahori, from NOAA RSD, gave an update on the NOAA SatBathy Tool Beta v2.0.4. The tool is the result of a collaborative effort between three NOAA offices – NGS, Coast Survey and the National Centers for Coastal Ocean Science (NCCOS). Development began in 2016 and has evolved over time to become the SatBathy beta tool. This tool utilizes 10-meter resolution satellite imagery from the Copernicus Sentinel-2 mission, the ACOLITE atmospheric correction processor, and updated research from Dr. Rick Stumpf and Dr. Isabel Caballero.

The SatBathy Tool (beta) incorporates new research to provide NOAA hydrographic field units and NOAA contractors with reconnaissance bathymetric data. Using SDB, the plan is to use the SatBathy tool to update NOAA Nautical Charts until traditional surveys can be applied and to fill in lidar and multibeam nearshore gaps in non-navigationally significant areas. Recent additions to the NOAA SatBathy tool include the ability to query and preview more Sentinel-2 images, the ability to add new components if needed by NGS and Coast Survey, improved snow and ice filtering, and a new semi-universal SDB calibration procedure. During preliminary testing, several large and potentially dangerous uncharted features (greater than 10m) were discovered. This discovery will aid in safe operations for Coast Survey's hydrographic contractors and field units.

NOAA hopes to expand the current in-house desktop SatBathy tool to develop a large-scale, automated global processing system for broader use among coastal mapping agencies, coastal managers, academia, and other geospatial users, etc.

Questions

To Ann Gibbs – Does the USGS products mention include any bathymetric data?Particularly in the Lidar and structure from motion products?
No – this is topo only.

To Stephen White – I'm using CUSP2 to map the shoreline boundary of marine mammal critical habitat. I'm curious to know if there is a plan to fill gaps in CUSP in areas where they are missing?
Yes, there is a plan to fill CUSP for the entire state of Alaska. For now, CUSP plan for VDatum is underway and the data will be made available once it is fed into VDatum.

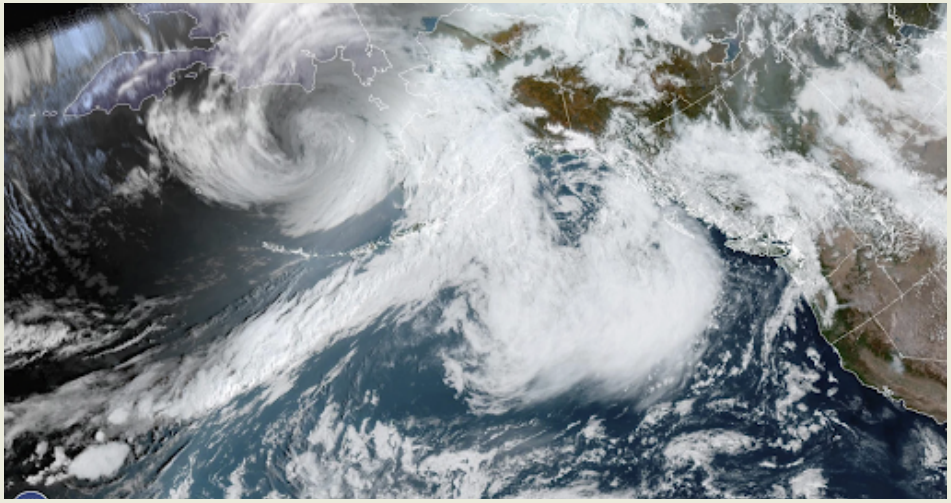
To Jaci Overbeck – Are there future plans for data utilization and integration for cross regime and interagency use such as analysis at food security, and species population management within the documented ecosystems? How are indigenous people such as Inuit equitably included for indigenous knowledge use?
Improved tribal engagement is occurring with the new collaboration that the Office for Coastal Management is standing up. Any data collection efforts are also ensured that the data is meeting the needs of the people in the state.

To Gretchen Imahori – Are there plans to provide a turbidity timed series product for the turbidity research efforts for less shallow areas as a proxy for seasonal and freshwater runoff patterns?
Good idea and question will have to follow up.

2022 Typhoon Merbok Recap Panel

Nic Kinsman, Alaska Regional Geodetic Advisor for NOAA NGS, introduced the collaborative scientific data response to Typhoon Merbok. Results of the coordinated efforts to record high water mark (HWM) data yielded the most extensive, accurate, and accessible documentation of flooding and erosion than any past coastal event of this scale in Alaska. HWMs document the height that water reached in and around communities and are used to understand and map flood extents. These data are also important to help secure post-disaster recovery and mitigation grants and enhance future flood forecast models.

For context, Typhoon Merbok peaked in intensity over the Bering Sea, with a **record minimum central pressure of 937 millibars**. The result was extensive coastal flooding when there was **no protective sea ice** in place. The storm **affected 50 communities along more than 13,000 miles of coastline**. Low-lying communities around Norton Sound experienced peak storm surges of 8-12 feet, with high-water levels lingering long after the storm passed.



A satellite image of Typhoon Merbok taken on Friday, September 16, 2022 by NOAA's National Hurricane Center.

Scientific response goals were to capture and preserve the data quickly ahead of clean up; to improve collaboration between different groups, so they could analyze the data; and to ensure the data were made accessible to the public as quickly as possible.

These activities provide considerable benefits to residents on multiple timescales – from directly assisting the response and recovery process to enhancing models and data that, in turn, improve the quality of future National Weather Service (NWS) watches warnings and advisories. Overall, this was a uniquely Alaskan grassroots response that pulled from known technical capacities regardless of where they resided to best meet the needs of the public. After action activities are being coordinated in multiple spaces to inform how such a response can be further enhanced in the future.

High Water Mark Data

Alex Nereson, from USGS-PCMSC, summarized the HWM survey efforts by the Alaska Department of Natural Resources (DNR), NOAA, USGS, USDA-NRCS, University of Alaska Fairbanks (UAF), JOA Surveys and CRW Engineers.

HWMs mark the highest elevation of floodwaters, typically as debris lines. They are often short-lived, so quickly identifying and preserving them can help communicate risk, validate flood models, and forecast future events.

Hampered by inclement weather and flight availability, survey crews collected 430 HWMs at 19 communities between September 16/17 and October 5. The crews were often welcomed and assisted by community residents who pointed out HWMs, shared personal or social media photos, and relayed flood observations, water levels, damage, blocked drainage pathways, etc.

Static or Real-time Kinematic Positioning (RTK) GNSS and tape measures were used to collect HWMs. Observations were recorded in photos, spreadsheets, and USGS HWM forms. All observations were submitted to USGS for quality checks and database entry, and the data were made publicly available at the Flood Event Viewer under the event called "2022 September AK Extratropical Cyclone."

Imagery Services

Andrew Herbst, from the Alaska DGGS, spoke about the Open Data Geoportal Imagery Services.

The interagency response to Typhoon Merbok spurred immediate demand for remotely-sensed data for over 30 affected communities. UAF, Alaska Department of Transportation, and others went into the field with UAS-mounted cameras and survey equipment to fulfill this demand. Additionally, there were 36 separate requests for SkySat imagery.

DGGS assisted the storm response by consolidating all imagery and elevation data and making it available to the response team. Hosted at UAF, a server with 15 petabytes of storage space was configured for ArcGIS Enterprise with ImageServer and contained a public file server which allowed people to download data. After one week, UAS ortho-imagery was available for the following areas: Unalakleet, Shaktoolik, Kotlik, Golovin and Emmonak. After two weeks, UAS ortho coverage increased to 10 communities, and 36 communities were mapped using SkySat ½ m imagery from the Planet website. Behind-the-scenes, collectors were submitting data to an AWS bucket following important file naming conventions. Then, Python scripts pulled in image files and mosaicked them, integrating metadata pulled from the file names. Lastly, services were published in a web map and shared to a mailing list. In the first two weeks, over 150GB of data were added to the portal.

Post storm, another terabyte (or more) of pre and post storm imagery and lidar will be ingested, processes will be refined to optimize response times and lessons learned will be integrated into long term projects.

Data Access and Uses

Jaci Overbeck, from NOAA's Office for Coastal Management, spoke about how to access all data related to Typhoon Merbok via a story map.

Data from Typhoon Merbok are critical to developing DGGS' actionable, community scale, flood assessment reports, showing the maximum extent of flooding from recent events, and quantifying erosion. Partners are determining how and who will quantify erosion over the winter. A DGGS product that forecasted erosion for a 60-year period is currently available but does not take into account erosion from Typhoon Merbok. Efforts to collect post-storm data are still ongoing, including ensuring HWMs are marked through winter.

Questions

To Jaci Overbeck – What Digital Elevation Model (DEM) did these storm surge models use in Elim?

Unsure if the model goes inland and unsure what DEM was used. The current forecast modeling is not being projected inland just has a point or so to where the storm surge could potentially be.

SESSION 2: Technology Lightning Talks

Within the panel session, we heard from six speakers from the private sector.

NOAA Coastal Mapping Project in Southeast Alaska as a Supporting Case for the Alaska Coastal Mapping Strategy

Colin Cooper, from NV5 Geospatial, spoke about a topobathy lidar project that his company did to support NOAA's Coastal Mapping Program in Southeast Alaska.

NV5 was tasked to collect about 370 sq miles of topobathy lidar, 4-band imagery, and shoreline mapping at the Revillagigedo Channel. Operational considerations and constraints for this task included weather, mountainous terrain, fjords, box canyons, tides, turbidity and aquatic vegetation, wind speed and direction as well as water surface conditions and wave height. Multiple sensors were used to assist as well with this effort, including Leica Chiroptera 4X, Riegl 1560 and UltraCam Eagle.

Tidal Coordination for Data Acquisition

Nathan Wardwell, from JOA Surveys, spoke about tidal coordination for data acquisition. For tidal datum coordination, JOA uses one year of data for each National Water Level Observation Network (NWLON) station and computes

the amount of time the water levels are below tidal datums of interest for the calendar year and for the months of June to September. Evaluations are based on tide type and region.

Seasonality has a large effect in the Bering Sea and Arctic. In the Arctic, the average percentage of time when water levels are below MLLW drops from 21% for the calendar year to 8% between June and September. The seasonality effect is more drastic for MHW, where it reduces from 52% to 29% over the same months. From June to September 2020, the water level at Unalakleet never dropped below MLLW.

Between Nome and Unalakleet in Norton Sound, there are NWLON stations with real-time water level data. During September 11-17, the tides are diurnal and in phase. The tide range however at Unalakleet is about twice as large as the tide range at Nome. The next week, between September 17-23, the tides transitioned to semidiurnal and out of phase. The tide range now at Unalakleet is smaller. Within Norton Sound, the tidal characteristics at Koyuk are similar to Unalakleet, Kotlik, and Stebbins.

In general, the main takeaways are that tide coordinated mapping in Alaska is challenging, especially in the Arctic. There are not enough real-time water level stations in Alaska to provide a complete picture for tide coordinated coastal mapping operations. When considering coastal mapping project specifications consider tide type and region of the state, so realistic objectives can be set.

Coastal Geo-data: what's new in means and methods of collection and thoughts on maximizing ROI

Rada Khadjinova, from Fugro, shared some thoughts on maximizing return on investment from coastal geo-datasets. Fugro has been providing advice, acquisition and analyses of land and marine Geo-data in Alaska for the last 50 years.

Three main aspects where private sector surveyors bring value are mapping technology, data buy models, and public-private partnerships. Clear goals, leveraging resources, meaningful engagement of the private sector can help overall.

Innovations in mapping technology include workflows, sensors, automation, communication, and computing. Satellite imagery and satellite-derived bathymetry products are currently used for habitat mapping, geomorphology, and bathymetry.

Innovations in acquisition include a coastal mapping suite for topo, bathymetry and imagery. These include RAMMS-Superior ALB system solution, simultaneous multi sensor data acquisition, seamless land-to-sea data, and ALB acquisition by drones.

Previous project experience collecting data on speculation reduced costs due to fewer mobilizations, more efficient line plan, larger area to mitigate adverse weather conditions. Faster completion pace occurred with annual funding gaps being absorbed by the private sector. Cost predictability of pre-negotiated rates were based on unit rate per area of interest.

NOAA's plan for New Blue Economy can help leverage public-private partnerships, which in turn can enable wider implementation of technology innovations offered by the private sector surveyors and delivery of customized geo-data products to end-users.

Satellite-Derived Bathymetry

Natalie Treadwell, from TCarta, presented about creating multi-temporal SDB and synthetic aperture radar (SAR) shoreline models in Teller and Yakutat, Alaska. SDB is an area of remote sensing research which utilizes ocean optics to estimate near shore bathymetry elevation values using satellite imagery and in situ depths collected via satellite lidar. To generate seafloor depths, the two algorithms used by TCarta are a Random Forest and Band Radio Method. The multi-band random forest model approach worked best for this project and both models are accessible via TCarta's Trident Toolbox available through ESRI.

TCarta produces multi-temporal image composites in a variety of ways, leveraging the metadata from individual images to group composites based on parameters such as tidal range, illumination azimuth, turbidity, and cloud cover percentage. 95 images at 3 m resolution from Planetscope and 521 images at 10 m resolution from Sentinel-2 were used to develop composites for this study. These composites help reduce obstructions in individual images and produce a more uniform surface for SDB production. To address the datum issue that has hindered production of SDB in Alaska, TCarta is working with NOAA for approval of their datum solution as a 'band-aid' fix until VDatum can be updated for the majority of Alaska (scheduled for 2025).

As a preprocessing step to SDB, SAR data can be used to model high and low shorelines and is utilized in the SDB process to remove land pixels from imagery. TCarta acquired SAR data from the Capella satellites to generate shorelines and identify coastal features by modeling temporal changes in backscatter values during high tide and low tides. The current TCarta work is both novel and dynamic as it involves precision tasking of high resolution SAR

data over chosen areas. To obtain a single low mean and tide line an average of all images acquired during low and high tide are computed on speckled filtered imagery which provides a clean single shoreline. More information about the work being conducted at TCarta and their available toolboxes can be accessed via tcarta.com.

SDB and PolArctic CENA Tool

Lauren Decker and Leslie Canavara, from PolArctic, presented the Coastline Evolution and Nearshore Approximation (CENA) tool. PolArctic develops custom artificial intelligence (AI) and machine learning tools for the Arctic. Focus areas include sea ice forecast, coastline evolution and nearshore approximation as well as aquaculture/mariculture and precision fishing support.

Arctic waters and coastlines present a lot of challenges and difficulties due to depth, organic matter, sediments, and temperature/ice. Erosion possesses a problem for Alaska communities and infrastructure. A seawall and bank stabilizations have been put in place for some areas in Alaska to help mitigate erosion. Melting permafrost is also causing an increase in coastal erosion rates. To track the changing coastline, the CENA tool was used. The test site for this tool was Homer, Alaska. To map nearshore coastline and beach classification, PolArctic identified unique Arctic coastline at a regional scale.

Bathymetry from wave inversion is a technique known as feeling the bottom with waves, which works in high-turbidity environments and interacts with waves with bottom bathymetry at ½ wavelength in many silty locations in the Arctic. AI has also been used to also identify uncharted hazards in Alaska. PolArctic found an uncharted seamount in Hudson Bay, Canada. Overall, Alaska's coastline and shallow nearshore is dynamic and impacted by erosion. Remote sensing bathymetry is more than just clear-water SDB or lidar. CENA is PolArctic's tool for remote sensing nearshore bathymetry in the Arctic environment.

3D Nation Study Update

Sue Hoegberg, from Dewberry, spoke about the 3D Nation Elevation Requirements and Benefits Study, led by NOAA and USGS. Study results are described in a StoryMap and are being used by the government as input to determine future program direction.

Study respondents included 45 Federal agencies, 56 states and territories, and 58 non-non-governmental organizations. A total of 1,352 mission critical activities binned into 30 different business use cases and four geography types (inland topography, inland bathymetry, nearshore bathymetry, and offshore bathymetry) were provided by respondents.

The top 5 business uses for elevation data in Alaska were flood risk management, infrastructure and construction management, marine and riverine navigation and safety, coastal zone management, and homeland security and emergency management.

In Alaska, the most frequently requested requirements were:

- inland topography: quality level 2 (and better) with 4-5 year (or better) update frequency.
- inland bathymetry: quality level 0B or better with 4-5 year update frequency;
- nearshore bathymetry: quality level 1B with a 2-3 year update frequency; and
- offshore bathymetry: IHO order 1A with a 2-3 year update frequency

The study documented a total of $13.5 billion in future annual benefits, if all requirements for elevation data were met. The study team believes that the benefits are likely underestimated due to a number of factors, e.g., (1) respondents may have been hesitant to estimate benefits from data they do not have yet or use regularly; (2) topographic data are better known and understood than bathymetry; and (3) input from smaller private firms and key industries, such as precision agriculture, oil and gas, aquaculture, auto manufacturers, and cruise lines, was missing.

Questions

To Natalie Treadwell – What validation data are you finding and what are you looking for regarding depth range, resolution, age, type, I'm trying to get at what type of data do we need more of to better be able to use these types of technologies.

The multibeam sonar and lidar surveys used have been published by NOAA and some things that could be helpful to continue validating this is shallow water multi beam sonar or even hydro balls that some agencies have. Also looking for shoreline validation data as well as lidar flights.

To Natalie Treadwell – Is there a depth band we are lacking and tend to have?
In most of the processes can use more than just the RGB bands, for the Planet data up to 8 bands can be used. This helps improve results but also depends on the area of the world you are looking at.

SESSION 3: The Path Forward

In this panel session, we heard from six speakers on a range of topics that advance the ACMS.

USGS Coastal National Elevation Database Update

Jeff Danielson, CoNED Applications Project Chief from USGS, spoke about the Coastal National Elevation Database (CoNED) Applications Project. The CoNED Applications Project supports coastal and marine spatial planning, by the CoNED at select focus regions, thereby establishing a topobathymetric digital elevation model (TBDEM) for scientific investigations and applications. With CoNED, the aim is to conduct 3D point cloud and satellite-based remote sensing research to establish TBDEMs and to create methods for fostering land change science studies. CoNED is built with the best available data.

Pilot 1-meter TBDEMs are being developed for AK communities to support coastal flood hazards. Accuracy of the flood hazard model is strongly influenced by nearshore bathymetry and elevation topography. USGS plans to expand CoNED efforts in Alaska beginning FY24.

Alaska Water Level Watch

Carol Janzen, from the Alaska Ocean Observation System (AOOS), spoke about the Alaska Water Level Watch (AWLW). The AWLW is a collaborative group working to improve the quality, coverage, and accessibility to water level observations in Alaska's coastal zone. It was formed to address the issue with low sensor density along Alaska's remote coastline, which is among the nation's most vulnerable to geohazards.

These data are needed for storm-surge forecasting, informed emergency response, safe navigation, and charting. NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) has an online system that hosts the NWLON, which, in Alaska, consists of 27 active sensors for Alaska's roughly 66,000 miles of coastline. Additional water level data exists, but are not easily found online. NWLON, non-NWLON, and predicted water level information are shared via the **AWLW Data Portal**.

The Portal has streamlined data ingestion and station page identification procedures to simplify data submissions from various providers. Data are qualified as Tier A, B and C based on accuracy and associated NOAA sanctioned uses. The Portal hosts other useful information, such as the new Flood Event layer from the AKDNR. From here, users can select stage information and view photos from multiple locations in communities.

Recently, AKDNR has been working with AOOS to install and maintain alternative water level stations in western Alaska. Onboard processing of real-time data reporting on the Portal occurred for one year, and JOA Surveys provided MLLW based on 5 benchmarks in the area. The Portal now has roughly 50% more water level stations – many of which came online in 2021-22 and captured peak water levels during Typhoon Merbok. Informed by the AWLW stations, a storm surge forecast model and in situ observational data comparison tool for the AOOS Data Portal will launch in December 2022.

Overview of Imagery and Elevation Acquisition Dashboard

Hillary Palmer, a geospatial project manager for Dewberry, demonstrated the ACMS Data Acquisition Dashboard that Dewberry developed under contract from NOAA-RSD, for the purpose of enhanced inter-agency coordination. The dashboard is designed to help answer questions, such as "What data already exists? Who's planning to collect new data? Where? When?" Users can access the application from the **Alaska Coastal Mapping Strategy website**.

As shown in Figure 1, the dashboard has several elements: (1) an embedded map showing all the mapping activities across Alaska; (2) a chart to the right showing the total square miles of data acquired by year; (3) a chart at the bottom right showing total square miles acquired by technology type, e.g., imagery, topographic lidar, shoreline delineation, sonar, structure from motion, and topobathy lidar; and (4) a chart on the bottom left showing the total project square miles listed by project status, e.g., planned, funded, in progress, and complete.

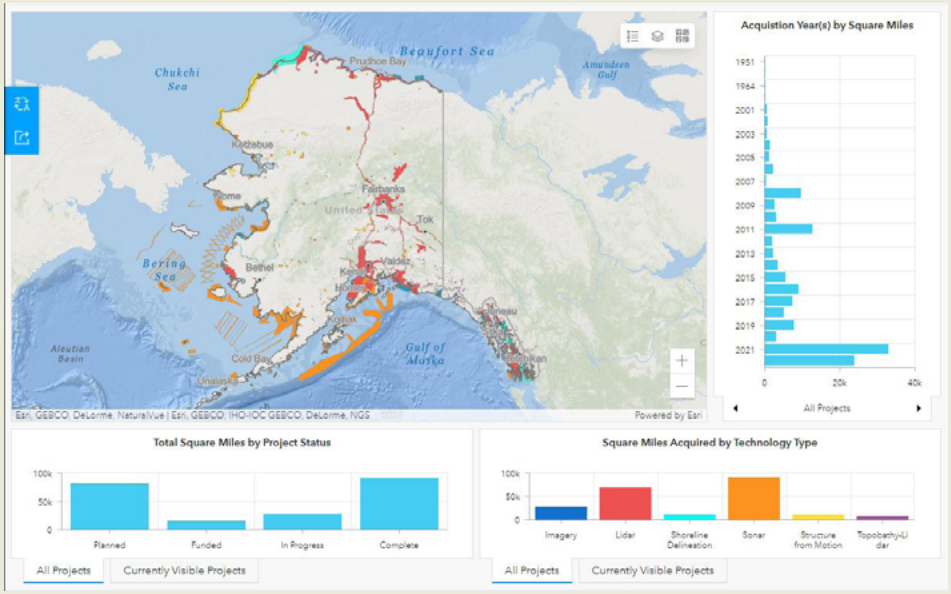


Figure 1 – A graphic showing a screen capture of the Alaska Coastal Data Acquisition Dashboard.

The embedded map can be filtered by clicking on any of the bars in the bar charts. For example, to force the map to display only imagery projects that are complete, click on the dark blue "Imagery" bar and the light blue "Complete" bar. To undo, simply click again on the "Imagery" and "Complete" bars. At the bottom of each bar chart on the dashboard are tabs for showing "All Projects" or for showing only those projects that are "Currently Visible" in the map. Clicking on the tab to view "Currently Visible Projects" means the charts will refresh automatically when zooming in or panning around on the map.

This data in this dashboard comes from the U.S. Mapping Coordination website, the State of Alaska Imagery and Elevation Geoportal, an inventory of historical imagery and elevation data available in Alaska that was compiled by Dewberry from various state and national data repositories, and several published data services from ACMS partner agencies. This dataset is updated quarterly with the next update scheduled for March 2023.

Near Real-time Data Processing for Topobathy Lidar

Karen Hart, from Woolpert, spoke about the importance of near real-time data processing for topo-bathymetric lidar operations. Woolpert is currently working on topo-bathymetric lidar operations with missions lasting weeks to months, deploying Leica sensors and collecting tens of terabytes of data.

Woolpert has developed software called FLiDAR to assist field data processing. It is sensor agnostic and near-real-time.

In less than two minutes, the tool produces a multipurpose digital surface model (DSM) that includes various statistics from Land Analysis System (LAS) data. The tool was tested recently on NOAA's NGS FY22-23 and Cook Islands topo-bathy projects. The tool can also combine high resolution DSM with corresponding lower resolution DSM to fill the gaps in input data. As shown in Figure 2, the tool applies a data filling algorithm one pixel depth at a time with multiple iterations as needed to make a smoother surface at the higher resolution.

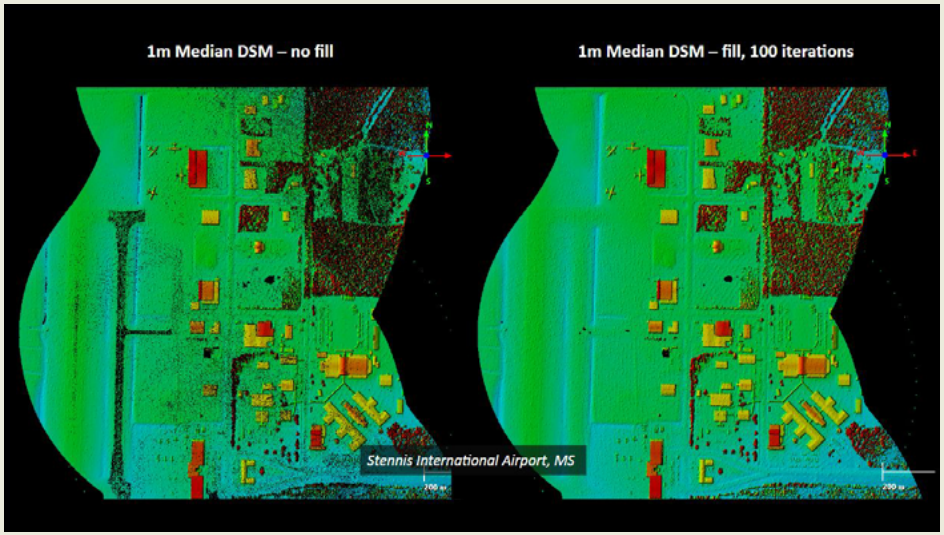


Figure 2 – A graphic illustrating the data filling algorithm and how it fills the void contours one pixel at a time with multiple iterations.

Preliminary field assessments showed that the tool was good at creating quick coverage that is useful for identifying data gaps that helps mitigate reflight wait times. However, it is not yet a replacement in the field as it does not give a good indication of seabed coverage. Woolpert will be further developing this promising new tool.

ACMS National Spatial Reference System Component Updates

Nic Kinsman, on behalf of colleagues at NOAA NGS and CO-OPS, provided updates on the National Spatial Reference System (NSRS) components of the ACMS. The NSRS is critical to build Statewide VDatum, which will unlock Alaska's ability to collect and use accurate geospatial data for applications like flood and sea level inundation mapping or the engineering and design of coastal infrastructure projects. VDatum progress in Alaska is presently proceeding at a steady rate towards projected completion of an initial model run in 2028.

Following is a list of ACMS Implementation Plan milestones associated with Objective 2.2 (Upgrade AK NSRS to Support Mapping Data Acquisition) with status updates.

Milestones	Description	Status
2.2.1.1	Remaining areas of the AK Gravity for the Redefinition of the Vertical Datum (GRAV-D) project to be completed over Aleutians by October 2024	Collection of the remaining Aleutians block is planned for April 2023
2.2.1.2	Establish an absolute Gravity Network and Geoid Monitoring Service (GeMS) to support a dynamic geoid (DGEOID) model by October 2025	DGEOID updates will be released with the GEOID 2022 beta version in 2023 and a final version is expected around 2025.
2.2.1.3	Full GRAV-D data incorporation into the gravimetric geoid model (GEOID 2022) by October 2025	The Experimental Geoid (xGeoid20) includes all GRAV-D data to date and covers all of mainland Alaska.
2.2.2	Establish 5 NOAA Foundation CORS (FCORS) in Alaska by October 2023	FCORS stations are proposed and field work is planned to establish two NGS-owned FCORS stations in Summer 2023 or 2024
2.2.3.1	Cost assessment to add GNSS to 27 existing AK NWLON sites and 31 new NWLON stations to fill Alaska gaps by October 2022	It costs NOAA CO-OPS $400,000 to $600,000 to install each NWLON station in Alaska, depending on many variables. NWLON stations that are hard to access may experience higher annual operations and maintenance costs, above the installation expense.
2.2.3.2	Improved geodetic control at Global Sea Level Observing System (GLOSS) stations in Sand Point, Sitka, Seward, and Unalaska by October 2025	CO-OPS is evaluating the logistics required for leveling ties between NWLON water level sensors and the existing NGS CORS stations for GLOSS. CO-OPS is evaluating and testing feasibility of co-locating new GNSS at NWLON stations.
2.2.4.1	Short term tidal observations acquired by October 2027	Observations have been acquired for 14 of 40 stations. Accelerated collection of remaining 26 sites as early as FY23 with help from the State of Alaska.
2.2.4.2	GNSS observations taken on tidal benchmarks by October 2027	Top priorities are any tidal bench mark from water level stations in Alaska where local tidal datums exist, but have not yet been linked to NSRS heights (NAVD 88) with GPS. Community OPUS shares have significantly advanced progress on this objective since 2014.

Workforce Development Through Community-Based Mapping

Reyce Borgardus, from UAF's Arctic Coastal Geospatial Lab (ACGL), spoke about four ways ACGL is integrating research with education to conduct geospatial, topographic, and bathymetric mapping and supporting resilient coastal communities.

The first case study combined UAF student research with local tribal governments at Nelson Lagoon in the Eastern Aleutian Borough. Student need for high resolution mapping data led to work with local environmental coordinators to implement an EPA-approved quality assurance project plan (QAPP) for future UAV surveys. This activity allowed Nelson Lagoon to acquire a real-time kinematic UAV, so they could carry out change detection mapping at higher resolution than UAF's field team and better inform their decisions with regard to relocation. This relationship with Nelson Lagoon and the ongoing mapping has bolstered community resiliency by helping to fund and inform other tribal and engineering firms working for Nelson Lagoon to address community priorities.

The second case study combined student research with city partners at Pilot Point in the Lake & Peninsula Borough. Through ongoing UAF mapping projects, ACGL has become a resource for the city when it comes to threatened infrastructure and instructure planning, and ACGL molds its fieldwork and mapping objectives to better align with these community priorities. ACGL has collected high resolution imagery and bathymetry to support private engineering firms and federal engineers. These projects provide workforce development for ACGL students, who collect, process and deliver the data that are most useful to engineers who translate ACGL planning products into action.

The third case study combined student research with state partners at St. Paul Island in the Aleutians West Borough. By integrating academics with real world needs, ACGL provides early career professionals to DGGS' Coastal Hazards program via internships. This relationship helps to ensure that science stays grounded in service.

Lastly, the fourth case study combined student research with middle and high school students at Naknek in Bristol Bay Borough. To inspire students to come to UAF, ACGL has developed a set of fun educational modules involving SfM and virtual reality.

Prioritization Survey Results & Mapping Partner Finder

Hillary Palmer, who spoke previously about the Alaska Data Acquisition Dashboard, spoke about two additional tools to help advance the ACMS: the Alaska Priorities Dashboard and the Mapping Partner Finder Tool.

The Alaska Mapping Priorities Dashboard is designed to help answer questions, such as "What areas are important? What map products are needed? How soon?" The 2021 Alaska Spatial Priorities Study results underpin the dashboard. The 'Intro' page of the dashboard website provides background on the survey and how the results were interpreted. The 'Priorities' page shows the weighted priorities across Alaska's coastal and ocean areas and includes the ability to toggle on/off the top 5%, 10%, and 20% of mapping priorities. The 'Filter Results' tab allows for customized data querying and display. The 'Map Products' tab shows what priority map products were preferred by participants and where.

The Mapping Partner Finder Tool is informed by the spatial prioritization results and is designed to answer questions, such as "Who else is interested in my area?" Its purpose is to help facilitate cost-sharing opportunities. Using this tool, users can draw an area of interest and generate a report to discover other survey participants with shared interests. Users can identify desired mapping products and their resolution as well as the square miles of overlap they share with others. The report can be saved as a PDF. If users need help reaching out to mapping partners listed on the custom report, they can email it to iwgocm.staff@noaa.gov to request assistance.

Alaska Coastal Mapping Plan of Action Dashboard

Hillary Palmer spoke about a fourth tool (under development) to help advance the ACMS: the Alaska Coastal Mapping Plan of Action Dashboard. Its purpose is to help inform which areas need to be mapped first. She spoke about the creation of Mapping Target Areas, which are the result of a complex geospatial analysis using both the prioritization survey results and a more equitable, community-based approach to inform the 10-year mapping plan of action.

Questions

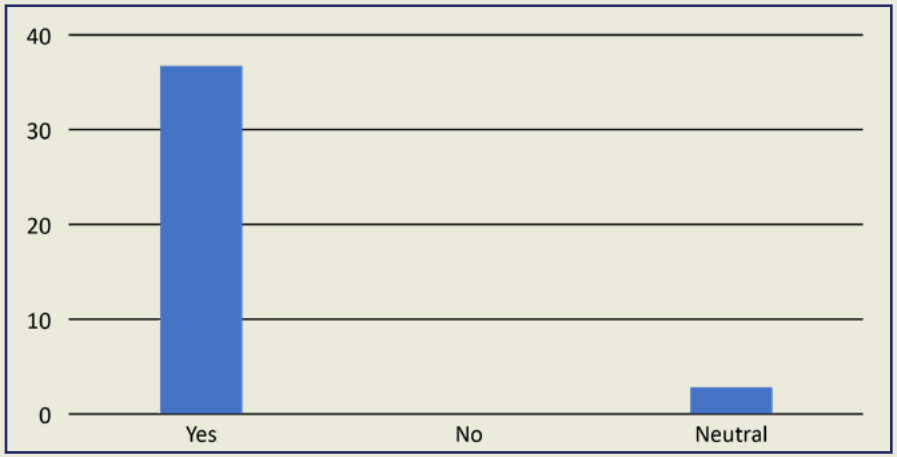
Is there opportunity for USGS to prioritize topobathy DEM development based on non-USGS modeling projects at communities that are more at risk to flooding, erosion, and permafrost degradation?

We can certainly talk about it. The work, as prioritized, is Program funded to support the modeling, but we can explore other funding strategies.

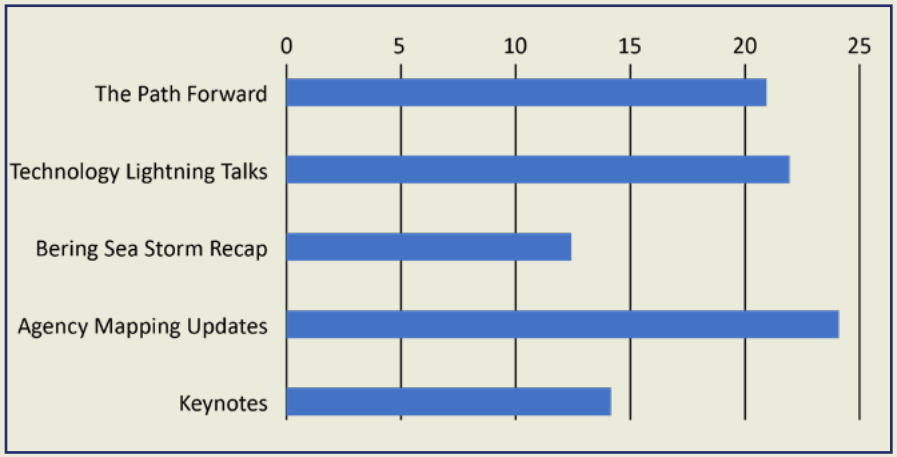
Day One Closeout Survey

At the end of the day one, attendees were prompted to respond to a series of questions in a closeout survey. The results are below.

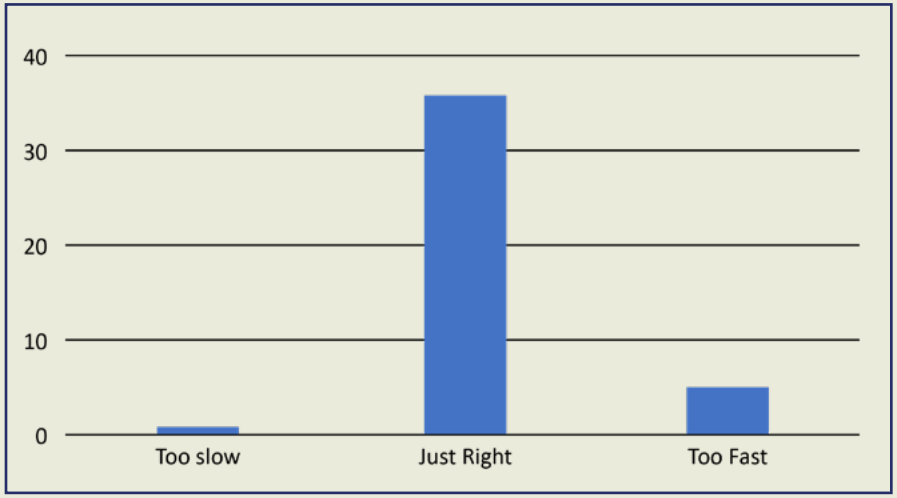
Did day one meet your expectations?



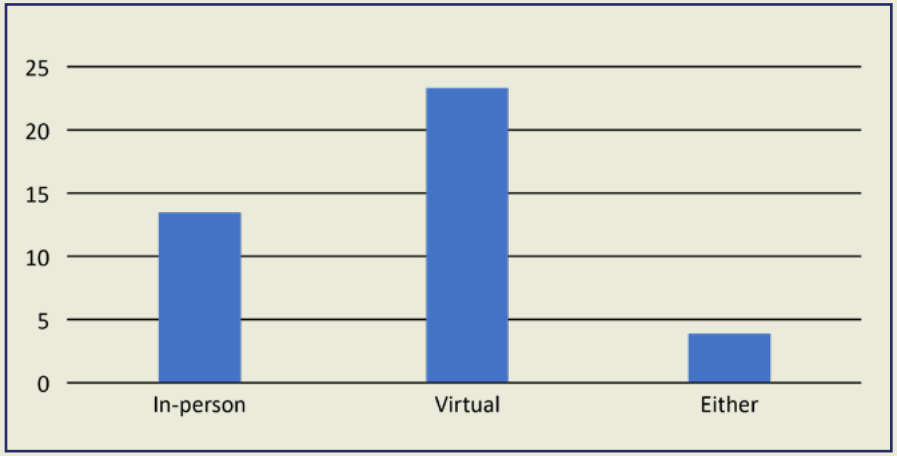
Which day one sessions would you like to hear more about in a futire webinar?



How was the pacing of the day?



For 2023, would you prefer to attend an in-person or virtual event?



Ocean Mapping Day

Day 2 started with Meredith Westington, Seascape Alaska regional mapping coordinator with NOAA's Integrated Ocean and Coastal Mapping (IOCM) program, welcoming participants and introducing opening remarks from Congresswoman Mary Peltola. RDML Benjamin Evans, Director of NOAA's Office of Coast Survey (OCS) and U.S. National Hydrographer, provided a welcome address. He reflected on the discussions at last year's summit, specifically recalling the presentations highlighting the importance of ocean and coastal mapping and how we might tackle the challenge of mapping Alaska's vast seascape by 2030, which remained 69% unmapped as of January 2022. RDML Evans spoke about the importance of this year's agenda and introduced our keynote speaker, Chris Marshall from the Canadian Hydrographic Service (CHS).

Keynote – Modern Hydrography in the Canadian Arctic: CHS Approach to Mapping the Arctic

Chris Marshall, the CHS Regional Director of the Ontario, Prairie, and Arctic Regions, spoke about the CHS approach to mapping in the Canadian Arctic. Canada's Arctic coastline is about 162,000 km long with an EEZ just over 3.5 million square km wide. It contains 36,000 islands, remote and extreme climates, short operational mapping windows, and declining sea ice increasing shipping traffic in the region. As of April 2022, CHS has mapped 42.6% of primary and secondary corridors, and only 15.8% of Canada's Arctic waters. Facing this challenge, CHS takes a risk-based approach that considers current and future commercial traffic, the shallowest depths and narrow channels, and community requirements. CHS takes multiple strategic avenues to increase mapping capacity:

- Canadian Coast Guard (CCG) Icebreakers;
- Hydrographic Survey Supply Arrangement contracts;
- Collaboration with DFO Science and other organizations using chartered vessels;
- Trusted sources for Trans-Arctic bathymetry, such as Amundsen Science; and
- Collaboration with Indigenous communities for crowdsourced bathymetry.

Six DFO-CCG icebreakers (CCGS *Amundsen*, CCGS *Pierre Radisson*, CCGS *Louis S. St. Laurent*, CCGS Sir *Wilfrid Laurier*, CCGS *Des Groseillers*, and CCGS *Henry Larsen*) are equipped with hull-mounted multibeam sonar systems. CHS uses force multipliers to maximize investments in survey operations using portable multibeam systems such as the NORBIT iWBMS. They recently tested uncrewed platforms such as XOCEAN X09 autonomous surface vessel (ASV) for multibeam surveys and are planning to assess platforms such as the Schiebel S-100 remotely piloted aircraft as a platform for airborne LiDAR.

Collaborations have included contributions from University of New Hampshire (UNH) researchers aboard the USCGC *Healy* as part of its transit through the Northwest Passage in 2021, and from an expedition with DFO Science and Paulatuk Hunters and Trappers Committee aboard the chartered vessel F/V *Frosti*. Other community and crowdsourced bathymetry projects have included Inuit Inukjuak community-led data collection along with work aboard the *Polar Prince* vessel in Hudson Bay, and contributions from DFO-CCG and the University of Quebec.

In August 2022, Canada announced a renewal of the Oceans Protection Plan and a significant investment of $84 million to CHS over the next nine years to improve hydrographic services in the Arctic. The bulk of the funding will be used over the next five years to accelerate bathymetric data collection by:

- Maximizing DFO-CCG vessel assets;
- Contracting the private sector and leveraging new technologies;
- Providing funding for a dedicated survey vessel;
- Creating a dedicated Arctic Data Integration and Chart Production team;
- Developing new services to better assess and communicate Arctic navigation risks; and
- Implementing a community hydrography program for coastal communities.

Questions

To RDML Benjamin Evans – There has been great progress in coordination in Alaska and also with the FCMAP that we saw yesterday. How can this be extended to other regions where there aren't the same number of stakeholders, particularly Hawaii and the Pacific Remote EEZ?

For context, in Alaska, understanding the mapping requirements and resourcing them is challenging and breaks the traditional model we apply in the lower 48, where populations are denser. If we extend to the western Pacific, the model is even more broken. But, the same general principles apply – it can't be the responsibility of any one government agency or private interest to achieve that work. Just as the Seascape Alaska effort has done in Alaska, the western Pacific will require a coalition of interests. Need to engage with the populations in the area. These are the folks most susceptible to the risks associated with

poorly mapped oceans and coasts and need to coalesce. NOAA is interested in increasing collaboration with a broader range of stakeholders to identify requirements and resources.

To Chris Marshall – Thank you for the information regarding Inuit involvement for the co-production of knowledge. I was wondering if the collaborative efforts currently underway were in partnership with Inuit Circumpolar Council?
I don't think we're plugged in. Our community hydrography projects and work with the Inuit are very much at the community level with local hunters and trappers. So, are those efforts plugged into the larger picture? I think so, but I'm not certain at that level. I know that at the government of Nunavik level, there's a lot of interest in working with us. They've been doing mapping for subsurface fiber optic cables, etc. and they want to ensure that the data is available to us. There are connections to the Council, but not specific to the hydrographic office. I can find out more because we're connected at a more senior level of the organization through the Arctic Council.

To Chris Marshall – Can you speak to the work CHS is conducting around satellite derived bathymetry and how these products are being integrated into the non-navigation dataset?
Partial answer is that we have a dedicated team in our Toronto office, the Remote Sensing Centre of Expertise. SDB is growing in interest and it's now part of our chart production methodology, especially in areas where there is a lack of modern bathymetry. So, we will often have a stripe of modern bathymetry through the middle of a chart and we lean on our remote sensing team to help us accurately characterize the shoreline. Where appropriate, we will determine if the SDB tools are going to inform that chart production. Right now, SDB is being used to help our understanding of how to build better charts. I do not believe that we have a significant volume of SDB in the bathymetry data holdings – it's managed as a separate dataset and not integrated into the core database.

SESSION 1: Seascape Alaska Mapping Updates

Within the session on Seascape Alaska mapping updates, we heard from eight speakers and members of Seascape Alaska representing industry, academia, and the federal government. Speakers discussed the updates from the past year, next year's plans, and future opportunities for mapping in Alaska.

Seascape Alaska Recap

Meredith Westington provided a recap of Seascape Alaska.

Seascape Alaska is primarily focused on NOMEC Strategy efforts to completely map U.S. waters deeper than 40 meters by 2030, and waters shallower than 40 meters by 2040. Their tagline is "working together to understand the depths of Alaska's vast seascape," and members are encouraged to promote five core values:

- Share high quality data and products using public archives;
- Ensure that data and products follow best practices;
- Work with others to maximize survey opportunities in shared areas of interest;
- Encourage innovation to make the most of mapping efforts; and
- Share plans and progress broadly so others may participate.

Since 2022, Seascape Alaska includes government and non-government organizations, so it has a terms of reference to remain collaborative across sectors. Most importantly, the campaign will not make group decisions because it is not a federal advisory committee, and members and attendees must disclose when they provide input on any activity for which they receive or might receive federal funds. The campaign's role is to:

- Facilitate exchange of information about mapping activities, accomplishments, and data contributions;
- Create a forum for communication to improve coordination and outreach activities; and
- Discuss current and future capabilities.

The group meets monthly and evolving subteams include a Data Management Technical Team; Aleutians, Southeast Alaska, and Arctic Planning Teams; and a new Exploration Team.

Office of Coast Survey Updates

LCDR Hadley Owen, NOAA's Alaska Navigation Manager, covered updates and future plans for NOAA OCS mapping activities in Alaska.

In 2022, OCS and its contracting partners collected nearly 2400 snm of bathymetric data in support of nautical chart updates in western and southeast Alaska. Preliminary results can be found in the "living" story map linked from NOAA's Current Year Survey Plans webpage.

For 2023, mapping plans cover the northern side of Norton Sound past Nome to Golovin Bay in the East; an extensive region in Bristol Bay relevant to fishing and lightering operations; the shelf break east of Kodiak, identified by Seascape Alaska; southern Clarence Strait approaching to Revillagigedo Channel; and the Pribilof Islands. The 2023 plans are still being finalized. Please reach out to LCDR Hadley Owen (alaska.navmanager@noaa.gov) with input.

Starting in 2021, NOAA has been transitioning to electronic navigation charts. The entire process is scheduled for completion by 2025. OCS is expanding its related products including the NOAA Custom Chart and NOAA Chart Display Service, which are intended for geospatial data display and analysis. For more information, visit the Office of Coast Survey website.

To tackle Alaska's vast area of unmapped waters, OCS is trying to maximize all opportunities for data collection, including transit surveys by NOAA vessels equipped with MBES, where feasible.

Lastly, NOAA Ships *Rainier* and *Fairweather* are in their sixth decade, and will be decommissioned by 2030 at the latest. Two new Class B ships are planned for an FY28 launch date to replace these vessels.

Nunivak Project Updates

Andy Orthmann, charting program manager from TerraSond, discussed OCS' contractor-supported hydrographic survey OPR-R302-KR-22 around Nunivak Island from June to August 2022.

Nunivak Island is navigationally significant for regional traffic and approaches to the Mekoryuk community, the only permanent inhabitants of the island. Much of the area is uncharted, and existing data were sparse and outdated from 1902 and 1953. TerraSond used the R/V Qualifier 105 from Support Vessels of Alaska and the C-Worker 5 ASV from L3-Harris. SDB was used as reconnaissance for safety during this project, helping to identify the size of a channel and an uncharted shoal extending about a mile offshore.

Key project accomplishments include:

- 1200 snm surveyed around the northeast, northwest, southern, and western sides of Nunivak Island to minimum depths of between 1 and 9.5 meters;
- 90 bottom samples collected for seafloor characterization;
- Improved trackline coverage from Nunivak to Kuskokwim Bay via the Etolin Strait to Kuskokwim Navigation Corridor;
- Deployment of two GNSS tide buoys off western Nunivak; and
- Testing and utilization of SDB data products.

Seafloor Geodesy and Mapping in Alaska

Dr. Peter Haeussler, Alaska Coordinator for USGS' Earthquake Hazards Program, spoke about USGS' seafloor mapping and geodesy updates in Alaska.

Bathymetry along the Queen Charlotte Fault in southeast Alaska acquired from 2015-2018 is now available as part of USGS Open-File Report 2022-1085. The bathymetry shows what complete mapping from the shoreline to the deep sea can look like, emphasizing the need for more transit mapping data.

In FY23, USGS and NOAA plan to collect bathymetry along Alaska's margin south of Kodiak using the NOAA Ship Fairweather as part of a Seascape Alaska project to study the geologic history in sediments that can shed light on faulting and climate change in the region.

Upcoming plans also include seafloor geodesy work. Three NSF-funded geodetic landmarks were established in the Aleutians in 2018, which helped to identify three M7.6+ earthquakes. As a result, six new offshore sites are to be installed along the Aleutians in 2023, which will contribute to a better understanding of subduction zones, earthquakes, and tsunami hazards in Alaska.

Aleutians Uncrewed Ocean Exploration

Colleen Peters, a bathymetry data manager for Saildrone, gave updates on the 2022 uncrewed exploration project coordinated by the Ocean Exploration Cooperative Institute in partnership with NOAA Ocean Exploration, the Office of Coast Survey, the Deep Sea Coral Research & Technology Program, BOEM, UNH, USGS, and MBARI.

The 72-foot Saildrone *Surveyor* was deployed from Dutch Harbor to the Aleutian Islands as part of a mission to test its endurance capability when operated completely remotely with finite resources on board. This platform was equipped with two ADCPs, an EK80 echosounder, EM304 and EM2040 multibeam sonar systems. Along with wind and solar power, the *Surveyor* uses a diesel engine to assist with propulsion and battery system charging. The survey window was cut to 52 days due to deteriorating weather. Over 16,000 square km of seafloor with transits were mapped, including 69 SVPs and 7430 linear km. This first half of the project elucidated the behaviors and operational aspects of mapping while sailing in Alaska. The *Surveyor* will finish out the remaining days of this project mapping the U.S. EEZ off the coast of California.

NOAA Ocean Exploration FY23 Call for Input for Results

Sam Candio, expedition coordinator for NOAA Ocean Exploration, discussed details about an upcoming expedition to Alaska on the NOAA Ship *Okeanos Explorer*.

The *Okeanos Explorer* will be employed in the Aleutians and Gulf of Alaska in 2023 as part of a five-expedition series. Their mission space is waters deeper than 200 meters, so the vessel will be equipped with an EM304 multibeam sonar, split beam water column sonar, sub-bottom profilers, as well as the ROV Deep Discoverer to explore deep water habitats. The expedition will be open for broad participation through telepresence.

All work in Alaska's waters on the *Okeanos Explorer*, currently scheduled from May to September 2023, will be planned in coordination with Seascape Alaska and the NOAA Alaska Deep-Sea Coral and Sponge Initiative. The work will build off other programs, such as the Saildrone Surveyor project, and will be responsive to results from the FY23 Call for Input on community priorities, which was distributed in spring 2022 and received responses from federal partners, the international community, the industry sector, and academia. Community priorities and the expedition schedule will solidify in the coming months. If you have input or questions, please contact Sam Candio (samuel.candio@noaa.gov) or visit www.oceanexplorer.noaa.gov.

Aleutian Trench Biodiversity Studies (AleutBio)

Dr. Angelika Brandt, professor at Senckenberg Research Institute and Goethe University in Frankfurt, and Dr. Anne-Cathrin Wölfl, postdoctoral research scientist at GEOMAR Helmholtz Centre for Ocean Research in Kiel, delivered a pre-recorded presentation with updates on Aleutian Trench biodiversity studies and mapping activities as part of AleutBio on the R/V Sonne in summer 2022, an extension of the KuramBio project.

Since 2010, German-Russian biodiversity expeditions known as KuramBio I and II have investigated the biology of benthic fauna in the Sea of Japan, the Sea of Okhotsk, the Northwest Pacific abyssal plain, and the Kuril-Kamchatka Trench on vessels like the R/V Akademik M.A. Lavrentjev and the R/V Sonne. In R/V Sonne's most recent expedition to US waters this summer, AleutBio's objective was to study the biology, faunal exchange, and connectivity between the Aleutian Trench and the Kuril-Kamchatka Trench, as well as between the Arctic and North Pacific. The expedition was captured in daily posts to the AleutBio Blog site.

Dr. Anne-Cathrin Wölfl, who managed bathymetry collection during AleutBio this year, mapped 15 stations in the working area, including three in the Bering Sea and the rest in and around the Aleutian Trench. Data was recorded at the stations in an approximately 7x7 nautical mile survey area with 100% overlap. Altogether, about 25,000 square km of bathymetry were acquired during this expedition for a depth range between 277 and 7200 meters. Bathymetry data will soon be publicly available in raw and processed form on the IHO DCDB as well as PANGAEA Data Publisher for Earth & Environmental Science.

Questions

There were a number of questions from attendees and panelists during this session.

To Meredith Westington – What is the Seascape Alaska Exploration Team?

Proposed objectives of the Seascape Alaska Exploration Team are:

- *Identify and share past, current, and future research projects focused on assessing the biological, physical and chemical characteristics of the unknown or poorly understood areas of the seafloor, sub-bottom, and/or water column (NOMEC goal 2);*
- *Identify and share available data sets; and*
- *Identify potential collaborators.*

To Colleen Peters – What was the realized endurance of the Saildrone Surveyor?

Saildrone is still working on pushing the vehicle to its limits, but has completed transits between California and Dutch Harbor Alaska, and between California and Hawaii in about 30 days with a mix of sailing and motoring. The last deployment was 22 days of survey and 30 days of transit. The endurance depends on the conditions in which the Surveyor is working – when surveying closer to islands or the coast, where currents are more prevalent, endurance may be less (still around 30 days), whereas working offshore in a more open-water environment may bring it closer to 60 days. It all depends on the wind and current.

To Colleen Peters – Was fuel a limiting factor in the Aleutians Saildrone work, or just time and weather?

At the end of the mission, the survey was cut short due to the impending weather conditions. Storm season kicks up around October 1, and since the Surveyor was transiting back across the Pacific, they needed to ensure a safe passage.

To Colleen Peters – Is Saildrone mapping on transit between survey areas and outside to contribute to Seabed 2030?
Saildrone mapped between survey areas in Alaska as part of the mission, but not when crossing the Pacific due to the need to conserve resources to ensure a safe transit. Perhaps in the future!

To Angelika Brandt – Did AleutBio also acquire and process seafloor backscatter? Also, what was the multibeam system?
From the AleutBio cruise report, "Distance between survey lines was defined based on estimated water depth to ensure 100% coverage with 100% overlap, since backscatter information was essential." Also, "Bathymetry and backscatter data have been processed on board using QPS Qimera and MBSystem. All raw and processed bathymetry products include the following:

- *Raw bathymetry data is provided in Kongsberg EM122 data files (ALL);*
- *Processed data is provided as cleaned soundings in XYZ ASCII format showing longitude, latitude and water depth*
- *Processed data is provided as GSF files for integration into the Global Multi-Resolution Topography Data Synthesis (GMRT)*
- *Processed data is provided as Floating Point GeoTIFF Grid with a resolution of 100 m"*

To Hadley Owen – TerraSond's presentation mentioned that stakeholder input was used for mapping the area around Nunivak. What was the composition of the stakeholder input considered? And how was it weighted for selection?
We emailed and followed up by phone with the Native Village of Mekoryuk and the NIMA Corp. I talked with Kathleen at Mekoryuk, and also emailed with Tisha Kuhns at Calista. However, the most direct feedback related to prioritizing survey areas came from the Alaska Marine Pilots group, and the tanker lightering operators, who provide services to the community.

SESSION 2: Mapping Vessels of Opportunity

Within the session on mapping vessels of opportunity, we heard from six speakers representing the federal government, academia, the nonprofit, and the private sector. For five minutes each, the speakers discussed various aspects of mapping vessels of opportunity and crowdsourced bathymetry (CSB).

Support Vessels of Alaska

Scott Hameister, Assistant General Manager for Support Vessels of Alaska, described the services and capabilities of the local charter vessel company. Support Vessels of Alaska (SVA) is a veteran-owned business located in Homer, Alaska that was founded on the idea of providing safe and efficient vessels and crew that support critical projects.

SVA's Alaska-based crew consists of many U.S. Coast Guard licensed mariners, all of whom are committed to safety and an understanding and respect for the environment. SVA works with many groups, including Federal and state agencies, universities, commercial companies, non-profits, and the U.S. military. Some of SVA's most capable vessels for mapping include:

- *Arctic Seal* (130'), with a centrally located moon pool and 45+ day endurance;
- *Qualifier 105* (105'), with a forward/side scanning sonar and hydraulic multibeam arm, 45+ day endurance, and housing for 30 people;
- *Woldstad* (121'), with a hydraulic multibeam arm and 90+ days endurance; and
- *Norseman II* (115'), with a hydraulic multi beam arm and 90+ days endurance.

For questions or more information, please visit www.svaboats.com.

U.S. Coast Guard Crowdsourced Bathymetry Efforts

Candace Nachman is a Senior Ocean Policy and Program Advisor for the U.S. Coast Guard Marine (USCG) Transportation Systems Directorate and the USCG Principal to the NOMEC Council and other OSTP interagency committees. She provided an overview of recent USCG CSB efforts that began in 2020 and 2021.

In 2008 and 2013, the USCG provided single beam sonar data from the Coast Guard Cutters (CGC) Hickory and Spar as part of a NOAA collaboration to improve nautical charting in the Kuskokwim River and Bechevin Bay. In 2020, USCG launched a pilot program of seafloor mapping data transfers to NOAA NCEI. Phase 1 testing began November 2020, with a single transfer of depth information from the Electronic Charting Display and Information System (ECDIS) of the CGC Frank Drew, which operates in the Hampton Roads area of Virginia. Phase 2 was initiated in June 2021 in Alaska and is ongoing, with quarterly ECDIS and HYPACK transfers to the NOAA NCEI IHO CSB Program from CGCs Hickory and Fir. There are only three cutters in the USCG fleet that do this work, and they all operate in Alaska. NOAA requested to add 60+ Alaska cutters to the CSB Program, and internal offices are assessing future fleet-wide participation.

Access to Data from Foreign Scientists Conducting Marine Scientific Research in Waters under U.S. Jurisdiction

Allison Reed and Liz Buendia from the U.S. State Department's Office of Ocean & Polar Affairs (OPA) and Jennifer Jencks from NOAA NCEI provided an overview of the U.S. consent process and data management for foreign scientists conducting Marine Scientific Research (MSR) in waters under U.S. jurisdiction.

The 1982 Law of the Sea Convention set up a process for foreign scientists to request consent to do research in waters around coastal states. Article 249 mandates that foreign scientists have a duty to provide coastal states access to MSR data collected during their cruise. Policy requires advanced consent for MSR performed in the U.S. EEZ. OPA processes 30-40 applications from foreign scientists every year and issues consent letters after review from USCG, DOD, CBP, ICE, NOAA, USFWS, DOE, EPA, BOEM, and NSF. Consent letters require foreign scientists to submit preliminary and final reports as well as data to NOAA NCEI within two years. For example, after Japan's R/V Mirai collected continuous multibeam bathymetric data in Alaska during research cruise U2020-004, Japan submitted bathymetry to NOAA NCEI via Send2NCEI.

NCEI has tracked 351 MSR requests since 2010. 77 MSR datasets are now publicly available from nine countries including Australia, China, France, Germany, Japan, Mexico, South Korea, Spain, and the UK. Most data contain oceanographic, chemical, and visual biological observations, but bathymetry is becoming more common. NCEI archives and makes MSR data more easily discoverable and accessible; this year, NCEI set up an MSR Data webpage.

Overcoming Barriers to Scaling Crowdsourced Bathymetry

Georgianna Zelenak, bathymetry data manager at NOAA NCEI, discussed ongoing efforts to overcome technical barriers to scaling CSB. The IHO CSB Working Group (WG) has been making efforts to expand the global collection and contribution of CSB since 2014. NOAA NCEI hosts the IHO DCDB, which makes CSB data publicly discoverable and accessible. Rosepoint Navigation Systems was the first company to commit to the collection and contribution of CSB data from U.S. and Canadian waters to DCDB, and has played a large role in establishing the pipeline. Today, seven data contributors (Trusted Nodes) are continuously collecting and contributing data, with several more in the final stages of testing. Current Trusted Nodes include:

- Rosepoint Navigation Systems;
- FarSounder Inc.;
- MacGregor Germany/Carnival Cruise Line;
- Petroleum Geo-Services;
- M2Ocean;
- Great Lakes Observing System; and
- Orange Force Marine.

CSB on a global scale is limited by technical barriers to collecting, contributing, accessing, and using bathymetry. DCDB accepts CSB from Trusted Nodes, including organizations, companies, or universities serving as data liaisons between mariners and the DCDB. Trusted Nodes streamline and simplify the process of contributing CSB data to the DCDB.

Data requirements for CSB should be kept minimal to encourage participation. DCDB currently requires latitude, longitude, depth, time, and a few basic metadata fields. This year, the IHO CSB WG updated the CSB guidance document to encourage robust metadata without enforcing strict data requirements. Through its Bathymetry Viewer, the DCDB is creating a cloud-hosted, scalable point data store to better handle CSB as a seamless collection of points, and initiating a pilot project to generate bathymetric grids of a given area using a user-specified resolution. For more information, visit the IHO Crowdsourced Bathymetry site.

Crowdsourced Bathymetry in the Great Lakes

Linden Brinks, geospatial analyst with the Great Lakes Observing System (GLOS), discussed a collaborative effort to work with vessels of opportunity to collect and contribute CSB from the Great Lakes. GLOS is a bi-national nonprofit organization leading efforts to contribute bathymetry from the Great Lakes – which are currently only 7-15% mapped – as part of Lakebed 2030.

With funding from the Integrated Ocean Observing System (IOOS), GLOS partnered with Orange Force Marine to develop an end-to-end data processing solution that includes the IoT devices (Mussel data logger) onboard vessels, automated data transfer, and a cloud-based data processing pipeline. The Mussel Kit, which connects to onboard systems, logs single-beam depth and positioning, locally stores data, and then transfers data to the cloud through 5G/wi-fi. On the cloud, the data is processed through a series of steps to convert and transpose data to various formats. Data is sent to the IHO DCDB as a Trusted Node (GLOS) within minutes of being processed making the Ping to Chart concept a reality in a matter of minutes not days, weeks, or months!

From 2021 to 2022, the program has more than doubled in size, and GLOS has expanded its fleet from two to over twenty vessels. Participating vessels have sailed around 1600 sea hours, 13,500 nautical miles, and collected over 5.7 million points. They have committed to forming a strategic working group to advance the goals of Lakebed 2030, including expanding CSB in the region; diversifying contributing technologies; increasing accessibility to more stakeholders and volunteers, and expanding and deepening the data pipeline to accept more types of data.

Questions

There were a number of questions from attendees and panelists during this session.

Does the U.S. Government treat bathymetry data collection as MSR?
There is no international agreement on what falls under the term "MSR" for diplomatic consent purposes. Rather than having a definition of MSR, the U.S. government has a list of activities which we do not consider MSR for diplomatic consent purposes (however I note that other countries might not agree with us on this list). One such activity that is not considered MSR is a hydrographic survey for enhancing safety of navigation. You can find the full list of "not MSR" activities at the MSR Consent Overview website.

For U.S. groups operating in foreign EEZ, do they still need to apply via the State Department, or can they apply directly to the other country?
Yes, US scientists should submit their application for MSR in Foreign Waters to the State Department via the RATS portal

I would like to affirm the UNDRIP instrument that the US is a party to and addresses Indigenous rights and land use. What, if any, Indigenous input is there for foreign researchers conducting activities within Indigenous lands, in particular, Inuit Nunaat?
The State Department MSR/RATS website notes that if the research is within 3 miles from shore, local authorities should be consulted. In addition, NOAA's Alaska Fisheries Science Center issues a Letter of Authorization (LOA) to detail POCs (such as Indigenous communities) who the scientists should coordinate with to conduct research in Alaska.

Is GLOS able to talk about how much it costs to set-up a CSB logger per vessel?
Mussel kits are currently free in the Great Lakes because they are funded by GLOS. Outside of that, I believe they are around ~$2500.

After this session, participants took a 30 minute break for lunch.

SESSION 3: Data, Products, and Processing

In the Data, Products, and Processing session, seven presenters spoke about sharing, accessing, and turning data into products for use in Alaska, with ideas for making the process more efficient and user-focused.

Seascape Alaska Data Management Technical Team Update

Christie Reiser, bathymetry data manager for NOAA NCEI, and Dr. Bob McConnaughey, research fishery biologist for NOAA Alaska Fisheries Science Center (AFSC), presented updates from the Seascape Alaska Data Management Technical Team.

The team identifies data needs for Seascape Alaska, and reviews the U.S. Bathymetry Gap Analysis to guide its efforts. In 2021, Alaska gained 28,000 square nautical miles of new bathymetry. While this demonstrates real progress in the region, we need to acquire 3-4 times more new coverage annually to reach NOMEC goals. Some of these data already exist, but are not publicly available at NCEI.

This year, the AFSC contributed 15 years of water column data (637,000 km of trackline data; about 12 million soundings) collected during fish surveys. These data were collected using an ES60 sonar outfitted on fishing vessels and contain seafloor depth information. CruisePack developed by the NCEI Water Column Group was used for data bundling, and Kluster software developed by OCS is being explored for processing. Fishing vessels of opportunity can be effective force multipliers for NOMEC; data quality can improve with better interaction between data providers and software developers.

Team members identified eight JAMSTEC cruises in the Arctic and several R/V Sonne cruises in the Aleutians and assisted with migrating the data to NCEI. The team is also seeking to add bathymetry points associated with BOEM gravity data in the Arctic. Continuing challenges for the team include data formatting and packaging, data restrictions, bandwidth of the team members, and communications with potential data providers. To help the group, please review the U.S. Bathymetry Gap Analysis and let us know if you have any data that are not included via the Data Provider Sharing form.

Crowdsourced Bathymetry in Alaska

Anthony Klemm, a physical scientist in the Atlantic Hydrographic Branch at NOAA Office of Coast Survey, provided an update on a workflow for processing CSB data from Alaska.

CSB data holds significant value, especially when it is the best available data in remote areas, such as many regions of Alaska. New open-source Python-based software is being tested to process CSB trackline data for navigational usage in waterways, such as the Ninglick River. The software filters and cleans the data, corrects for tides using NOAA CO-OPS tide predictions, derives and applies an estimated vertical transducer offset, and grids and interpolates the data. Preliminary results have been promising for charts in Houston, TX and the Chesapeake and Delaware Bays, where CSB was demonstrated to represent bathymetry well and identify mischarted shoals.The software could be applied along with SDB to improve chart products for areas of navigational significance in Alaska, such as the Yukon River.

GMRT: Processing and Grid Products

Dr. Vicki Ferrini, a senior research scientist in the Lamont-Doherty Earth Observatory (LDEO) at Columbia University and head of the Seabed 2030 Regional Center for the Atlantic and Indian Oceans, discussed how bathymetry is processed and grid products are provided through the Global Multi-Resolution Topography (GMRT) Synthesis.

GMRT is an infrastructure for delivering elevation data (bathymetry and topography) in a variety of user-defined formats (grids, images, points, profiles) with a tiling scheme maintaining data simultaneously in three projections. GMRT products are accessible via the GMRT MapTool web app, GeoMapApp desktop app, and GMRT Web Services, providing full attribution and provenance to data sources, curating, and delivering fit-for-purpose processed swath files into the public domain and global synthesis.

GMRT maintains input raster data at native resolution and curates four discrete tiled elevation components at multiple resolutions: GEBCO 2022 (~400 m), topography (10-30 m), contributed grids (1 to 100s of m), and GMRT-curated MBES Synthesis (~100m). Custom local products are created on-demand by merging raster data and delivering in netCDF, GeoTiff, and ESRI ASCII Raster format.

The latest GMRT V4.1 global synthesis has integrated multibeam sonar data from 1,387 cruises and 43 different ships, with about 10% global coverage using data from 1980-2021. The team aims to accelerate the pace of data processing and curation by making GMRT QA/QC tools distributable for anyone to generate processed transit data that is fit-for-purpose in the context of the global synthesis. This tool has been tested at sea and is now part of at-sea standard operations with Ocean Exploration Trust's E/V Nautilus. Tools are available at the GMRT-Tiler Wiki.

There are a number of different metadata-driven overlays, and downloadable shapefiles are now available at the GMRT Web Services page.

NCEI Bathymetry Viewer and Grid Extract Tool

Jessica Nation, a bathymetry data manager at NOAA NCEI, demonstrated how to discover, access, and extract data from the NOAA NCEI Bathymetric Data Viewer. NCEI is the U.S. national archive for multibeam bathymetry data and holds over 3500 multibeam surveys, equating to roughly 65 terabytes of data. The Bathymetric Data Viewer is an interactive mapping application for this data, and the primary way to discover and access it.

The Bathymetric Data Viewer supports several datasets, including multibeam surveys, NOAA NOS Hydrographic surveys, singlebeam surveys, CSB, digital elevation models (DEMs), and coastal LiDAR. These layers can be filtered by using the "Search Bathymetric Surveys'' tool built into the viewer. Clicking on any dataset feature on the map will bring up more information about that feature and links that route to resources for downloading the data. Downloading multiple datasets or surveys within an area of interest can be achieved using the "Identify" tools located in the upper right corner of the map. Additional instructions for navigating the data viewer can be found under the "Help" tab to the left of the map.

The majority of the multibeam bathymetry data in the NCEI archive are raw and uncleaned; these data are typically used by those who know how to process data and create their own products. NCEI has also developed tools that allow non-expert users to easily create and download grids themselves. The Grid Extract tool, located in the bottom left corner of the viewer, can be used to create and download grids in GeoTIFF format from the multibeam, NOS Hydrographic, and DEM datasets. The Autogrid tool can export grids of the multibeam archive in NetCDF, ESRI ASCII Raster, and XYZ format.

Data Processing Capacity and Expertise Gaps in Alaska

Dr. Erin Trochim, a research assistant professor in Alaska Center for Energy and Power (ACEP) at the University of Alaska Fairbanks (UAF) since 2020, spoke about expanding efforts to develop skills for undergraduate students in order to fill local expertise gaps in Alaska.

Summer interns in UAF's ACEP Undergraduate Summer Internship (AUSI) Program recently participated in projects with JALBTCX to learn about coastal mapping and geospatial data to observe change in Kaktovik's coastline. Interns processed mapping data, worked with JALBTCX staff, and applied research projects to real-world problems. These projects included fieldwork to collect single-beam bathymetry using a Hydroball in Elson Lagoon off the Beaufort Sea; verifying topobathy lidar using single-beam and multi-beam bathymetry; and tracking changing coastlines on the North Slope using CoastSat and the Landsat temporal record.

These internships provide real-world practical experience and support career growth in coastal and ocean mapping fields. Future research projects with JALBTCX could include testing military prototype sensors; producing National Coastal Mapping Program analysis products; addressing community threats and updating Alaska's Environmentally Threatened Communities rankings; and developing capacity and coordination. Applications for the 2023 AUSI will open on December 5.

Dr. Trochim proposed a student/training pipeline development which includes project fellows supported by a cohort program to refine technical skills and leadership (such as Alaska Sea Grant Fellows), and undergraduate interns who want exposure to geospatial data, coastal applications, and data processing. The proposed pipeline aims to create building blocks for careers in Alaska with coastal and ocean applications. Some examples of foundational education include:

- Experiences with basic research, such as an internship or fellowship program;
- Geospatial and data skills development using different approaches such as Google Earth Engine, Esri ArcGIS, and machine learning;
- Field and technical skills development with hands-on experience acquiring ocean and coastal data; and
- Providing opportunities for place-based experiences, including community-focused projects.

Habitat Mapping with Waterborne Technology

Liza Hasan, an intern at the National Park Service (NPS) and masters student at UAF, discussed habitat mapping work performed in Alaska. Liza's work focuses on nearshore coastal habitat mapping and primarily uses tools for ecological research. Benthic habitat characterization can be used to apply habitat information to different questions, such as her graduate work modeling sea otter species distribution.

A drop camera was used by NOAA NCCOS in Kachemak Bay to collect visual data and point surveys. It has been effective for a high density of visual sampling and ground truthing acoustic backscatter. Drop survey point locations can be viewed on the NCCOS Kachemak Bay BIOMapper data viewer and used to complement the backscatter. ROVs are used at NPS for habitat mapping and can perform visual transect surveys. The tethered instrument can be outfitted with other sensors such as a multibeam, and are valuable for exploration during small-scale projects. In 2020-2021, an ROV surveyed regions of Lake Clark National Park, East and West Cook Inlet, Katmai National Park, and North and South Kachemak Bay. The ASV is about 5.5' long and contains a multibeam echosounder that runs continuous surveys. The ASV can be programmed to survey a grid within an area of interest, and surveys larger areas than the camera or ROV, and from a farther distance since it is untethered.

Considerations for which tool to use depend on whether the project requires surveying with visual vs. acoustic surveys, manual vs. algorithmic habitat characterization, and exploration versus surveying specific sites.

Tsunami Inundation Mapping in Alaska

Dr. Dmitry Nicolsky, research associate professor in the Geophysical Institute at UAF, discussed bathymetry needs for a project to develop tsunami inundation maps in Alaska. Dr. Nicolsky's group uses topobathy DEMs developed by NCEI to produce tsunami inundation maps along Alaska's coastline. They have developed inundation maps for many coastal communities in Alaska with a 15 meter resolution. See the Alaska Earthquake Center website for a list of modeling reports.

While the minimum DEM resolution requirement for inundation modeling is 90 meters, this sparse resolution can negatively affect modeling of tsunamis in Alaska. It is preferred to use DEMs that resolve straits and openings to harbors in great detail. To model tsunami currents, e.g., near Kodiak Harbor, resolution requirements are much more demanding and must be ~10 meters to resolve the harbor entrance and breakwaters. In Akutan, an inundation model required adjustments to the DEM to account for construction of a new harbor, requiring cooperation with harbor developers to resolve tsunami currents and impacts on infrastructure. The tsunami modeling group is adjusting DEMs using RTK GPS surveys, if necessary.

As the group pivots towards considering tsunamis in the Bering Sea, better bathymetry in coastal areas of Bristol Bay would be instrumental for accurate modeling of potential inundation. Besides being instrumental for modeling

tsunamis, high-resolution DEMs can provide information about historical landslides and fault offsets, such as in the Aleutian Trench. High-resolution DEMs from multibeam mapping can also help characterize tsunami sources.

Questions

Unfortunately, at the end of this panel, there was no time for questions and discussion. In the chat, the following questions were answered.

To Anthony Klemm – How are you tide correcting CSB in western Alaska with sparse tide gauge coverage and poor tidal predictions? You mentioned that discrete tide zones are not available in all the areas that you currently need; are you retrieving this data via the Discrete Tidal Zoning Map? Please send along your known gaps to CO-OPS so that we can prioritize these areas for updating the zoning map.

I'd love any ideas for Western Alaska :) I would love to use CO-OPS discrete zone tides. I use the currently available zones (from their zones map they host as a feature service online) by performing a spatial join of the CSB point data on the zones to get a time min/max, then use the CO-OPS tide datagetter API to download the data in 31 day chunks for each control station. I'll have to reach out to CO-OPS to discuss future areas that can be published to their service. If areas are really close to a current control station, I could make my own discrete zone polygon without a time/magnitude offset.

To Dr. Erin Trochim – What is your processing turnaround time for a typical JALBTCX collection?

It depends right now, it takes time for the students to come up to speed with the processing. Then the data still needs to go through QA/QC.

To Dr. Erin Trochim – How do you deal with the lack of resolution in Landsat imagery products for determining erosion rates at a community scale, since you mentioned using Landsat to make updates to the Denali Commission report?

The CoastSat project on the North Slope will be useful looking at the assumption of linear change over time periods, but at the 30 m resolution. This is separate from revisiting the Environmentally Threatened Communities work. The new Cloud-Based Remote Sensing with Google Earth Engine textbook is available for free at https://www.eefabook.org/. There is a chapter on Benthic Habitats using Planet imagery. My chapter was on the Built Environment.

SESSION 4: Collaboration and Planning

In our last session of the day, we heard from seven speakers on ways to improve collaboration and planning to support campaign-style mapping activities in Alaska.

Satellite-Derived Bathymetry to Improve Hydrographic Survey Planning

Starla Robinson, physical scientist in the Hydrographic Surveys Division at the NOAA Office of Coast Survey, provided an overview of SDB to assist with hydrographic planning.

SDB can be used to provide data on possible shoaling, which improves project planning and field safety, such as during the Nunivak Project this year. In Nunivak, collaboration with the NOAA SatBathy Team helped with data to inform how best to approach areas like the Mekoryuk River Channel and other uncharted dangers. Although SDB has limitations, such as with IHO object detection and turbidity resulting in variations to the extinction depth, it enabled the survey team to go into the project with navigational awareness.

Alaska has many areas where SDB could help field teams navigate inadequate charts. Some limitations of SDB include the need for shoal data to calibrate and validate SDB, glacial runoff which increases turbidity, and ice and cloud cover which limit the windows when SDB can be used. Nevertheless, SDB has been used for reconnaissance applications to improve field safety, track shoals, plan and prioritize, and fill in data gaps for contours and modeling. Some examples of applying SDB in Alaska include projects in Elson Lagoon, Utqiaġvik (Barrow), and Yukon. As SDB tools improve, more effort will be made to ground truth and calibrate SDB and to find opportunities to collaborate using CSB and other hydrographic data.

Efficiency in Real Time GIS Project Management Tools

Dave Neff, geospatial program director for Woolpert, provided an overview of real-time GIS project management tools to assist with survey planning.

Woolpert's GIS tool set includes a cloud-based GIS sharepoint; multi-browser support; a collaboration space and a blueboard (for intra-company, client/vendor, and public planning); a customizable environment and architecture; 2D, 3D, and 4D data visualization; and no licensing or training necessary. It has been used for projects in Alaska, such as the Cape Newenham hydrographic survey in Goodnews Bay this year and a Barry Glacier emergency survey, as well as projects focusing on sediment transport in San Francisco Bay and a

cable routing survey in Hudson River. The utility allows clients and the public to see vessels moving and tracklines being created in a broadcast to get real-time updates on the progress of surveys. The portal can be used to make decisions about how to move forward with features found during surveys.

The public-facing feature of the GIS tool can be accessed at eTrac's Open Map Layers, which shows nautical chart products over aerial imagery and provides a simple and easy way to communicate spatial data and areas of interest by outlining and extracting the data in KMZ or JSON format.

Developing Partnerships – How IWG-OCM Spatial Priorities Can Inform Mapping Collaboration

Cathleen Yung, GIS coordinator with NOAA IOCM, spoke about the 2021 Alaska Spatial Priorities Study results and the utility of derived geospatial tools. The study can be used to inform more efficient allocation of resources.

Building on the results of the 2019 Alaska Spatial Priorities Study, the 2021 Study was finalized in Spring 2022 and posted to the U.S. Mapping Coordination website. The 2021 Study results are more comprehensive, spanning both coastal and ocean mapping needs and introducing additional map products, such as water column, backscatter intensity, and sub-bottom profiling, as well as project justifications tailored towards ocean mapping initiatives. Alongside a view of agency mapping plans (funded, proposed, and recently completed), the Overlap Analysis layer enables users to view where multiple organizations have shared interest in map products.

The 2021 results are also available in a more interactive format on the Alaska Mapping Priorities Dashboard, and the Mapping Partner Finding Tool. As mentioned yesterday, the Dashboard is designed to help answer questions, such as "What areas are important? What map products are needed? How soon?" This tool might be a good place to start, if you have funding, but are unsure where to best apply those funds.

The Mapping Partner Finder Tool is designed to answer questions, such as "Who else is interested in my area?" By enabling users to find and rank potential partners by area of interest, the tool can help facilitate cost-sharing opportunities. Reports from the tool can be saved as PDFs and shared with the IWG-OCM staff at iwgocm.staff@noaa.gov, who can assist with identifying appropriate points of contact for partnerships. This tool might be a good place to start, if you have a mapping capability in a certain region and are looking to make the most of your efforts.

Mapping Partnership Mechanisms

Ashley Chappell, program director at NOAA IOCM, presented ways to partner with NOAA and other federal agencies for mapping.

The NOAA Rear Admiral Richard T. Brennan Matching Fund (BMF) Program is a way for NOAA to partner with outside entities on mapping initiatives. It leverages NOAA and non-federal partner funds to acquire more ocean and coastal mapping data, primarily through contract surveys. For the FY24 opportunity, NOAA is providing up to 70% of the total project cost, with the selected entity contributing at least 30% for projects to support mapping needs. Any non-federal groups are eligible to apply. Qualifying proposals must demonstrate the ability to provide their matching funds to NOAA upfront via a memorandum of agreement (MOA). MOAs require details on Parties and Purpose, Authorities, Scope of Work, Funding Arrangements, Timelines, and Recourse. BMF proposals are evaluated for whether:

- The project would provide intrinsic value to IOCM or relevance to NOAA missions and priorities;
- There is a clear need, anticipated outcomes, and/or public benefit;
- Persons of contact, partners, and funding sources have been identified; and
- The proposed budget is realistic and the project is feasible and flexible.

Selected proposals combine NOAA funding with the partner match, along with NOAA's hydrographic survey and shoreline mapping expertise, contract management and oversight, survey compliance and services, data processing, management, high-resolution products, and data stewardship with NOAA NCEI. The BMF is executed through Geospatial Contract Vehicles, which includes the Hydrographic Surveying Services, Shoreline Mapping Support Services, and Coastal Geospatial Services contracts. NOAA and other federal agencies are enthusiastic about partnering on mapping collaborations through BMF and beyond. For questions, contact iwgocm.staff@noaa.gov.

IWG-OEC Strategic Priorities for Ocean Exploration and Characterization

Caitlin Adams, from NOAA Ocean Exploration, spoke about strategic priorities for ocean exploration and characterization of the U.S. EEZ (Goal 3 of the NOMEC Strategy), which is the primary focus of the newly formed Interagency Working Group on Ocean Exploration and Characterization (IWG-OEC). She spoke about the IWG-OEC's process to identify the priorities on a thematic and geographic basis.

Starting November 2020, Federal subgroups composed of 92 subject matter experts from 15 agencies were formed to draft white papers covering the following themes: benthic ecology, cultural heritage, marine resources, seafloor hazards, and water column. At the same time, public input was sought via a Federal Register Notice. In Summer 2021, the IWG-OEC compiled a summary report from both the subgroup white papers and public input. The report underwent extensive Federal review and there was a public comment period of the draft final report from March to June 2022. On October 28, 2022, the report was officially released by the White House and can be found on the IWG-OEC website.

Alaska, specifically the Aleutian Arc, was the only region prioritized by all five subgroups. The benthic ecology group was interested in the dense and diverse deep sea coral habitat. The seafloor hazards group had two main areas of interest: (1) the submarine volcanoes and subduction zone of the central Aleutian Arc, which includes the Islands of Four Mountains, the Shumagin Island slope, and the Unimak Island area; and (2) the eastern Alaska subduction zone area, which includes Middleton Island and Montague Island. The marine resources group was interested in aquaculture, deep sand and gravel, and marine natural products. The cultural heritage subgroup expressed interest in paleolandscapes in the Aleutians, Gulf of Alaska, and Bering Sea. Lastly, the water column subgroup highlighted the importance of understanding climate change-driven regime shifts in the Arctic and North Pacific.

The IWG-OEC anticipates updating these priorities every couple of years throughout the life of the NOMEC Strategy. Federal agencies have begun using the report to guide project planning and investments. The IWG-OEC is beginning work on NOMEC Goal 3.2– standards and protocols for ocean exploration and characterization.

Overview of Alaska's Coastal and Ocean Mapping Initiatives and Forums

Hillary Palmer, Alaska coastal project manager from Dewberry, spoke of Alaska's organizational framework supporting various mapping initiatives. The Alaska Mapping Executive Committee (AMEC) includes State and Federal agencies coordinating appropriations tied to mapping modernization in Alaska. The Alaska Geospatial Council (AGC) has open membership. It is chaired by the AKDNR Commissioner and is led by Dr. Leslie Jones, Alaska's GIO. The AGC is a great way to get involved in any Alaska mapping initiatives. The AGC Coastal and Ocean Technical Working Group meets quarterly, and at each meeting, you can expect to hear about the AMEC-Coastal Subcommittee; State of Alaska, DGGS Coastal Hazards Program; USACE National Shoreline Management Study; Alaska Regional Coastal Resilience Assessment. Other open membership forums include Seascape Alaska and the Alaska Water Level Watch. As a general rule, if you felt more aligned with the content shared on day 1 of this summit, email Hillary Palmer (hpalmer@dewberry.com) to join the AGC Coastal and Ocean group. If you felt more aligned with day 2 material, email Meredith Westington (meredith.westington@noaa.gov) to join the Seascape Alaska regional mapping campaign. You are welcome to join both of these groups.

Questions

There were a number of questions from attendees and panelists during this session.

To Dave Neff – Were the Barry Arm data available to all of the emergency response partners involved or just NOAA and USGS? Any issues with immediate data licensing or access to your portal?

To be clear, this was not an emergency response survey but rather a fast turnaround survey because there was a thought that the glacier could collapse and cause a tsunami, which thankfully did not happen. As far as I know that data went immediately to USGS via NOAA's Office of Coast Survey. And, all of the different portals for the different clients are handled on a case-by-case basis. When working with OCS and NOAA, there is not a public link to these portals, but on a case-by-case basis, they will allow Woolpert/eTrac to loosen the credentials to allow access.

To Ashley Chappell – Noting it's been around a while, are there any examples of successful Brennan fund projects?

It hasn't been around that long. That said, the first couple of times, we didn't get viable proposals, but this year, we have three good proposals that we're getting to the memorandum of agreement stage. Also it's worth pointing out that we can do Brennan Matching Fund-like projects all the time. Recently, we've had two projects occur outside of the Brennan Matching Fund opportunity: St Johns River Water Management District in Florida and Indian River Lagoon for topo/bathy LIDAR acquisition. So don't let missing a Federal funding opportunity deadline slow you down– reach out to iwgocm.staff@noaa.gov.

To Ashley Chappell – NOAA Coast Survey rough outyear plans are public. Is it possible that another group could expand an existing project regardless of percentage, or upgrade a project's data requirement? An example of this would be increased bottom samples or full coverage rather than partial? Or characterization?
Yes, any NOAA project and often those of our sister agencies can be modified with early partner engagement and funding (if needed) to meet more objectives. Sometimes we can absorb a small requirement but we can also augment a project with incremental funding to do more. The sunk costs are already covered, so this can potentially be a great way to partner with us.

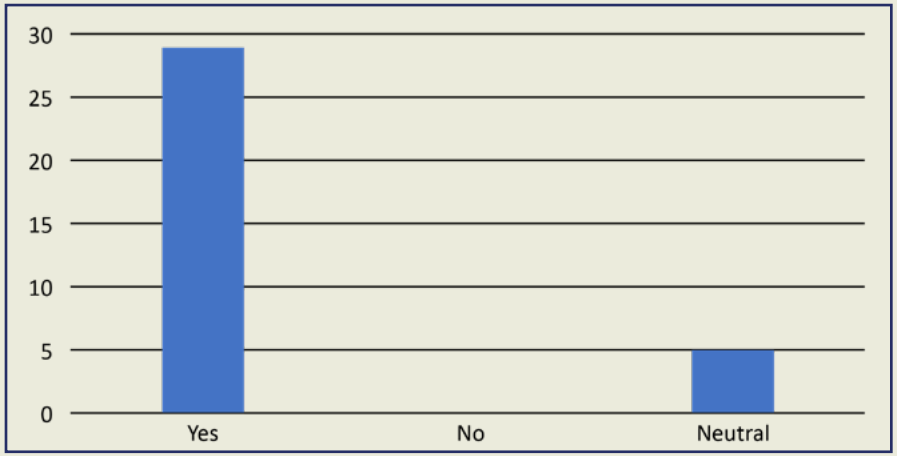
To Hillary Palmer – I did not see iNGOs listed. Are iNGOs able to join?
Anyone is welcome to join Seascape Alaska and/or AGC!

To Ashley Chappell – Are funds restricted exclusively to direct mapping initiatives or can funds be applied that map Indigenous Knowledge such as placenames that directly benefit international work and utilized regionally?
Probably depends upon the funding mechanism but we'd like to meet up and discuss this idea with you after the summit.

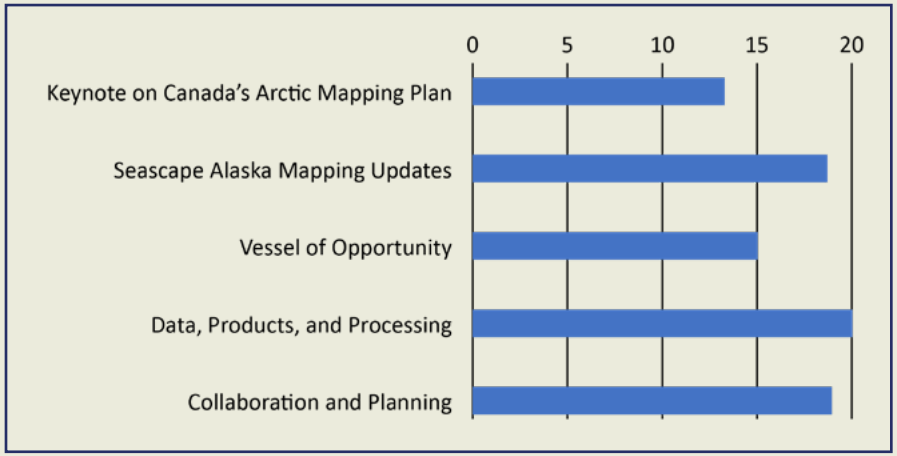
Day Two Closeout Survey

At the end of the day two, attendees were prompted to respond to a series of questions in a closeout survey. The results are below.

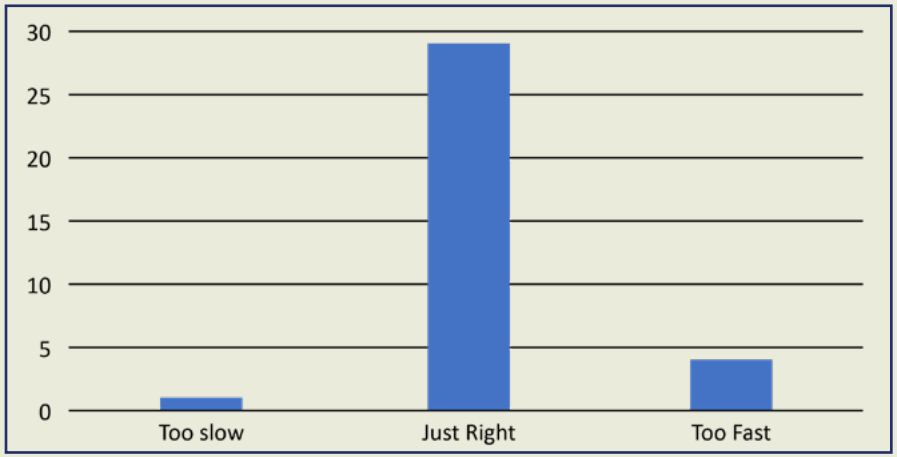
Did day two meet your expectations?



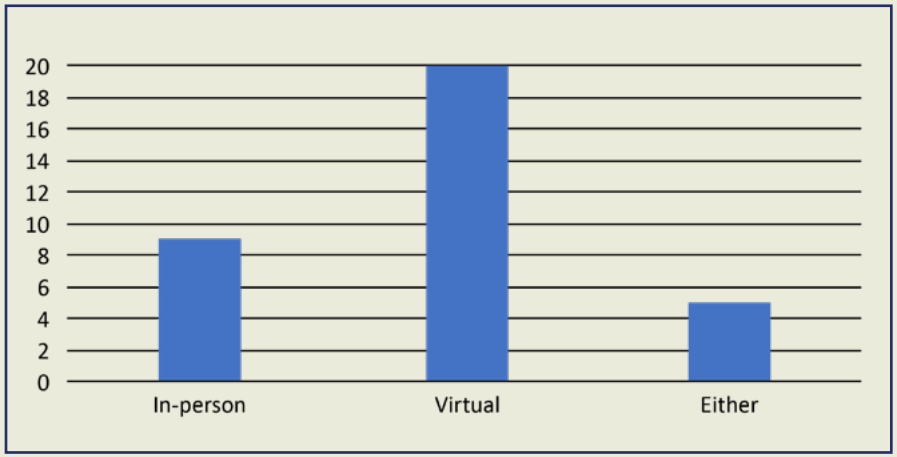
Which day two sessions would you like to hear more about in a futire webinar?



How was the pacing of the day?



For 2023, would you prefer to attend an in-person or virtual event?



Key Takeaways

Both days of the summit featured keynote speakers that are advancing funded mapping campaigns, which left an open question from summit attendees – how do we better connect what is going on in Alaska with other efforts like that in Florida ($100M) and the Canadian Arctic ($84M) to increase funding for Alaska's coastal and ocean mapping? The AMEC-CS Mapping Plan of Action discussion was cut short and will require additional outreach to move forward.

For coastal day, Typhoon Merbok response and data collection efforts reiterated the importance of statewide coastal mapping and the NSRS framework. Water levels and VDatum are the first steps in achieving this framework, and with a $5M earmark to the State of Alaska to fund the remaining gauge sites, NGS is poised to advance delivery of Statewide VDatum in FY24 – a foundational piece of the ACMS. That said, data collection is still a challenge due to narrow operational windows, but SDB featured prominently on both days of the summit as a potentially valuable tool to inform mapping plans. Mapping data may then be integrated into seamless, topobathy DEM products, but the path forward for an Alaska-wide topobathy DEM is unclear, because there are numerous DEM compilation efforts occurring in small localities as data become available.

For ocean day, the piecemeal efforts expressed on coastal day continued with further emphasis on how to align different activities across the state. From poll results, we learned that participant knowledge of the data, processing, and product landscape varied greatly. Relatedly, poll respondents indicated that they use a minimum of eight different web-based tools to help with planning and coordination and that there is frustration when these tools do not agree. Recognizing that we have limited control over the development of many of these tools, it may be useful to work together and hone the data sources that are going into these tools to limit variability. In addition, there is a suggestion to increase common knowledge of the data landscape through training and webinars covering basic themes, such as (1) how to collect bathymetry for maximum re-use; (2) how to share bathymetry with NCEI; (3) how to process bathymetry; and (4) how to easily find bathymetry collected by others. To expand on low cost data collection efforts, there was a lot of discussion on CSB models and a need to show the value of CSB data through products to increase participation. Lastly, given limited funding to support broad scale mapping activities, there is a need to better identify existing funding opportunities to advance ocean and coastal mapping goals in smaller iterations.

For next year's summit, the majority of participants requested to meet virtually; however, a few expressed interest in also having an in-person event with more room for discussion.

Image credit: Joe Kujawski

Appendix A – Abbreviations and Acronyms

3D	three-dimensional
3DEP	3D Elevation Program (USGS)
ACEP	Alaska Center for Energy and Power
ACMS	Alaska Coastal Mapping Strategy
ADCP	Acoustic Doppler Current Profiler
AFSC	Alaska Fisheries Science Center (NOAA)
AGC	Alaska Geospatial Council
AGO	Alaska Geospatial Office
AI	artificial intelligence
AIS	Automatic Identification System
AKDNR	Alaska Department of Natural Resources
AMEC	Alaska Mapping Executive Committee
AMEC-CS	Alaska Mapping Executive Committee – Coastal Subcommittee
ANTHC	Alaska Native Tribal Health Consortium
AOOS	Alaska Ocean Observing System
ASCII	American Standard Code for Information Interchange
ASV	autonomous surface vehicle
AUSI	ACEP Undergraduate Summer Internship (Program)
BAA	Broad Agency Announcement
BAG	Bathymetry Attributed Grid
BMF	Brennan Matching Fund (NOAA)
BOEM	Bureau of Ocean Energy Management
cm	centimeter
CAFF	Conservation of Arctic Flora and Fauna (Arctic Council)
CBMP	Circumpolar Biodiversity Monitoring Program (Arctic Council)
CBP	Customs and Border Protection
CCG	Canadian Coast Guard
CENA	Coastline Evolution and Nearshore Approximation (PolArctic)
CHS	Canadian Hydrographic Service
CoNED	Coastal National Elevation Database (USGS)
CO-OPS	Center for Operational Oceanographic Products and Services (NOAA)
CORS	Continuously Operating Reference Stations
CoSMoS	Coastal Storm Modeling System (USGS)
CSB	crowdsourced bathymetry
CSCAP	Coastal Shoreline and Change Analysis Program (NOAA)
CUSP	Continuously Updated Shoreline Product (NOAA)
CZMIL	Coastal Zone Mapping Imaging Lidar
DCDB	Data Centre for Digital Bathymetry (NOAA)
DEM	digital elevation model
DFO	Fisheries and Oceans Canada
DGGS	Division of Geological and Geophysical Surveys (Alaska)
DInSAR	Differential Interferometric Synthetic Aperture Radar
DOD	US Department of Defense
DOE	U.S. Department of Energy
DSM	digital surface model
ECDIS	Electronic Chart Display and Information System
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
ERMA	Environmental Response Management Application (NOAA)
FCMaP	Florida Coastal Mapping Program
FCORS	Foundation CORS
FEMA	Federal Emergency Management Agency
GB	gigabyte
GEBCO	General Bathymetric Chart of the Oceans (IHO-IOC)

Appendix A – Abbreviations and Acronyms

GeMS	Gravity Network and Geoid Monitoring Service
GEOMAR	Helmholtz Centre for Ocean Research Kiel, Germany
GIO	Geographic Information Officer
GLOS	Great Lakes Observing System
GMRT	Global Multi-Resolution Topography
GMTDS	Global Maritime Traffic Density Service (NGA)
GNSS	Global Navigation Satellite System
GNSS-A	Global Navigation Satellite System-Acoustic ranging combination
GNSS-R	Global Navigation Satellite System-Reflectometry
GPS	Global Positioning System
HWM	high water mark
iNGO	indigenous non-governmental organization
IoT	Internet of Things
ICE	US Immigration and Customs Enforcement
IHO	International Hydrographic Organization
IOCM	Integrated Ocean and Coastal Mapping
IOOS	Integrated Ocean Observing System
IWG-OCM	Interagency Working Group on Ocean and Coastal Mapping
IWG-OEC	Interagency Working Group on Ocean Exploration and Characterization
JALBTCX	Joint Airborne Lidar Bathymetry Technical Center of Expertise
JSON	JavaScript Object Notation
km	kilometer(s)
KMZ	Keyhole Markup Language
LAS	Land Analysis System
LDEO	Lamont-Doherty Earth Observatory (Columbia University)
LE	Low Energy (Bluetooth)
lidar	Light detection and ranging
m	meter(s)
MBARI	Monterey Bay Aquarium Research Institute
MBES	multibeam echo sounder
MFP	Marine Facilities Planning (UNOLS)
MOA	memorandum of agreement
MP	megapixel or referring to one million pixels
MSR	marine scientific research
NCCOS	National Centers for Coastal Ocean Science (NOAA)
NCEI	National Centers for Environmental Information (NOAA)
NetCDF	Network Common Data Form
NGA	National Geospatial-Intelligence Agency
NGS	National Geodetic Survey (NOAA)
NIMA	Nunivak Island Mekoryuk Alaska (Corporation)
NMEA	National Marine Electronics Association
NOAA	National Oceanic and Atmospheric Administration
NOMEC	National Strategy for Ocean Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone
NOPP	National Ocean Partnership Program
NOS	National Ocean Service (NOAA)
NPS	National Park Service
NRCS	Natural Resources Conservation Service (USDA)
NSF	National Science Foundation
NWLON	National Water Level Observation Network
NWS	National Weather Service (NOAA)
OCM	Office for Coastal Management (NOAA)
OCS	Office of Coast Survey (NOAA)
OPA	Office of Ocean and Polar Affairs (US Department of State)

Appendix A – Abbreviations and Acronyms

OPUS	Online Positioning User Service (NOAA)
OSTP	Office of Science and Technology Policy (White House)
PCMSC	Pacific Coastal and Marine Science Center (USGS)
QA/QC	quality assurance/quality control
RATS	Marine Scientific Research Application Tracking System
ROV	remotely operated vehicle
RSD	Remote Sensing Division (NOAA)
RTK	real-time kinematic
snm	square nautical miles
SBES	single beam echo sounder
SDB	satellite derived bathymetry
SD	secure digital (card)
SfM	structure from motion
SOMP	Standard Ocean Mapping Protocol
SVA	Support Vessels of Alaska
SVP	Sound Velocity Profiler
TBDEM	topobathymetric digital elevation model
UAF	University of Alaska, Fairbanks
UAS	unmanned aircraft system
UAV	uncrewed aerial vehicle
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
UNH/JHC	University of New Hampshire/Joint Hydrographic Center
UNOLS	University-National Oceanographic Laboratory System
US	United States
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USIEI	United States Interagency Elevation Inventory
VDATUM	Vertical Datum Transformation Tool

Appendix B – Summit Agenda

Day 1 – November 16, 2022

09:00 – 10:00	Welcome and Keynote Addresses
Opening Remarks from Alaska Senator Dan Sullivan	
Orientation – Nadine Doiron, NOAA Digital Coast Fellow	
Alaska Summit Welcome – Dr. Rob Thieler, USGS	
Alaska Geospatial Council Update – Dr. Leslie Jones, State of Alaska	
Florida Coastal Mapping Program Keynote – Cheryl Hapke, Nicole Raineault	
10:00 – 11:20	**Coastal Subcommittee Agency Mapping Updates**
NOAA OCM Update – Jaci Overbeck	
State of Alaska Mapping Updates – Autumn Poisson	
U.S. Geological Survey – Ann Gibbs	
JALBTCX – Jennifer Wozencraft	
U.S. Fish and Wildlife Service – Sydney Thielke	
An Update on the NOAA Coastal Mapping Program – Stephen White, NOAA RSD	
NOAA SatBathy (beta) Update – Gretchen Imahori, NOAA RSD	
11:20 – 12:00	**2022 Ex-Typhoon Merbok Recap Panel**
Introduction – Nic Kinsman, NOAA	
High Water Mark Data – Alex Nereson, USGS	
Imagery Services – Andrew Herbst, State of Alaska	
Data Access and Uses – Jaci Overbeck, NOAA	
12:00 – 12:30	**Break for lunch**
12:30 – 1:40	**Technology Lightning Talks**
NOAA Coastal Mapping Project in Southeast Alaska as a Supporting Case for the Alaska Coastal Mapping Strategy – Colin Cooper, NV5 Geospatial	
Tidal Coordination for Data Acquisition – Nathan Wardwell, JOA Surveys, LLC.	
Coastal Geo-data: what's new in means and methods of collection and thoughts on maximizing ROI – Rada Khadjinova, Fugro	
Satellite Derived Bathymetry – Natalie Treadwell, TCarta Marine	
Satellite Derived Bathymetry – Lauren Decker & Leslie Canavara, Polarctic	
3D Nation Study Update – Sue Hoegberg, Dewberry	
1:40 – 3:00	**The Path Forward**
USGS Coastal National Elevation Database (CoNED) Update – Jeffrey J. Danielson, USGS	
Alaska Water Level Watch – Carol Janzen, AOOS	
Overview of Imagery & Elevation Acquisition Dashboard – Hillary Palmer, Dewberry	
Near Real-time Data Processing for Topobathy Lidar – Karen Hart, Woolpert	
GRAV-D & CORS Updates – Nic Kinsman, Steve Bassett, Will Freeman	
Workforce Development Through Community-Based Mapping – Reyce Bogardus, UAF	
Prioritization Survey Results & Mapping Partner Finder – Hillary Palmer, Dewberry	
Mapping Plan of Action Dashboard – Hillary Palmer, Dewberry	
3:00	**End of Day 1**

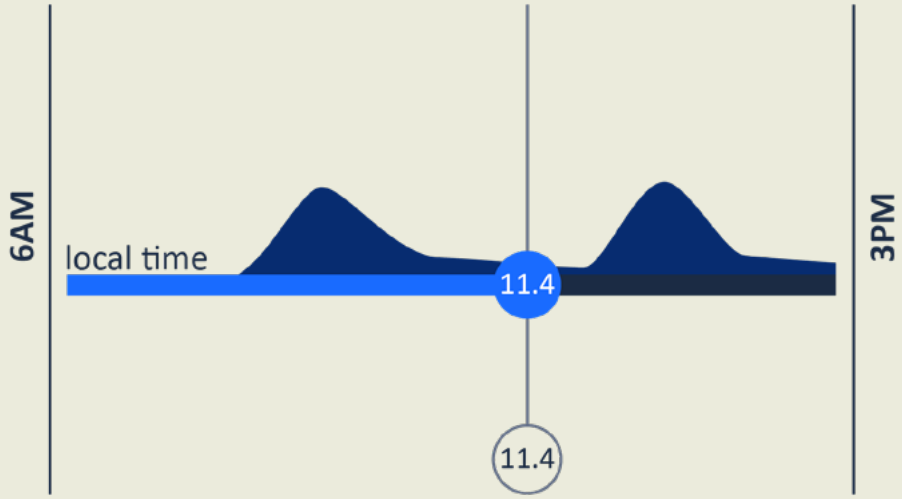
Day 2 – November 17, 2022

9:00 – 9:55	Welcome and Keynote Addresses
Orientation – Meredith Westington, NOAA	
Opening Remarks from Alaska Congresswoman Mary Peltola	
Welcome – RDML Benjamin K. Evans, Office of Coast Survey Director, NOMEC Council Co-Chair	
Keynote on Arctic & Ocean Protection Plan – Chris Marshall, Canadian Hydrographic Svc	
9:55 – 11:05	Panel Session 1: Seascape Alaska Mapping Updates
Welcome, Logistics, Introduction to Menti Polls – Nyla Husain, NOAA Knauss Fellow	
Recap of Seascape Alaska, a regional mapping campaign – Meredith Westington, NOAA Office of Coast Survey (OCS), Integrated Ocean and Coastal Mapping (IOCM)	
Office of Coast Survey Updates – LCDR Hadley Owen, NOAA OCS	
Nunivak Project Updates – Andy Orthmann, TerraSond	
Seafloor Geodesy and Mapping in Alaska – Dr. Peter Haeussler, USGS	
Aleutians Uncrewed Ocean Exploration – Colleen Peters, Saildrone	
NOAA Ship Okeanos Explorer FY23 Cruise Plans – Sam Candio, NOAA Ocean Exploration	
Aleutian Trench Biodiversity Studies (AleutBio) – Dr. Angelika Brandt, Goethe University; Dr. Anne-Cathrin Wölfl, GEOMAR	
11:05 – 12:00	Panel Session 2: Mapping Vessels of Opportunity
Support Vessels of Alaska – Scott Hameister, Support Vessels of Alaska	
US Coast Guard Crowdsourced Bathymetry Efforts – Candace Nachman, USCG	
Marine Scientific Research – Data from Foreign-Flagged Vessels – Jennifer Jencks, NOAA NCEI; Allison Reed & Liz Buendia, OES/OPA, State Department	
Crowdsourced Bathymetry Progress – Georgie Zelenak, NOAA NCEI	
A System Solution for Volunteer Bathymetry Collection – Dr. Brian Calder, CCOM/NOAA-UNH JHC	
Crowdsourced Bathymetry in the Great Lakes – Linden Brinks, Great Lakes Observing System	
12:00 – 12:30	Break for lunch
12:30 – 1:55	Panel Session 3: Data, Products, and Processing
Seascape Alaska Data Management Technical Team Update – Christie Reiser & Dr. Bob McConnaughey	
Crowdsourced Bathymetry Processing - Anthony Klemm, NOAA OCS	
GMRT Processing and Grid Products – Dr. Vicki Ferrini, Lamont-Doherty Earth Observatory, Columbia University	
NCEI Bathymetry Viewer and Grid Extract tool – Jessica Nation, CIRES/NOAA NCEI	
Data Processing Capacity and Expertise Gaps in Alaska – Dr. Erin Trochim, University of Alaska Fairbanks	
Habitat Mapping With Waterborne Technology – Liza Hasan, National Park Service, University of Alaska Fairbanks	
DEMs for Tsunami Modeling – Dr. Dmitry Nicolsky, University of Alaska Fairbanks	
1:55 – 2:55	Panel Session 4: Collaboration and Planning
Satellite-Derived Bathymetry to Improve Hydrographic Survey Planning – Starla Robinson, NOAA OCS	
Efficiency in Realtime GIS Project Management Tools – Dave Neff, eTrac/ Woolpert	
Developing Partnerships: How IWG-OCM Spatial Priorities Can Inform Mapping Collaboration – Cathleen Yung, NOAA OCS, IOCM	
Mapping Partnership Mechanisms – Ashley Chappell, NOAA OCS, IOCM	
IWG-OEC Strategic Priorities for Ocean Exploration and Characterization – Caitlin Adams, NOAA Ocean Exploration	
Overview of Alaska's Coastal & Ocean Mapping Initiatives and Forums – Hillary Palmer, Dewberry	
2:55 – 3:00	Closing Remarks

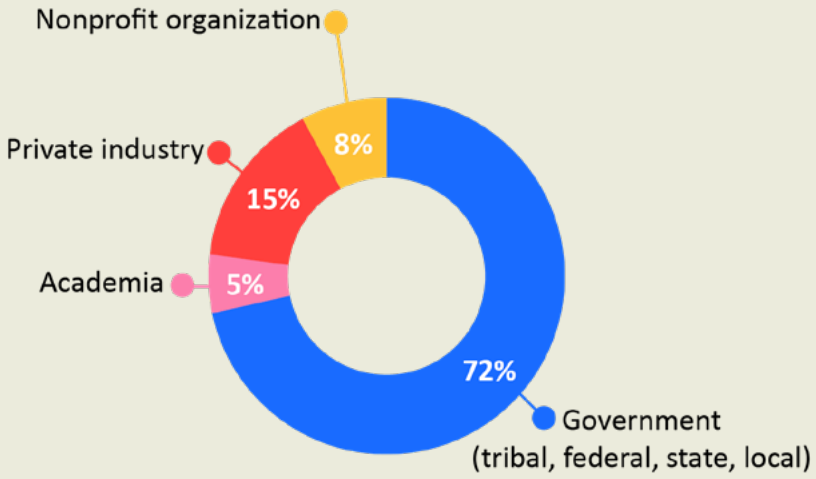
Appendix C – Day 2 Poll Results

Throughout day 2, participants were asked a series of poll questions. Below are the results:

1. What is your local time?



2. What stakeholder group(s) do you best represent?

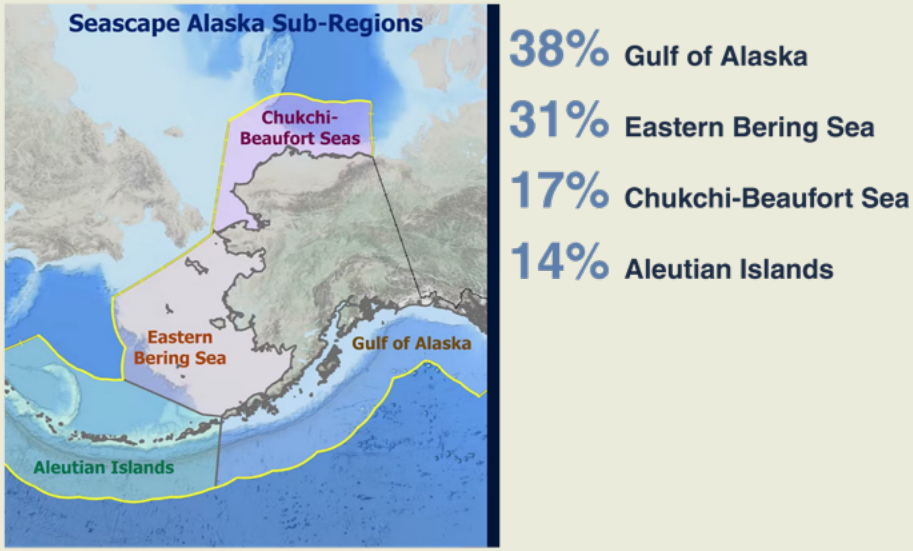


3. What are you hoping to learn today?

If people have bathymetry data to share!	More about boats	Why we are not a large island near Hawaii
Partnership options	What other groups are doing	Where is Alaska
Gaps in coastal mapping	Interest is in coastal mapping w UAV	Everything!
More about successful collaborations	About Alaska ocean mapping plans	Business development opportunities in Alaska
What efforts are ongoing in offshore mapping and new technologies	Current and future monitoring efforts in the Southwest, Northwest, Bering Straits, and North Slope. As well as, any scientific publications from the latest research, Inuit involvement across regimes and any relevant application of research	
Understand requirements, challenges and possible solutions for Alaska mapping.	Hoping to learn about ocean mapping efforts in Alaska waters	What areas AK needs SDB
Habitat impacts	I am trying to learn about all the available geospatial data related to oceans and coastal areas of Alaska	Awareness of other deepwater mapping activities in AK and ways to connect
Updates on coastal and ocean mapping, especially innovative programs like crowdsourced bathymetry	Coastal/ocean mapping plans for this summer, learn about vessels of opportunity, and processing developments	I am looking for opportunities to collaborate and tailor OCS products and projects to the stakeholder needs.
Mapping events underway to improve marine safety.	Future plans	Crowdsourced bathymetry plans
Collaborative ocean mapping opportunities	Current Project Locations for Collaboration	About the most recent technology for AK mapping

4. What key ideas did you hear from our speakers this morning?

5. Which sub-region are you MOST interested in mapping over the next year?



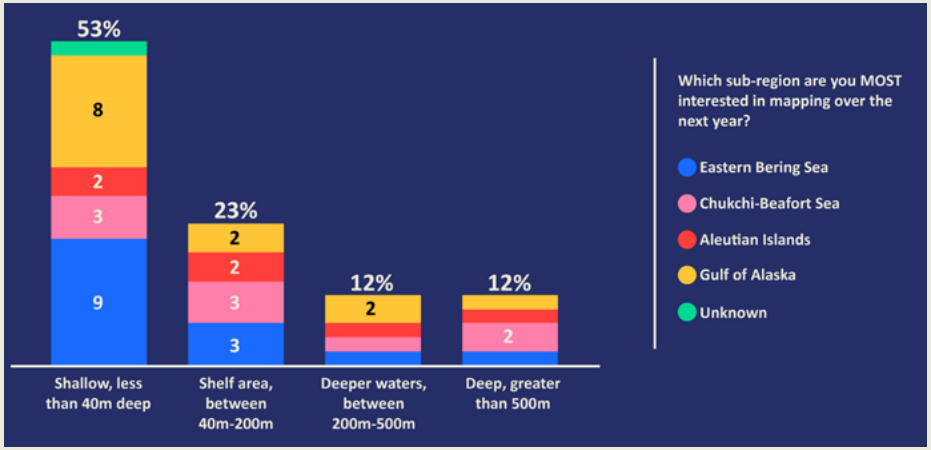
38% Gulf of Alaska

31% Eastern Bering Sea

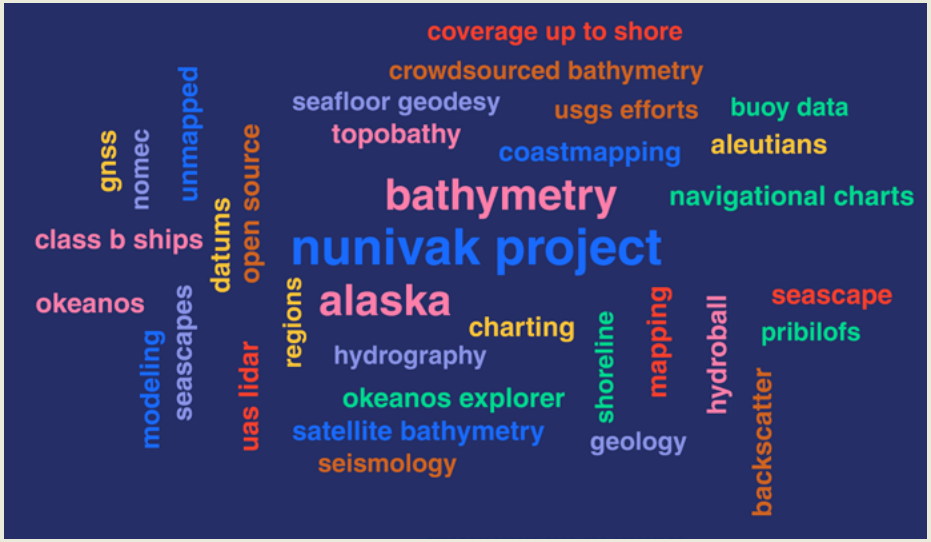
17% Chukchi-Beaufort Sea

14% Aleutian Islands

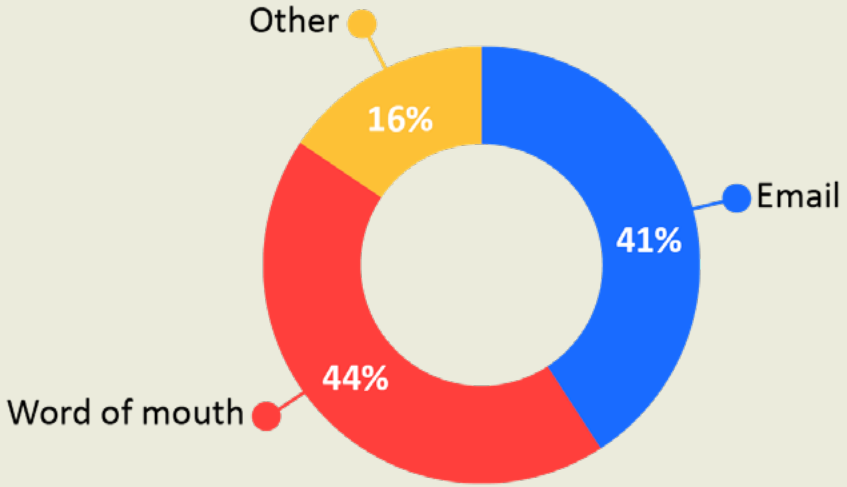
6. For your area of interest, which coastal and ocean depths are you most interested in?



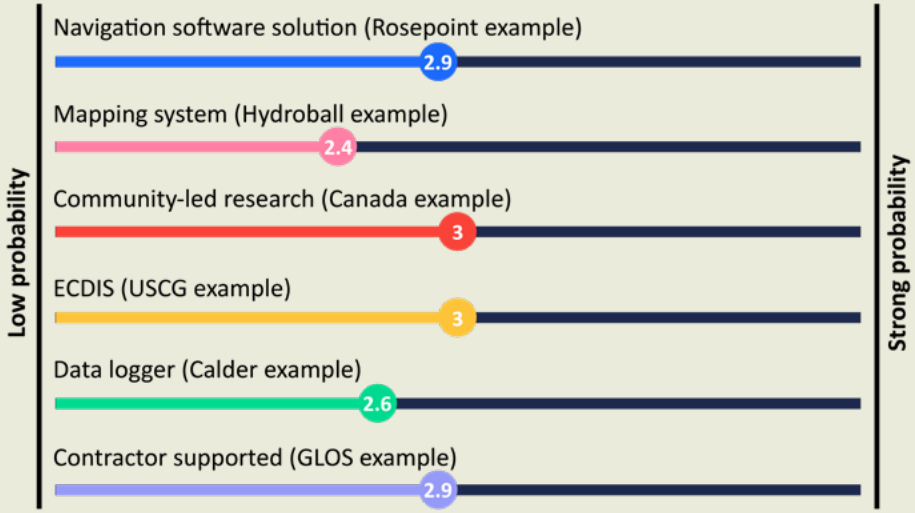
7. Which updates are you most excited to hear about?



8. How did you hear about the Alaska Coastal and Ocean Mapping Summit?

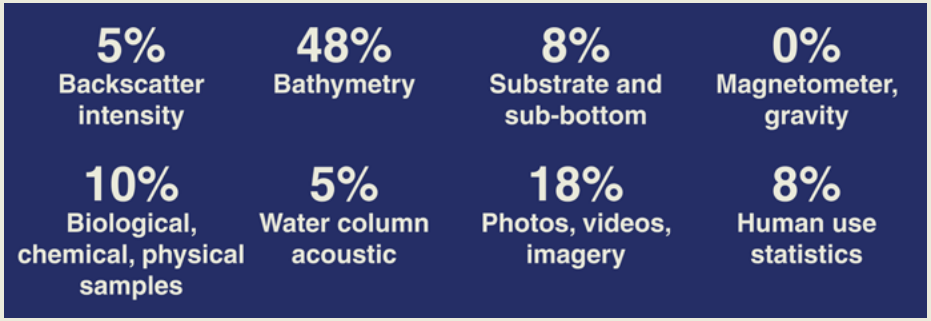


9. Which crowdsourced bathymetry model has the highest probability of success in Alaska?

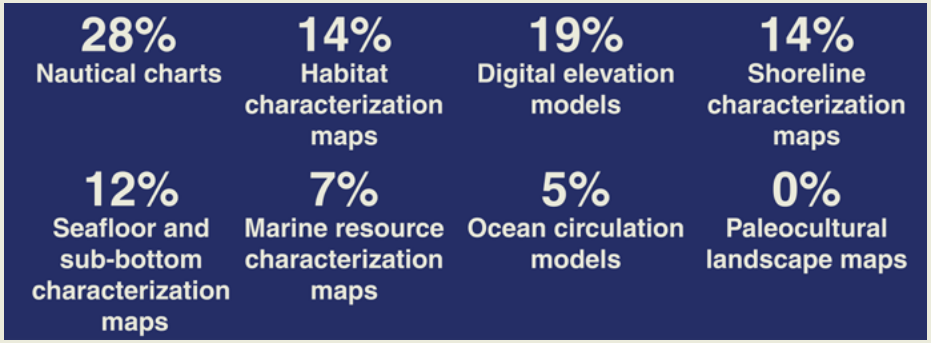


10. What are some key limiting factors for acquiring more bathymetry data from non-traditional mapping vessels?

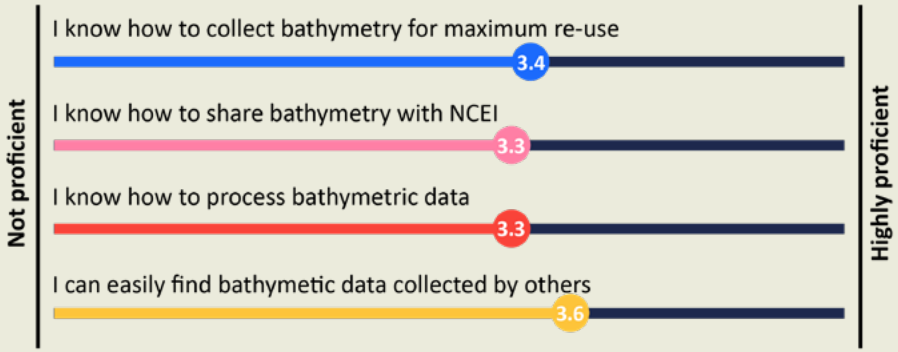
11. What type(s) of mapping data do you work with the most?



12. Which products drive your mapping data needs?



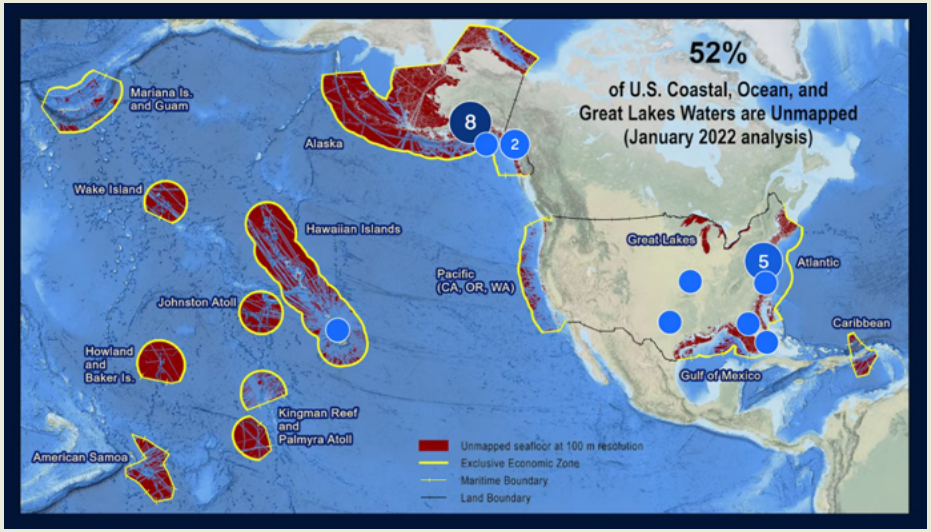
13. Rate your level of proficiency with bathymetry data handling.



14. How might we make data sharing and product development more efficient for the broadest set of users?

Common and easy to use metadata standards	There are many disparate data repositories. Consolidation would be very helpful
Keep NOAA data portals funded. Been go to source for decades	It would be great to have a resource listing the multiple data synthesis platforms and data viewers and their associates best uses.
Variable resolution BAGs have really thrown off my workflow in ArcGIS. I need seamless bathymetry for full analysis in ArcGIS that goes beyond the service layers	Allowing data to be publically accessible. However, allowing data sovereignty to be equitably and ethically used by others. i.e. Indigenous Knowledge acknowledged and affirmed when utilized for the co-production of knowledge. This will allow internat
Work with Google? I do think these conferences help get the word out but think we can do more	Better seasketch
A central data hub with a web interface that hosts data on the cloud	I would put SBES sonars on whales and set them loose.
Easy to use data repository that doesn't require login. User-friendly websites. Faster data processing turnaround time.	More sanders for meta data
Think about the questions being asked and use that to drive how to retrieve data.	Stop it with the VR BAGs

15. Where are you joining us from?



16. To which forum or initiative do you belong?

7 Alaska Geospatial Council (AGC) Coastal and Ocean Technical Working Group	**4** Other AGC working groups	**7** Seascape Alaska
5 Alaska Mapping Executive Committee (AMEC) Coastal Subcommittee	**4** Other AMEC subcommittees	**9** None yet

17. What publicly available bathymetric data sources or products inform your mapping plans in Alaska?

NOAA bathy	Digital Coast
Bathy dem web services	NCEI. Also AIS data
NOAA data, nautical charts, need a continuous shoreline	Charts, Esri Oceans Basemap
NCEI. Digital coast.	NCEI, ENC, Seascape for plans, Nav Manager input, IOCM emails, Environmental Compliance
NCEI, USIEI	NCEI, GMRT, GEBCO and direct reach out to mapping groups
Any public source data (validated) for utilization in Arctic Council projects under CAFF.	NCEI bathy viewer and federal seasketch coordination page
NCEI, Alaska spatial priorities study, GEBCO	Charts, seasketch, bathy data viewer
My uncle seems to know everything, so I usually consult with him before starting a hydrographic project. Other than that, I find Alaska Shorezone to be a great resource to learn more about the nearshore conditions of a prospective area.	

18. What software or web-based tools help you to develop mapping plans in Alaska?

Ak mapping acquisition	SeaSketch, Alaska Imagery & Elevation Portal, The National Map
Seasketch, AK Mapping Acquisition Dashboard, AK Partners Dashboard	AIS tracklines sites (GMTDS, LivingAtlas Vessel Traffic Data)
Seasketch	ESRI
I probably have all of those bookmarked and get frazzled as they don't all agree. Seasketch is my go to, but it doesn't always agree with others.	
GIS	Not in AK but use UNOLS MFP for academic vessels
Seasketch	seasketch. powerpoint
AK Mapping Acquisition and AK Priorities Dashboards	ERMA, SeaSketch, AK Dashboards
Alaska Shorezone, NOAA nautical charts, and NCEI datasets.	https://shoreline.noaa.gov/data/datasheets/cusp.html

19. How can we best support collaborative mapping in the region?

Parallel efforts are confusing. One stop shopping somewhere.		
Data sharing incentives. Public-Private Partnerships. Wide distribution of project funding.		
More datums, real-time water levels, and VDatum in Alaska		
Better connectivity of the people who care. Despite all the tools we develop it is the opportunities to meet and dream that feed the future.		
It would help if more people committed to sharing info on their mapping plans at one place, e.g. seasketch or AK dashboard		
Successful achievement of the overall NOMEC goals requires the leadership of a dedicated individual with a broad view of national capabilities.		
Focus on intertidal coastal lands for shoreline modeling. One coordinator for other agencies to coordinate with NOAA. Too many acronyms.		
Yes	Communication, funding	More people!
A platform such as Arctic Council's CBMP database, under development, for utilization across scales and regimes to better understand current or developing research for faster and adaptive responses for Arctic concerns and issues.		
Pooled funds, NOPP		
Collaboration when funding is available for mapping, budget sharing.		
Where can I submit something like a completed CUSP layer to share with others who might be working shorelines? NOAA's Protected Resources Cross-Regional committee has been discussing whether we should create a webapp		
We should collaborate with the natural world. We should look closely at utilizing marine mammals, perhaps with attached survey equipment and GPS tracking, to collect bathymetric data as they move about their aquatic wonderland.		

Appendix D – Summit Library of Helpful Hyperlinks

2022 Summit Agenda plus materials from previous Alaska mapping summits – https://agc-coastal-soa-dnr.hub.arcgis.com/pages/aksummit

Integrated Ocean and Coastal Mapping Strategic Plans – https://iocm.noaa.gov/about/strategic-plans.html

Alaska Geospatial Council – https://alaska-geospatial-council-soa-dnr.hub.arcgis.com

Florida Coastal Mapping Program – https://fcmap-myfwc.hub.arcgis.com/

Pilot Project to Support Tribal Climate Resilience in Alaska – https://www.noaa.gov/news-release/pilot-project-to-support-tribal-climate-resilience-in-alaska

Geospatial Contract Vehicles, Grants, and Agreements – https://iocm.noaa.gov/planning/contracts-grants-agreements.html

NOAA Data Access Viewer – https://coast.noaa.gov/dataviewer/

Environmentally Threatened Communities Dashboard – https://soa-dnr.maps.arcgis.com/apps/opsdashboard/index.html#/ba8ebf93adec4b6d9f601e2d59179fdd

USGS Coastal Change Hazards Portal – https://marine.usgs.gov/coastalchangehazardsportal/

National Coastal Resilience Fund – https://www.nfwf.org/programs/national-coastal-resilience-fund

Alaska Water Level Watch – https://water-level-watch.portal.aoos.org/

USGS Coastal Storm Modeling System – https://www.usgs.gov/centers/pcmsc/science/coastal-storm-modeling-system-cosmos

USGS Operational Total Water Level and Coastal Change Forecasts – https://www.usgs.gov/centers/spcmsc/science/operational-total-water-level-and-coastal-change-forecasts

Using Video Imagery to Study Wave Dynamics – https://www.usgs.gov/centers/pcmsc/science/using-video-imagery-study-wave-dynamics-unalakleet

Using Video Imagery to Study Sediment Transport and Wave Dynamics – https://www.usgs.gov/centers/pcmsc/science/using-video-imagery-study-sediment-transport-and-wave-dynamics-nuvuk-point

USGS Topo-Builder – https://topobuilder.nationalmap.gov/

JALBTCX Tools and Data Products – https://experience.arcgis.com/experience/f4c9c24ea6364a508ba7d9254060fdc1/page/Tools-%26-Data-Products/?views=Find-Data%2CSearch-All%2CView-5

National Coastal Resilience Fund – https://www.nfwf.org/programs/national-coastal-resilience-fund

US Fish and Wildlife Service, Wetlands Mapper – https://www.fws.gov/program/national-wetlands-inventory/wetlands-mapper

Statewide National Wetlands Program – https://www.fws.gov/program/national-wetlands-inventory#:~:text=The%20U.S.%20Fish%20 and%20 Wildlife%20 Service%20National%20 Wetlands%20 Inventory%20

NOAA Shoreline Data Explorer – https://www.ngs.noaa.gov/NSDE/

NOAA Digital Coast – https://coast.noaa.gov/digitalcoast/

Identifying and Preserving High Water Mark Data – https://pubs.er.usgs.gov/publication/tm3A24

USGS Flood Event Viewer – https://stn.wim.usgs.gov/FEV/

USGS Short Term Network (STN) Photo Viewer – https://test.wim.usgs.gov/STNPhotos

State of Alaska Imagery Portal – http://gis.data.alaska.gov/pages/imagery

Ex-Typhoon Merbok Post-Storm Data Response StoryMap – https://arcg.is/1umjSH0

NV5 Geospatial – https://www.nv5.com/geospatial/

JOA Surveys – http://www.joasurveys.com

Fugro – https://www.fugro.com/

TCarta – https://tcarta.com/

PolArctic – https://polarcticllc.com/

Dewberry – https://www.dewberry.com/

3D Nation Elevation Requirements and Benefits Study (USGS Website) – https://www.usgs.gov/3d-elevation-program/3d-nation-elevation-requirements-and-benefits-study

3D Nation Elevation Requirements and Benefits Study (NOAA Website) – https://www.iocm.noaa.gov/planning/3DNationStudy.html

Alaska Tidal Datum Portal – https://dggs.alaska.gov/hazards/coastal/ak-tidal-datum-portal.html

Building Coupled Storm Surge and Wave Operational Forecasts – https://legacy.aoos.org/western-alaska-storm-models/

Alaska Coastal Mapping Strategy – https://www.alaskacoastalmappingstrategy.com/

2021 Alaska Coastal & Ocean Mapping Prioritization Survey Results – http://akmappingpriorities.com/

Alaska Coastal & Ocean Mapping Partner Finder Tool – https://www.akmappingpartnerfinder.com/

About the NOMEC Strategy – https://www.noaa.gov/nomec/about-nomec-strategy

2022 Progress Report on Unmapped U.S. Waters – https://iocm.noaa.gov/documents/mapping-progress-report2022.pdf

2021 Alaska Coastal and Ocean Mapping Summit Report – https://repository.library.noaa.gov/view/noaa/41597

Canadian Hydrographic Services Dashboard – https://data.chs-shc.ca/dashboard/map

Introducing Seascape Alaska, Story Map – https://storymaps.arcgis.com/stories/094abb14281e4b2489146a3f3e030961

NOAA, Office of Coast Survey – https://nauticalcharts.noaa.gov

NOAA, Office of Coast Survey's Current Year Survey Plans, including link to "living" story map – https://nauticalcharts.noaa.gov/data/current-year-survey-plans.html

2022 NOAA Hydrographic Survey Projects – https://arcg.is/1OGeWf

Planned NOAA Hydrographic Survey Projects (2020-2026) – https://arcg.is/1PmyHT

NOAA ENC Display Services (REST and WMS) – https://nauticalcharts.noaa.gov/data/gis-data-and-services.html#enc-display-services

UNH CCOM BathyGlobe GapFiller Tool – https://ccom.unh.edu/vislab/tools/gapfiller/

Pydro, a suite of software tools used to support hydrography and cartography – https://svn.pydro.noaa.gov/Docs/html/Pydro/universe_overview.html

Kluster, a distributed multibeam processing system built using the Pangeo ecosystem – https://github.com/noaa-ocs-hydrography/kluster

USGS Open File Report 2022-1085, Systematic Mapping of the Ocean-Continent Transform Plate Boundary of the Queen Charlotte Fault System, Southeastern Alaska and Western British Columbia—A Preliminary Bathymetric Terrain Model – https://doi.org/10.3133/ofr20221085

NOAA, Ocean Exploration – http://www.oceanexplorer.noaa.gov

AleutBio Blog – https://aleutbio.sgn.one/de/blogs/aleutbio/

Local news stories about AleutBio – https://alaskapublic.org/2022/08/24/alaska-news-nightly-wed-aug-24-2022/ and https://alaskapublic.org/2022/08/24/an-international-team-of-scientists-is-mapping-out-life-in-the-deep-bering-sea/

New Zealand's Crowdsourced Bathymetry Initiative, video, "Mapping the oceans through citizen science" – https://niwa.co.nz/videos/mapping-the-oceans-through-citizen-science

Support Vessels of Alaska – http://www.svaboats.com

Marine Scientific Research Consent Overview – https://www.state.gov/marine-scientific-research-consent-overview/

Marine Scientific Research Application Tracking System – https://www.state.gov/research-application-tracking-system/

Marine Scientific Research Data web page at NOAA, NCEI – http://www.ncei.noaa.gov/products/marine-scientific-research-data

IHO Data Centre for Digital Bathymetry (DCDB, hosted by NOAA, NCEI) – http://www.ngdc.noaa.gov/iho

IHO DCDB Bathymetry Viewer (includes links to non-US data sources) – http://www.ncei.noaa.gov/maps/iho_dcdb/

NOAA NCEI Bathymetry Viewer (US focus for finding bathy, LIDAR, and DEMs; can extract grids from multiple bathy layers) – https://www.ncei.noaa.gov/maps/bathymetry/

NOAA NCEI Autogrid Tool (create grids of non-hydrographic multibeam data) – https://www.ncei.noaa.gov/maps/autogrid/

IHO Guidance to Crowdsourced Bathymetry, B-12, Edition 3.0.0 – http://www.iho.int/uploads/user/pubs/bathy/B_12_CSB-Guidance_Document-Edition_3.0.0_Final.pdf

IHO Crowdsourced Bathymetry main page – http://www.iho.int/en/crowdsourced-bathymetry

U.S. Bathymetry Gap Analysis – https://noaa.maps.arcgis.com/home/item.html?id=4d7d925fc96d47d9ace970dd5040df0a

IOCM Data Provider Sharing Form (use form to let NOAA know if you have data to share) – https://iocm.noaa.gov/data-sharing/provider-engagement-form.html

NOAA, NCEI CruisePack (data packaging and metadata gathering tool to simplify data submission preparation for cruise-based data to NCEI) – https://www.ncei.noaa.gov/products/cruisepack

GMRT MapTool (to extract grids and images from global DEM) – https://www.gmrt.org/GMRTMapTool/

GMRT Web Services for grids, profiles, points, and shapefiles of data coverage – https://gmrt.org/services/index.php

GMRT-Tiler Wiki – https://github.com/gmrt-org/GMRT-Tiler/wiki

GeoMapApp (map-based application for browsing, visualizing, and analyzing global and regional datasets) – https://www.geomapapp.org/

Alaska Center for Energy and Power (ACEP) Undergraduate Summer Internship Program – https://ausi.alaska.edu/

Alaska Earthquake Center site – https://tsunami.alaska.edu/

Cloud-Based Remote Sensing with Google Earth Engine Book – https://www.eefabook.org/

Open Map Layers – http://www.openmaplayers.com/

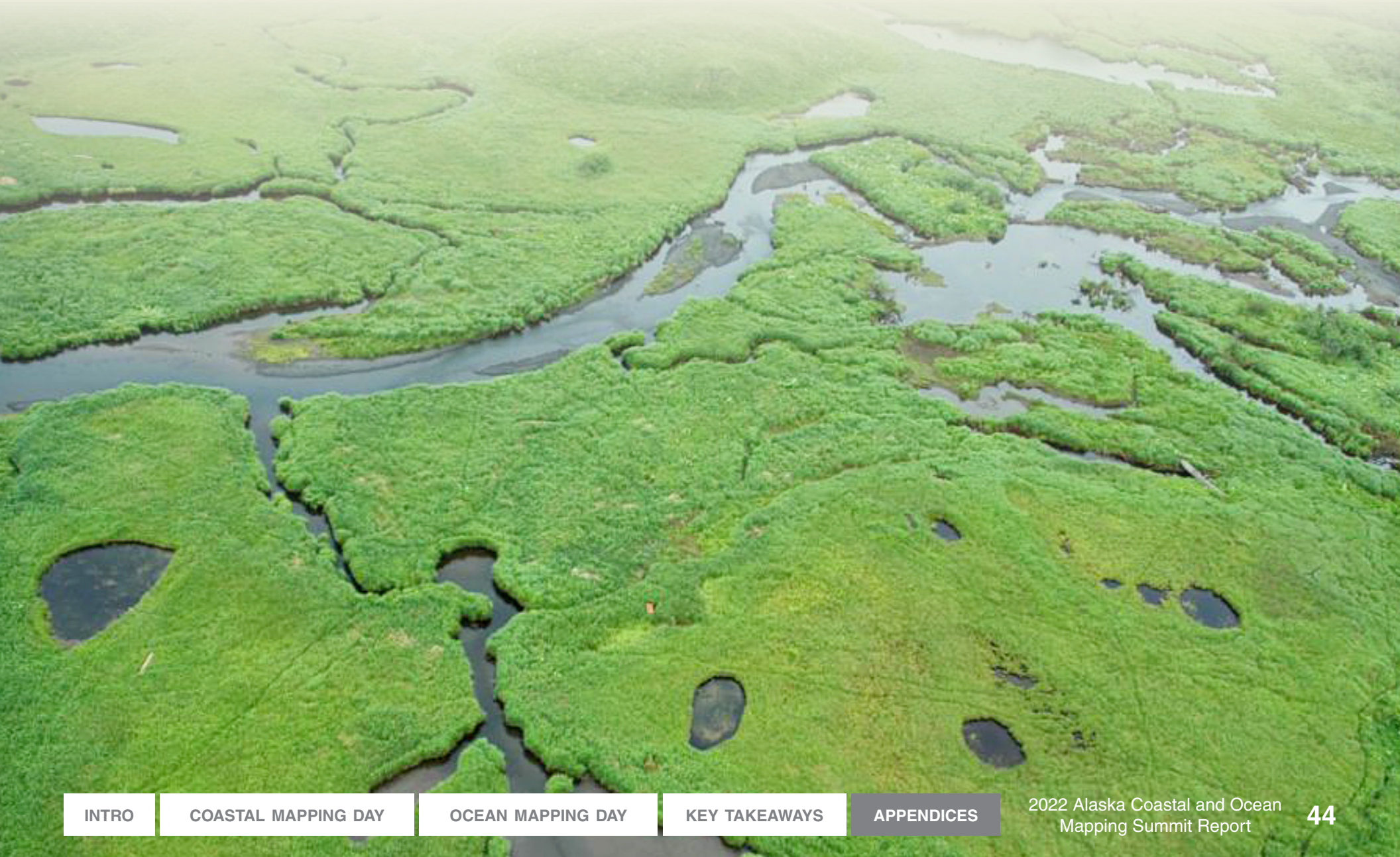
NOAA, Office of Coast Survey's Ocean Mapping Capabilities (May 2019) – https://nauticalcharts.noaa.gov/about/docs/about/ocean-mapping-capabilities.pdf

Interagency Working Group on Ocean Exploration and Characterization (location of IWG-OEC strategic priorities report) – https://www.noaa.gov/nomec/IWG-OEC

Alaska Geospatial Council's Coastal and Ocean Technical Working Group – https://agc-coastal-soa-dnr.hub.arcgis.com/

Inuit Circumpolar Council - Alaska – https://iccalaska.org/our-work/

U.S. Board on Geographic Names – https://www.usgs.gov/us-board-on-geographic-names



For More Information

Alaska Coastal Mapping Initiative
https://www.alaskacoastalmappingstrategy.com/
Hillary Palmer, hpalmer@dewberry.com

Seascape Alaska
https://storymaps.arcgis.com/stories/094abb14281e4b2489146a3f3e030961
Meredith Westington, meredith.westington@noaa.gov

Image credit: Hillary Palmer