

**Meeting Summary
Hydrographic Services Review Panel
September 20-22, 2022
Honolulu, Hawaii**

Tuesday, September 20, 2022

On the call of the Designated Federal Officer (DFO), Rear Admiral Benjamin Evans, NOAA, the Hydrographic Services Review Panel (HSRP) meeting was convened on September 20, 2022, in the Prince Waikiki Hotel Pi'inaio Ballroom, 100 Holomoana Street, Honolulu, Hawaii. The following report summarizes the deliberations of this meeting. The agenda, presentations, and documents are available for public inspection online at

<http://www.nauticalcharts.noaa.gov/hsrp/meetings.html>

Copies can be requested by writing to the Director, Office of Coast Survey (OCS), 1315 East West Highway, SSMC3, N/CS, Silver Spring, Maryland 20910.

Opening and Introductions

Rear Admiral Benjamin Evans, Director, Office of Coast Survey (OCS), National Ocean Service (NOS), and HSRP Designated Federal Officer, called the hybrid meeting to order at 8:59 a.m. HDT.

Julie Thomas, Chair, HSRP, thanked the State of Hawaii for welcoming the HSRP. This was the first in-person HSRP meeting since 2019. She acknowledged several attendees that were present and called for introductions from the members.

Opening Hawaiian Cultural Protocol

Dr. Haunani Kane, Randy Navarez, and Malia Evans performed a Hawaiian mele to open the meeting. This is a foundational element whenever meetings or important events are held in Hawaii in order to set the stage and to help attendees come together and find solutions. They introduced the Hawaiian practice of aloha 'aina, which embodies the love and stewardship of the lands and waters of the archipelago and the deep relationships they have maintained with the natural world and each other through generations. These practices have evolved over a millennia of place-based observations, practice, and knowledge acquisition. Staff from the Papahānaumokuākea Marine National Monument provided some of the complex history of Hawaii since the overthrow of the Kingdom and briefly introduced the re-introduction of traditional voyaging in 1976, which will be discussed in more detail later in the meeting. Hawaiian ancestors were scientists and their descendants, with or without academic degrees, are perpetuating these ancestral knowledge systems, growing the inquiry process, and weaving other tools and knowledge systems into research. They urged the HSRP to consider the need for Hawaiian and Indigenous capacity in more of these spaces.

David Y. Ige, Governor, State of Hawaii, welcomed the meeting participants. As the nation's only island state, the people of Hawaii are pleased the HSRP chose to convene their first in-person meeting in Honolulu. Everyone in Hawaii depends on the critical mapping work that keeps their Maritime Transportation System moving safely and efficiently every day. Hawaii has ten commercial harbors across six islands, which are the primary gateways for goods into the state. These ports and harbors sustain Hawaii's supply chain. Maritime operations provide most necessities, including food, clothing, construction materials, fuel, and other essential supplies. Hawaii's Department of Land and Natural

Resources Division of Boating and Ocean Recreation aims to preserve Hawaii's natural and cultural resources while ensuring public access to state waters and enhancing the ocean experience. Whether for commercial or recreational purposes, these activities all depend on data from hydrographic surveys in order to be successful. Hawaii is working to incorporate Native traditions and cultural knowledge and practices into how best to manage ocean resources. In the nearly eight years of his governorship, Mr. Ige has worked to build partnerships at all levels of government and with the private sector because they recognize that this work is important and too large for any entity to take on independently. From disasters, such as hurricanes, tropical storms, and flooding, to climate change, these partners are working together to find solutions to the challenges the state is facing. Measuring and mapping the physical features of ocean and coastal waters will play a large part in the success of these efforts moving forward.

Brian Schatz, U.S. Representative, Hawaii's First Congressional District (via video), said that 49% of America's western Pacific waters are unmapped, which represents almost 830,000 square nautical miles. This is the largest geographic gap in any U.S. region and it needs to be addressed promptly. The best way to do this is by adding more NOAA ships and personnel. While private sector partners and uncrewed technology can help gather the data needed, NOAA's expertise developing and maintaining nautical charts cannot be replaced. An expanded presence in the Pacific would help the agency fulfill its mission and help the nation meet its maritime priorities.

Rear Admiral Benjamin Evans, Director, Office of Coast Survey, National Ocean Service, and HSRP Designated Federal Officer, said the recent typhoon in Western Alaska and hurricane in Puerto Rico serve as reminders of the vulnerability of island and coastal communities. RDML Evans, along with Paul Scholz and NOAA staff, met the previous day with local partners to hear some of their concerns and visited the NOAA ship *Rainier*, which was on its way back from a field season in the Marianas. NOAA's observation products and navigation services play a critical role in providing the foundational data for operational products which enable responsible economic development, equitable delivery of services, coastal resilience, conservation, infrastructure, and many other critical missions. Nowhere is this more true than in Hawaii. As a recent example of the HSRP's value to NOAA, RDML Evans pointed to OCS' new data licensing policy, which the Panel addressed at its previous meeting. The policy will make OCS' data open to the public and streamline ingestion, while also aligning with NOAA's overall Data Strategy. RDML Evans reviewed the meeting agenda and reminded members of their responsibilities as NOAA Special Government Employees during the meeting.

Paul M. Scholz, Deputy Assistant Administrator for Ocean Services and Coastal Zone Management, National Ocean Service, NOAA, asked HSRP members to be forward-leaning in their recommendations to NOS and to think beyond the navigation, observation, and positioning portfolio to other elements of NOAA that intersect with it. NOAA was impressed with the HSRP's outputs from their March meeting, including the issue papers on public-private partnerships, recreational boating, and electronic charting. In the Pacific region, nothing happens without partnership and connection. There are critical risk points to the flow of goods into Hawaii and disruptions to just-in-time delivery could lead to the state running out of fuel in just two or three days.

Policy teams for both NOAA and the Department of Commerce have completed their strategic plans and NOAA is broadly represented in the Department's plans, which has not been the case traditionally. The administration's top priorities guiding NOAA's efforts are: (1) Establishing that NOAA is the primary authoritative source for climate products and services; (2) Advancing NOAA's complementary work on environmental stewardship and economic development; and (3) Exhibiting equity in how the agency builds and provides services. Two political appointees have been confirmed since the last HSRP meeting: Dr. Michael Morgan, who is the new Assistant Secretary of Commerce for Environmental Observation and Prediction, and Dr. Sarah Kapnick, the new NOAA Chief Scientist. Work on NOS' Strategic Plan is underway and the priorities outlined in it will fall under four headings: (1) Coastal resilience; (2) the New Blue Economy; (3) Conserving, restoring, and connecting; and (4) Diversity, equity, inclusion, and

accessibility. He asked the HSRP to consider if there are any areas or communities and/or activities that NOS is not currently focusing on or that are not able to use their products and services. NOS has a new position for a Deputy Assistant Administrator for Navigation, Observations, and Positioning that is currently open.

The FY23 President's Budget and marks from the House and Senate are strong for NOS with significant increases beyond the FY22 levels. The trend for NOS is positive and there is a lot of support for new endeavors, however, they have had challenges getting support for base programs. NOS has been able to get cost of labor adjustments, which is probably less than half of the cost escalation they have seen. NOAA is open to HSRP recommendations on how to make a stronger case for increasing support for base programs. Two other appropriations that have been passed this year include the Bipartisan Infrastructure Law (BIL) and the Inflation Reduction Act (IRA), both of which include equities for NOS efforts. These significant increases represent support for NOAA's mission priorities on coastal resilience, conservation, and habitat restoration. The Secretary of Commerce, Gina Raimondo, has made it clear that she will be making decisions on any flexible spending within the IRA appropriation; NOAA does not have guidance yet on how they will move forward. The pending Coastal Resilience Data and Services Act would provide clear authority and direction for NOAA's coastal resilience efforts, particularly as they relate to data, products, and services in response to coastal flood risk including sea level rise. Additionally, the National Ocean Exploration Act reauthorizes some of the key programs that support these efforts. Dr. Spinrad has signed an MOU with Seabed 2030 in conjunction with the UN Oceans Conference, formalizing U.S. participation. This is intended to facilitate cooperation on the exchange of information and promotion of joint efforts to map the world's oceans by 2030. The goals of the initiative, along with those of the domestic agenda, cannot be realized without NOS' foundational programs and the critical advice and recommendations provided by the HSRP. NOAA looks forward to sharing its Standard Ocean Mapping Protocol Implementation Plan with the Panel after it is released this fall. Mr. Scholz asked the HSRP to consider how other fields might contribute to expanding the successful public-private partnerships. Specific to NOAA's work in Hawaii, Mr. Scholz briefly discussed the regional partnership Pacific Risk Management 'Ohana (PRiMO), which includes emergency response organizations, nonprofits, government agencies, universities, local planning institutions, and the medical and private sectors. This will be discussed further in the next session.

Partnerships for the Pacific - Local, State, and Federal Perspectives

Julie Thomas and Paul Scholz moderated the panel.

Rear Admiral Michael H. Day, Commander, 14th U.S. Coast Guard District, offered the perspective of the end user of NOAA products and services. His perspective has been shaped by two contrasting experiences: one as Captain of the Port of New York and the other as Coast Guard Commander in Hawaii. Across these two very different areas, the common denominator is the professionalism of NOAA employees. The vastness of the Pacific and the community that exists within it is unique and without equal. As the maritime service that operates throughout the blue Pacific, the U.S. Coast Guard (USCG) sees the challenges of remoteness and of a changing environment. USCG cutters routinely use NOAA products to safely navigate across the Pacific and have mostly transitioned to solely electronic navigation. USCG uses NOAA bathymetric data to operate their search and rescue pattern modeling, and the success of their SAR missions is directly correlated to the accuracy of NOAA's data. NOAA also provides much of the science that supports USCG and its partners' work in disaster management and how they train with foreign partners. USCG works with NOAA's Office of Restoration and Response extensively. The changing climate is exacerbating natural disasters and methods and models must be adapted to meet the new demands for assistance. The blue Pacific is truly a village and must work collectively to thrive in these ever-changing times. The challenge of accurate, up-to-date charting becomes more critical as sea levels continue to rise. Some of areas of the Pacific in which USCG operates are not well surveyed and too often they are forced to rely on information that is outdated. A collaboration of entities to revisit some

of the areas of older datum in the Pacific would further buy down risk in the execution of USCG missions in the region. Admiral Day discussed the fragility of the Marine Transportation System in Hawaii. A stray container, sunken vessel, or natural disaster affecting Honolulu Harbor could severely cripple the Hawaiian maritime sector. NOAA, with its unique capabilities, would be one of the first calls for assistance in any number of scenarios. There is a lot of work to be done in the Pacific, given the current climate situation, and working together USCG and NOAA will be best positioned to meet the tasks at hand.

Jose E. Sanchez, SES, Director of Regional Business, Pacific Ocean Division, U.S. Army Corps of Engineers, discussed the USACE Pacific Ocean Division's area of responsibility. USACE has long been a partner of NOAA, from scientific work to applications. There are 27 federally maintained deep draft and small boat harbors within Hawaii and the Pacific territories, mostly on the small boat harbor side. The district has a number of federal control projects, as well. The Pacific Ocean Division also includes Alaska, which along with Hawaii, are the two areas where USACE does the majority of its civil works in the Pacific. In Alaska alone, there are 53 deep draft and small boat harbors that USACE has authority over. They are working on the initial stages of expanding the Port of Nome to be a deep draft harbor. USACE's mission is to support water-borne transportation for commerce, national security, and recreation and these projects all require robust, high quality data. USACE recently rolled out a strategy to emphasize the importance of quality in their projects, along with time and cost. They have also recently embarked on a strategy to expand their Coastal Hazards System (CHS) for the Pacific Rim from Alaska to Korea. This is a major five-year effort costing \$25 million, which will collect all the information for the parameters required to develop engineering features in the coastal area. In order to do these models, USACE needs NOAA data. Mr. Sanchez briefly discussed several upcoming USACE projects where further NOAA data is needed, including nearshore bathymetry needed for a harbor expansion study for Atka, Alaska, and topography and bathymetry needed for inundation modeling for proposed improvements in Kwajalein in the Republic of the Marshall Islands.

Joseph D. Martin, SES, Director, Center for Excellence in Disaster Management and Humanitarian Assistance, U.S. Indo-Pacific Command (INDOPACOM), shared how INDOPACOM is looking at climate change and its impact. The CFE-DM has been around for almost 30 years and its mission is to provide training, education, applied research, and information sharing primarily with respect to natural disasters. The Center is stationed in Hawaii but has a global mandate with respect to these lines of effort. Mr. Martin discussed some of the climate impacts that INDOPACOM is working on, particularly the human security and state security/stability impacts. These threats can be existential for smaller islands across the Pacific as climate change puts an increased stress on fragile governments. He discussed how these impacts feed into warfighting missions as more humanitarian assistance and disaster relief responses are needed. Indications are that military humanitarian assistance responses are going to become more frequent and intense, which reduces the services' ability to defend the nation. There is an increased likelihood for conflict in the face of sea level rise and saltwater inundation, as well as upstream restriction of water flow. Climate-induced migration, instability from climate impacts on weak or failing governments, and the weaponization of climate change are all major concerns for INDOPACOM.

Bill Thomas, Senior Advisor for Islands, Indigenous and International Issues, Office of Coastal Management, NOS, NOAA, began by discussing some of the history of Polynesian voyaging and Hawaiians' long-standing grasp of science and processes. He discussed the importance of words and their context when interacting across cultures, particularly terms like "partners" or "collaboration." Definitions can provide a general framework, but they are subjective and can be limiting. Instead of having definitions of partnership, it is more important to know what the parties are after. Partnerships and collaborations should include: sharing common goals and priorities; sharing knowledge, resources, experience expertise, and perspectives; free from hidden agendas; obligations are broadly distributed. Some of the challenges for partnerships in the Pacific include the remoteness/distances, time differences,

the number of different cultures and languages spoken, and the sheer number of islands (~30,000). Foundational lessons learned from over twenty years of engaging across the Pacific include the need to: acknowledge and honor Pacific Indigenous diversity; understand the uniqueness of people and places; know the nature-culture nexus; respect and understand the importance of ceremony and protocol and incorporate them into processes; communication is an active and iterative process; identify and know those who have these skills - who to ask permission from; honor the principle of Free, Prior, and Informed Consent. Mr. Thomas shared some specific insights gathered from the many Native/Indigenous elders he has worked with and discussed PRiMO as an example of a successful partnership across the Pacific. More than 100 organizations participate in this effort to help Pacific Island communities become more resilient. PRiMO began in 2003 as an effort to explore opportunities to enhance communication and collaboration among local, national, and regional organizations involved in risk management. PRiMO members participate in working groups where the various organizations come together to develop and implement action plans that improve resilience in the Pacific region. Membership is purposely varied across levels of government and areas of expertise and they also encourage collaborations between Tribal and Pacific and Caribbean islands. Other successful Pacific partnerships discussed included INDOPACOM, UCAR and the Wilson Center, and Global Breadfruit Heritage Council. The Rising Voices Center for Indigenous and Earth Sciences is working to incorporate more Indigenous perspectives into addressing climate issues. They have developed the National Indigenous and Earth Sciences Conversion Hub to co-produce research that improves modeling and prediction of coastal processes that support decision making by Indigenous communities, develop an inclusive framework for cross-cultural convergence research, and broaden participation among Indigenous students and researchers. Mr. Thomas concluded his presentation with the observation that relationships move at the speed of trust, which was reiterated several times throughout the rest of the meeting.

Matthew Gonser, Executive Director, Office of Climate Change, Sustainability and Resiliency, City and County of Honolulu, said that NOAA has a lead role in the Pacific, filling gaps that other federal agencies would traditionally serve in different geographical settings, including land-based data for the Pacific Islands. Some of the challenges in the area include connecting people with information, making research applicable, and ensuring the research is answering the questions that community members have. Climate change brings uncertainty to the future of people, places, and economies. In Hawaii, NOAA supports adaptation efforts by providing critical science and also communication skills. Digital Coast and other tools are good resources that allow cities to extend information to meet people where they are at and help the information resonate for whatever setting users are responsible for. The foundation for much of Honolulu's community awareness around coastal hazards is built upon NOAA-produced resources such as tide gauge data and the National Sea Level Rise Viewer, or NOAA-funded resources such as the Hawaii Sea Level Rise Exposure Area and partnerships for community science. These tools and resources allow planners to think about coastal management and hopefully make resilience more possible, but they do not guarantee it. There is a gap in what NOAA can deliver and what is expected of local governments in tackling climate change impacts. Planners need to continue to be acutely local and hyper focused on their context but we cannot afford to lose sight of the challenges, potential lessons, and connections with others globally. It is important to remember that local leaders are just people, whether they were equipped to deal with the challenges they face or not; they make decisions, but data is not always what motivates them. Local leaders need courage, as well as coalitions and community members standing up to obligate them to think about how they connect people with information and with other people.

Linkages with Traditional and Modern Navigation: Navigating Change from the Deep Sea to Coastal Communities

Ray Tanabe, Director, Pacific Region, National Weather Service, NOAA, introduced Dr. Haunani Kane and described his experience with the Polynesian Voyaging Society as a local NOAA forecaster, assisting with charting a course that would present the least risk for the voyagers.

Dr. Haunani Kane, Assistant Professor, School of Geographical Sciences and Urban Planning, Arizona State University, and Member, Polynesian Voyaging Society, discussed the Polynesian Voyaging Society and their use of ancient navigation methods to sail thousands of miles in traditional double-hulled canoes from Honolulu to Tahiti. The boat, Hokule'a, was a replica canoe built in the 1970s as part of the Hawaiian Renaissance to recreate the journey of ancestors that originally came to Hawaii. It was done not only to revitalize Native Hawaiians' pride in being islanders, but also to prove that ancient people had the knowledge and skills to purposely find the islands. Dr. Kane described her experience on the 18-day trip from Hawaii to Tahiti in 2014. Experiences such as these have inspired many Hawaiians to pursue careers that improve their homeland. Crew members do a series of projects on the canoe, including water quality monitoring and investigating the gut contents of the fish they eat, along with outreach with students via satellite and sharing their experiences when in port.

Last year, with the support of the Office of Hawaiian Affairs, they were able to organize a research expedition to study how the islands in Papahānaumokuākea are responding to changes in the climate. She will discuss the study further later in this meeting, but here she briefly described their assessment of how the 2018 Hurricane Walaka impacted the low lying atoll islands. The research staff and students were all Native Hawaiians. They looked at how some of the intertidal organisms are living in the area and how they could potentially be impacted by sea level rise. They also conducted GPS surveys of the islands and collected sediment to assess how the islands' compositions changed before and after the event. Dr. Kane shared some of her students' reflections and her own thoughts on how to move forward by doing. If we are to move forward and adapt to climate change, we must learn and be accepting of diversifying the sources of knowledge and the values that we use to inform decision making. We need to start with students and local communities and acknowledge and foster their connection to place. We must rely upon and learn from the past and be open to allowing that to inform our future.

Updates: Opportunities, Challenges and Priorities for NOS' Navigation Services Portfolio

National Ocean Service's office directors addressed navigation services such as the 2022 updates to the National Spatial Reference System (NSRS), datums, Seabed 2030, National Ocean Mapping, Exploration and Characterization (NOMECE) and the SOMP, surveying, charting, uncrewed systems (UxS), remote sensing and lidar, photogrammetry, positioning, sea level rise and water levels in support of seamless data.

Rear Admiral Benjamin Evans, Director, Office of Coast Survey, National Ocean Service, and HSRP Designated Federal Officer, provided a program update on OCS. OCS is in the midst of a transformation to meet the world's growing demands for data-based products and services while continuing to honor their core mission to support safe navigation. OCS not only collects ocean and coastal mapping data, but must also provide that data in a form that is fit for purpose and in a timely fashion. OCS is seeing increased demand for high-resolution mapping data across all depths. Their strategy seeks to make maximum use of in-house assets, contracted surveys, and collaborations with partners. The Standard Ocean Mapping Protocol (SOMP) will be publicly released later this fall. The MOU for Seabed 2030 supports many of NOAA's mission areas reliant on bathymetry as well as broader U.S. interests and global relations. OCS had their first significant deployment of a NOAA ship in the Great Lakes in 30 years, conducting high resolution bathymetric surveys. This year's field season featured an increased use of UxS, including operational testing and operations for the iXblue DriX uncrewed surface vehicle (USV) to augment and amplify the capabilities of the NOAA ship *Thomas Jefferson* crewed survey launches. A UxS deployed to the Chesapeake Bay completed four weeks of nearshore shallow water bathymetry, which is specifically required by NOAA's storm surge modeling program. UxS use is increasing efficiency, safety, quality, and cost effectiveness of OCS' field work. In addition to OCS' traditional role of supporting navigation in U.S. waters, there is growing U.S. interest in the Pacific region and the role that mapping can play as part of the nation's scientific diplomacy efforts. In 2020, OCS published a study of the effort necessary to finish mapping the U.S. EEZ. Most of the Pacific EEZ can be mapped using

lidar and approximately 1,000 days of ship time. NOAA ship *Rainier* surveyed parts of the Hawaiian Islands in 2019, the first high resolution surveys in over 40 years. These surveys are available through the National Centers for Environmental Information (NCEI) and are in the process of being applied to the nautical charts. This year, the *Rainier* embarked on a collaborative mission to Guam and the Commonwealth of the Northern Mariana Islands (CNMI) to deliver high-quality data products and tools to the region, including a seamless map linking the hilltops to underwater depths. Lidar data, which made this possible, made the shipwork much more efficient and NGS' Remote Sensing Division (RSD) has issued a contract in advance of *Rainier's* work in American Samoa next year. U.S. scientific and technical engagements are critical to diplomatic efforts around the Pacific. RDML Evans saw this first hand at a meeting this year with the Mekong River Commission and through engagements with the South West Pacific Hydrographic Commission. It is important that NOAA ensure developing countries are not left behind as they move towards making digital products at the global standard. A ship transiting from Hawaii to Australia will benefit from modern navigation services, but it will tend that data from countries like Fiji, Kiribati, and others. Pacific bathymetry is vital for OCS' Marine Modeling Branch, as well, which uses it to develop and run hydrodynamic models. The branch plans to include surface currents in the Pacific region, scheduled to be operational in FY24 or 25. NOAA has contributed to the IHO's Empowering Women in Hydrography project, including one candidate joining the *Rainier* crew in Guam and CNMI in July of 2022. NOAA is recapitalizing and enhancing its ship in the Pacific region. Two new Class A vessels should be coming online in 2024 and 2025, one of which will be based out of Hawaii. Plans call for replacing NOAA's oldest hydrographic ships, the *Rainier* and *Fairweather*, with new Class B vessels this decade; they expect these ships to focus on the Pacific and Alaska.

RDML Evans discussed some of OCS' current public-private partnerships, including with the University of South Florida's Center for Ocean Mapping and Innovative Technologies (COMIT) and the Brennan Matching Fund, which allows non-federal entities to partner with NOS' ocean and coastal mapping programs on jointly funded projects of mutual interest. The Seascope Alaska campaign has published a storymap and convened its first ocean mapping summit and they are now partnering with the Alaska Coastal Mapping Initiative to develop a common operating picture. Nautical charts remain central to OCS' mission and the transition to ENCs is proceeding per plan. OCS has accelerated the pace of ENC regriding for the Northeast and expect completion of that region in about six months, following which they will move on to the Gulf of Mexico. OCS is working on drafting an updated nautical charting plan to refresh the previous one published in 2017. Partly as a result of the HSRP recommendations at the last meeting, OCS has worked with USCG to revise disclaimer language on the NOAA Custom Chart Tool output, which will allow use of the product to meet carriage requirements in cases where USCG finds it to be appropriate. OCS is building out the National Bathymetric Source (NBS), which creates and maintains high-resolution bathymetry composed of the best available data. BlueTopo is the public-facing realization of the NBS, providing high quality data in a consistent format and a means for OCS to deliver coastal intelligence required for NOS strategic goals of coastal resilience and conservation. Precision navigation is featured prominently in NOAA's new Strategic Plan and serves as a great example of how OCS' data enables NOAA to serve a wider range of users with timely fit-for-purpose products. OCS is continuing to develop additional products for dissemination, including the recently developed prototype S-102 high resolution bathymetry layer and preliminary development on the S-104 water level forecast information.

Richard Edwing, Director, Center for Operational Oceanographic Products and Services (CO-OPS), NOS, NOAA, provided an update on CO-OPS' recent activities and what they plan to focus on in the coming year. The FY22 Disaster Supplemental Bill only included a small amount of funds for CO-OPS, primarily because their repairs were relatively minor despite having a very active storm season. During the recent storms in Alaska and Puerto Rico, all of the stations have been operating continuously though there may be some damage they are not yet aware of. Disaster supplemental funding allowed CO-OPS to collaborate with other offices in NOAA on modeling data assimilation and coupling. Under the BIL, CO-OPS was allocated ~\$100 million over five years to improve and enhance coastal, ocean, and

Great Lakes observing systems. The development and publication of their recapitalization plan ensured CO-OPS was ready and able to apply this money to its prioritized projects. The largest portion of these funds will go to recapitalizing National Water Level Observation Network (NWLON) stations with failing infrastructure. The funding will also allow them to complete the NWLON transition to microwave water level sensors and modernize their underlying IT infrastructure. CO-OPS will be receiving a larger allocation for coastal and inland flooding and inundation efforts, including accelerating the development and transition to operations of Operational Forecast System models and advancing the coupling of the NextGen National Water Model to 3D numerical coastal models. Under the BIL, CO-OPS will work to prototype next generation prediction systems for water levels and coastal inundation across subseasonal-to-annual scales and develop new coastal inundation products and applications. Since the last HSRP meeting, CO-OPS enhanced its PORTS program in Lake Charles, Portsmouth, Jacksonville, and Narragansett. In June, a new PORTS in Kitsap, Washington, became the 38th operational system. PORTS now covers 84 of the country's major seaports. In the coming year, new PORTS are expected to become operational in Freeport, Pearl Harbor, and Brownsville. CO-OPS has started a two-year tidal current survey for the Columbia River, which was necessitated by the deepening of the main river channel. Predictions will be updated at 29 locations in the Lower Columbia River and 15 have already been deployed. New approaches for this survey include the deployment of CURBY buoys, which were developed by CO-OPS and enable current measurements where there are no existing structures and can assess tidal currents in areas of significant bathymetric change, validate numerical models, and inform circulation studies. In May, CO-OPS issued their State of High Tide Flooding and 2022 Outlook, as well as continued work on the underlying support products, including transitioning the content to an interactive GIS platform. The data collected by NWLON stations were a core contributor to the interagency 2022 Sea Level Rise Technical Report, which provides sea level rise projections by decade for the next 100 years and beyond. CO-OPS has received a lot of positive feedback on the report and how useful it has proven. In the coming months, CO-OPS will undergo an external review focused primarily on their observing systems, maritime products and services, and future directions. The final recommendations will be delivered by the end of the year and the HSRP will be briefed on them at their next meeting. CO-OPS will also be contracting out a PORTS assessment to determine the requirements for a fully built out system and outline and evaluate a variety of options for governance models. In FY23, CO-OPS will be developing their new five-year strategic plan which will be informed by the external review.

Dr. Larry Mayer and Captain Andy Armstrong, Co-Directors, NOAA-University of New Hampshire (UNH) Joint Hydrographic Center (JHC), provided an update on activities at the JHC, particularly USV technology developments and work done in the Papahānaumokuākea Marine National Monument. The goal of their project around the island of Nihoa was to refine and demonstrate the operational procedures to carry out simultaneous deep water and shallow water seabed mapping from a ship and an embarked USV, each using their own multibeam system in an area with depths ranging from 20m to ~4,000m. They partnered with the Ocean Exploration Trust to use the E/V *Nautilus*, as well as OCS and OAR's Office of Ocean Exploration and Research to accomplish their joint goals of mapping, exploring, and characterizing U.S. waters. RSD had recently completed bathymetric lidar mapping of the nearshore waters around the island through a contract with Woolpert. This effort was a great example of the kind of public-private partnerships needed for Pacific mapping. Dr. Mayer described the sea trials with various DriX autonomous surface vehicle (ASV) models, which stayed very stable in winds up to 35 knots and collected high quality hydrographic data at speeds of up to 12 knots. The ASV was able to keep pace with the mothership, which has many advantages, though the system's autodocking capabilities were inconsistent and need further refinement. The second leg of the work with the vehicle was focused on expanding the ocean exploration footprint and developing and demonstrating collaborative behaviors between multiple vehicles operating simultaneously. Among the features of the vessels used was an eDNA sampler, which opens up the possibility of "verified - directed sampling" and many potential new applications, including avoidance. On its most recent leg, they focused on the charting uses of the DriX system. Their goals included developing protocols for dual vessel operations, junction with recently

collected lidar data, filling gaps where lidar went to extinction, redoing sparse multibeam surveys from University of Hawaii's compilation, and comparing the mothership 30kHz multibeam to shallow water 2040. DriX can survey at high speed with little data degradation and has impressive endurance. They had no problems with the dual vessel operations and over 95% of the data collected met or exceeded NOAA specifications. Overall, they were very pleased with the capability of the vessel. They hope to have full over-the-horizon capability by next year's trials.

Mike Aslaksen, Chief, Remote Sensing Division, National Geodetic Survey (NGS), NOS, NOAA, provided an update on NGS' activities with a specific focus on those happening around the Pacific. BIL and Hurricane Supplemental Funding provided opportunities for NGS' Coastal Mapping Program to begin providing inland bathymetry for the first time. NGS has been given ~\$100 million over four years to begin doing this work which presents a major opportunity for growth in RSD towards safety of life and property. These funding sources have also provided additional support to help speed the completion of their Gravity for the Redefinition of the American Vertical Datum (GRAV-D) mission and to look at vertical land motion with their Foundation CORS and Deformation Models. NGS has begun to re-stack their priorities for the National Spatial Reference System (NSRS) modernization effort and now expect to release the modernized NSRS in alpha and beta versions in mid-2025 with limited data and tools. Working with several partners, NGS plans to establish about 200 Foundation CORS stations for the federal framework. BIL funded ten stations to be established in FY23, including one in Guam. As of August 2022, NGS has collected 95.72% of the targeted area for GRAV-D using contracted and NOAA assets. 82% of Guam and CNMI is complete and NOAA is determining whether they need to return for the remaining lines. NGS will be collecting in the Aleutians, Hawaii, and American Samoa in FY23 to establish geoids in the Pacific region. The Coastal Mapping Program updated 7% of the National Shoreline with new aerial imagery and elevation data, including 554 statute miles of Alaska. They updated the shoreline and features in 58 ports and did a change analysis for 50 of the ports. NGS delivered 6,503 square miles of topobathy lidar data for inclusion in Digital Coast and updated 3% of their Continually Updated Shoreline Product. Mr. Aslaksen presented maps of the FY22 and '23 coastal mapping operations for acquiring aerial imagery as well as the FY23 topobathy lidar operations. NGS continues to develop its satellite-derived bathymetry capabilities but more research is needed before it will work well for Alaska. The VDatum tool is currently in version 4.4.2 and version 4.5 will be released in 2023, which will integrate the Columbia River Datum and move towards regional model development approaches that allow NGS to update their models as new data becomes available.

Partnerships and Priorities: Mapping Collaborations in the Pacific Region

Joyce Miller, former HSRP Chair, Lindsay Gee, HSRP Member, and Commander Briana Hillstrom, Chief, Hydrographic Surveys Division (HSD), OCS, NOS, NOAA, moderated the session of NOAA, federal, academic, commercial partners, and users/stakeholders discussing current and future projects, gaps, and priorities for mapping, lidar, data, and services. Speakers offered suggestions for how NOAA can direct its finite resources to leverage partnerships and collaboration and enhance efficient and environmentally sound maritime operations.

Dr. John R. Smith, Oceanographer, Hawaii Undersea Research Laboratory and Department of Oceanography, University of Hawaii at Manoa (ret.), presented a review of the University of Hawaii (UH) partnerships with state, local NOAA facilities, federal agencies, and private foundations to carry out extensive surveys and data syntheses of Pacific regions using Hawaii-based vessels and assets along with those home ported elsewhere. The Hawaii Institute of Geophysics and Planetology housed within the University of Hawaii at Manoa has been a major force in research and development of mapping system technologies since the 1960s. Dr. Smith reviewed some of the institute's advancements and efforts over the years, as well as his own work with a NOAA-funded group conducting multibeam surveys in Hawaii from 1995 through 2017. The current research vessel UH uses is a SWATH ship and was used to do the

first extensive multibeam surveys of what would become the Papahānaumokuākea Marine National Monument. Using this ship they also conducted surveys of essential fish habitats around all of the main Hawaiian Islands, seven surveys for the Extended Continental Shelf program, numerous annual charters by foreign clients doing polymetallic nodule research, and supports for ROVs. The unique hull design allows for multibeam surveys in any direction in any workable seas. Dr. Smith briefly discussed some of the NOAA and non-NOAA multibeam equipped vessels that are or have been used in Hawaii. Many of the major seamounts and other features in the Pacific EEZs and Marine National Monuments have now been mapped by 30 and 12 kHz multibeam systems. While the higher 30 kHz resolution is great to have on these seamounts and other features of relief, it is not always taken advantage of in the generation of derived data products. A large portion of the most recent mapping in the expanded areas of the Pacific Marine National Monuments have focused on large areas of abyssal depth seafloor in the 4,500m and greater range between already mapped seamounts and other features all while using 30 kHz systems. This results in spending a substantial amount of time mapping areas outside the sweet spot of the 30 kHz systems, while a 12 kHz multibeam system would easily provide 3-4 times the coverage in these depth ranges. Having a fully staffed and experienced mapping team is still critical to successful completion of these missions. Dr. Smith shared some examples from recent mapping in Papahānaumokuākea. He encouraged NOAA to provide external funds for ship time charters to carry out seafloor mapping missions in the Pacific EEZs and Marine National Monuments when the appropriate NOAA assets are not available. He also suggested expanding the charters to include vessels with full ocean depth 12 kHz wider swath systems that can map the remaining seamounts and abyssal depth seafloor in the Pacific EEZs with far more efficiency. Because UH's R/V *Kilo Moana* is based in Hawaii and regularly works across the Pacific, transits to and from the EEZs and Marine National Monuments are reduced, allowing more time on site for surveying for less overall cost. NOAA should coordinate with an organization like the Ocean Exploration Trust to assemble and fund an experienced mapping team to sail on 12 kHz multibeam-equipped vessels that may not have a full in-house team with adequate experience, established methods, and computing resources.

Dr. Jennifer Samson, Archipelagic Research Program Lead, Ecosystem Sciences Division, Pacific Islands Fisheries Science Center (PIFSC), National Marine Fisheries Service, NOAA, presented on how accurate and complete mapping information (including quality backscatter) is critical for fisheries and habitat assessment and monitoring efforts that allow NOAA Fisheries to more effectively meet their mission of conserving and managing coastal and marine ecosystems and resources. The RICHARD Marianas 2022 Cruise set out to conduct two different but equal projects simultaneously. The Fisheries team completed over 1,600 scuba dives collecting data on coral reef communities, fish populations, and oceanographic conditions while the ship's hydrographic team collected high-resolution bathymetry to close out 13 surveys for a total of 7,981 linear nautical miles. The PIFSC component of the RICHARD mission focused on the Pacific execution of the National Coral Reef Monitoring Program, a long-term program tracking the status and trends of U.S. coral reef ecosystems. The fish and benthic components of the survey employed a survey design stratified across three depth bins spanning 0-30m of all hard bottom habitat. Having better maps will help prevent mismatches or misallocated survey sites that require reallocation in real time. In well-surveyed areas, the current rate of mismatch is not bad but there is room for improvement. Around Oahu, divers found mismatches at a 26% rate across the sites. Lidar data is somewhat better with mismatch and missing data rate of 11% and 7% respectively. On the big island of Hawaii, mismatch rates get much worse with up to 66% mismatch and over 20% missing. Lidar coverage is variable and for some islands is only partial or is absent altogether. There are better bathymetry and lidar products available for the main Hawaiian Islands that will be utilized when planning the 2024 National Coral Reef Monitoring Program (NCRMP), but in many regions where they have been working this has not been the case. Better maps would improve PIFSC's survey efficiency, but robust, domain-scale benthic habitat maps from which they could re-stratify their surveys would be even better. Bottomfish surveys represent another high priority PIFSC effort that relies on high-quality map products to increase precision and efficiency as well as reduce costs. Having bathymetry and clean backscatter are

equally important. Moving from a nine to 24 level stratification based on depth, hardness, and seafloor complexity would result in 34-57% reduction in the sampling effort required to achieve the needed coefficient of variation statistical targets. Prior to the recent *Rainier* mapping work conducted as part of the RICHARD project, much of the Marianas' bathymetry was of too low a resolution and did not extend deep enough for the bottomfish domain of 75-400m. In addition, there was little usable backscatter. The RICHARD mission will fill many of these gaps, including bathymetry coverage from 2-1500m with a 5m resolution for 95% of these depth ranges. The U.S. Pacific region is so vast that identifying, describing, and protecting essential fish habitats for federally managed and endangered species with limited resources can be a major challenge. The RICHARD cruise not only provided much needed mapping products to improve PIFSC's surveys and models, but also created an unprecedented opportunity for OCS and Fisheries' scientists to collaborate and identify specific ways their different data products can mutually support each other.

Dr. Daniel Wagner, Chief Scientist, Ocean Exploration Trust, presented a summary of E/V *Nautilus'* mapping operations in the Pacific in 2021-2022, and provided an overview of plans for 2023. The *Nautilus'* mission is to explore the ocean, seeking out new discoveries in the fields of geology, biology, and archaeology while pushing the boundaries of technological innovation and STEM education. They are most well-known for the 24/7 live streams from the *Nautilus*. The images and deep sea habitats are what captivates most people, but foundational to all of it is the mapping. The *Nautilus* has two mapping systems onboard, a Kongsberg EM302 multibeam and a Knudsen 3260 sub-bottom profiler, which can map buried features up to 80m below the seafloor. Beginning next field season, they will also be incorporating a mid-water fisheries sonar. In collaboration with partners, the Trust is integrating additional mapping capabilities, USVs and HROVs. In order to map the entire Pacific, more than just ships will be required, but a lot of these technologies are still in the testing and development phase. Since bringing the *Nautilus* to the Pacific in 2016, the Trust has mapped over 675,000 square kilometers, primarily focusing on Marine National Monuments but also doing opportunistic transit mapping. The Trust has developed Hawaiian names for some of their expeditions, published educational resources in Hawaiian language versions, and included Papahānaumokuākea Marine National Monument staff and local students on expeditions, as well as engaging cultural liaisons. The Trust's 2023 draft plans will again focus heavily on the U.S. EEZ in the central Pacific but will also include working with partners that will bring the ship into non-U.S. waters, such as the Marshall Islands and British Columbia. They will be putting out a call for input in the next month before finalizing the schedule.

Stephen White, Remote Sensing Division, National Geodetic Survey, NOS, NOAA, presented an overview of efforts to collect topobathy lidar in the Pacific Islands ahead of NOAA ship operations to assist with planning and situational awareness, as well as to increase efficiency and safety. For this presentation, Mr. White focused primarily on RSD's Coastal Mapping Program which is mandated to conduct remote sensing surveys to demarcate the nation's legal coastline, providing up-to-date, accurate, and consistent National Shoreline, as well as acquiring nearshore elevation data. NGS' topobathic lidar data is collected for several purposes, but supporting hydrographic surveys is one of their highest priorities, increasing the efficiency and safety of launch and ship operations. The sensor RSD generally uses is the Leica Chiroptera 4x, but when the water is clear they are able to use the HawkEye sensor which can get much deeper (40-50m). Mr. White went through several examples of areas where lidar was collected side-by-side with lidar combined with multibeam surveys. Feedback from users of this data included hydrographers feeling much more comfortable with the buffer that NGS' data provides, and that it amounted to huge time savings. Mr. White shared some of the data collected in Papahānaumokuākea and Southeast Alaska. One thing NGS has been working on with UNH and the University of Oregon is developing uncertainties associated with their data and they are working with sensor manufacturers to include total propagated uncertainty calculations for their products. They are also working to make normalized intensity more consistent, which is helpful for benthic habitat classification and other applications. The Joint Airborne Lidar Bathymetric Technical Center of Excellence (JALBTCX) has been

receiving funds in recent years to do work in Alaska and getting priorities from many different organizations. They have spent the last few years on the West Coast of CONUS, but Wake Island is going to be acquired this year and they are tentatively planning for Kwajalein as well. All of this data is publicly available through Digital Coast. The National Centers for Coastal Ocean Science (NCCOS), Oregon State University, and Woolpert have been taking a lot of this data and using lidar waveform metrics to help predict benthic classification mapping and have had very good luck using those metrics to assist in that work. Logistics are a major obstacle in the Pacific, but RSD is looking at new platforms that may allow them to get further out; steep terrain can also mean there are places where they cannot acquire data due to safety hazards. There are also areas with Department of Defense (DoD) operations that make it unsafe to collect data.

Dr. Ashton Flinders, Research Geophysicist, Hawaiian Volcano Observatory, U.S. Geological Survey, presented a brief overview of past, present, and future mapping partnerships and priorities of USGS and the national interest in the Pacific. The Expanding Pacific Research and Exploration of Submerged Systems (EXPRESS) is a multiyear, multi-institution cooperative research campaign in the deep sea areas of California, Oregon, and Washington, including the continental shelf and slope. It is intended to guide wise use of living marine resources and habitats, inform ocean energy and mineral resource decisions, and improve offshore hazard assessments. EXPRESS partners include NOAA, BOEM, USGS, MBARI, and the USC Sea Grant who to date have collaboratively mapped 11,700 square miles of ship-based multibeam and 167 square miles of AUV activity. Seascape Alaska is a NOAA-led regional campaign supporting NOMECS, working toward a common goal to fully map the U.S. waters off Alaska. As of January 2022, 69% of these waters are unmapped. Seascape Alaska seeks to reduce this number by tracking down existing datasets and ingesting them into NCEI, encouraging mapping areas that are unexplored or underexplored, and encouraging multidisciplinary plans and technology to maximize data collection. The U.S. West Coast and Alaska Marine Geohazards project is a USGS-led effort that has partnered with NOAA since 2016 bringing together data collected by both agencies from areas that have experienced sudden and extreme events beneath the ocean. Between FY19 and '22, NOAA and 3DEP worked together across several projects to collect topobathy for most of subaerial CNMI. In FY20, NOAA collected data for all of Guam and USGS will bring this data into the 3D Elevation Program (3DEP) as a contributed project. NOAA provided significant portions of topographic lidar data for the Island of Hawaii. USGS' Global Marine Mineral Resource Project aims to provide stakeholders with the best available science regarding potential resources and environmental impacts associated with accessing those resources. Priority areas for polymetallic nodule and ferromanganese crust include abyssal plains seamounts around Wake Island, Jarvis Island, Kingman Reef and Palmyra Atoll, and priority areas for hydrothermal minerals include Gorda Ridge, the Mariana arc and back-arc, and the Aleutian arc. The Pacific Islands Climate Adaptation Science Center (PI-CASC) is a collaborative partnership between USGS and a university consortium and is designed to support sustainability and climate adaptation in communities across the Pacific Islands. Current priority areas for PI-CASC topobathy data collection include Pacific Remote Island Area (PRIA), the Republic of Marshall Islands, the Federated States of Micronesia, and Palau. American Samoa is a high priority for PI-CASC as well as 3DEP and the Volcano Science Center. The Interagency Working Group on Ocean Exploration and Characterization (IWG-OEC) has convened thematic working groups to discuss priority geographic areas, all of which identify needs for higher resolution mapping data. These areas included the Aleutian arc, Cascadia, Hawaiian Islands, Remote Pacific Island Areas, and the California coast. Dr. Flinders discussed downstream USGS products and projects that use NOAA mapping data but currently have no identified priority areas. These are potential future projects for collaboration with increased return on investment of NOAA mapping data. These include: the Marine Geomorphology, Evolution, and Habitats Project; the Coastal Storm Modeling System (CoSMoS); and the Coastal Habitats in Puget Sound Project (CHIPS).

Commenters

Dr. Malia Chow, Branch Chief, PIRO Habitat Conservation Division, NOAA Fisheries, said she was excited to hear about all the work underway in the Marine National Monuments. PIRO needs fine resolution mapping of nearshore environments for essential fish habitats, but they also protect large areas of the Pacific Ocean. Dr. Chow thanked the HSRP for including a fisheries management perspective on this panel. She emphasized the importance of the need to create usable maps and disseminate information in quality products. Fisheries is in the process of developing management plans for the Pacific Remote Islands Marine National Monument and needs to use the best available information in the development process. One of their targets continues to be characterization and exploration of these large and unknown areas. Fisheries appreciates having been included in the considerations for upcoming expeditions.

Sarah Falzarano, Chief, Technical Integration Branch, Honolulu District, USACE, further discussed the USACE Honolulu District's area of responsibility, which is the entire Pacific. JALBTCX will be collecting data for the Hawaiian Islands in FY23, which will be made available on Digital Coast. USACE maintains the federal channels for all of the U.S. ports across the Pacific and makes that data available on eHydro. They also maintain the breakwaters that protect these harbors. The Honolulu District has added a drone program and they use these to collect data on the harbors to get before pictures in the event that a natural disaster takes out a breakwater and for some of the inspections, as well as part of USACE's military mission.

Captain Hector Casanova, Commanding Officer, NOAA Ship *Rainier*, said that during the 6-7 month deployment to the Marianas, from combining the Structure from Motion photogrammetry and bathymetry to produce 3D models of corals to assessing the potential early effects of ocean acidification on corals to updating the nautical charting products, the synergy between these programs and the local scientists from the Marianas was an amazing collaboration. All this hard data was not its only success. The locals were very thankful for all the data and work accomplished. He hopes they can do the same in the PRIA and American Samoa next year.

HSRP Q&A

Qassim Abdullah said it would be a good idea to convene a technical conference on mapping the Pacific to bring the right people to collaborate, set priorities, and explore possible solutions.

Ed Saade noted that the needs off the coasts of California and Alaska are deepwater mapping. He asked how easy it is for NOAA and USGS to share vessels or collect data for other agencies, as well as how easy it is to get commercial vessels involved. He also asked how shallow the shallowest part of the work off California has been. There is going to be a lot of activity up to 24 miles offshore relative to offshore wind that would seem to overlap with USGS' priority areas. Dr. Flinders said that some of the EXPRESS work was done in partnership with BOEM for these specific reasons. USGS' interest spans the full range in terms of water depth but they do not have deep water capabilities without partnerships. RDML Evans said OCS has interest in deeper water for charting purposes, but it is not a priority since they do not explicitly have a safety of navigation mission there. OCS does have capacity in the fleet and are able to partner very effectively with USGS and BOEM to utilize the ships and crews. He did not believe they have executed any of the EXPRESS projects via contracting vehicles.

Anuj Chopra asked if there was a way to come up with a common risk-based prioritization for collaboration and optimization of resources. Mr. Gee said they need someone at a high level actively coordinating across agencies that knows where all the projects are and understands the priorities. Optimizing resources is especially important in an area as vast as the Pacific. Ms. Miller said there are issues with how to contract academic vessels out of NOAA. It does not make much sense to have three 30 kHz ships deploying all the time when one ship with lower frequency sonars could accomplish more on an extended cruise. The head of the UH Marine Center, RDML (ret.) Anita Lopez, is very interested in hearing from NOAA on this. Dr. Flinders said the prioritization effort has already partially been done

through NOMEAC and the draft strategic priorities for the IWG-OEC. The IWG-OCM has also done a lot of work identifying mapping needs. Captain Armstrong added that the Integrated Ocean and Coastal Mapping (IOCM) initiative manages the SeaSketch Program, which is a common platform displaying work that is underway or planned among various agencies. There has also been a mapping priority exercise by IOCM that incorporates inputs from academia and other federal agencies.

Anuj Chopra said that commercial needs and input must also be considered.

Larry Mayer noted that, as they have the important discussion about how to address mapping the Pacific, there was no one present from NOAA's Office of Exploration and Research. They need to recognize that there are artificial barriers placed on the distribution of mapping that need to be resolved, perhaps in a joint OEAB-HSRP meeting.

Ed Saade said there will be many vessels coming from other places to the West Coast of CONUS because there are virtually no deepwater or shallow water vessels available there currently. Many will be transiting with mapping technologies and for clients willing to donate data. There must be a way to connect those people with the data needs identified by this panel.

Public Comment

Lynne Mersfelder-Lewis read the following comments received during the first day of the meeting:

Suwan Shen, Assistant Professor, UH-Manoa: The university of Hawaii is conducting research on disaster relief supply chain. If you have anything to share, please consider participating through a short interview.

Pamela Chelgren-Koterba: NOAA Custom Chart - As a recreational boater, I am hoping for a more complete paper product, especially regarding display of Controlling Depths (either on the plot or in the Supplemental sheets) and ATON Light characteristics (disappearing quicker than they do on the online "Chart Display" and if not appearing on the plot, at least include in the Supplemental sheets).

NOAA/MCD Weekly Chart Updates - I am hoping for a version that can span a number of weeks at one time. I had heard this was being considered, but have not seen it. RDML Evans said OCS is actively working to further develop the NOAA Custom Chart Tool and incorporate additional capability. This is moving as quickly as resources allow, but appreciate requests that they can incorporate into their prioritization for additional features.

Guy Noll: I am very interested in how the PORTS requirements become federated and standardized (?) across the implementation spectrum as a "system." Could NOAA create a systemic approach to navigation and related requirements to encourage maritime ports to have a minimum digital content 'signature' that creates opportunities for cross-port collaboration? Mr. Edwing said he would have a follow up conversation with Mr. Noll to better understand what he is asking. Mr. Duffy spoke specifically to the Mississippi River's PORTS program and some of the challenges they face, including maintenance and the costs associated with installation (particularly shutting down bridges to install air gap sensors).

Standardizing PORTS is difficult because each system is different and has different needs. Captain Chopra said, regarding PORTS funding, the Houston-Galveston Ship Channel has been the largest U.S. port in terms of tonnage and container traffic has already grown over 22% this year. They are about to enter the fog season in another month or so and this area does not have even one visibility sensor. There are smaller ports with several sensors because the entities there were willing to pay for it. He asked if NOAA could consider a program based on national economic need. The closure of the Port of Houston

for one day has a huge economic impact on the country. Maybe there's another way to look at how they designate visibility sensors so as to make it more objective. Mr. Wardwell said the problem with this approach would be around equity for underserved communities. If decisions are made strictly on economy, Alaska would never get any of the coastal monitoring systems they will eventually need in order to serve their communities. Mr. Edwing said these are the considerations that will be addressed in the PORTS Assessment.

Starla Robinson, NOAA Hydrographic Services Division: It sounds like bringing up the Brennan Matching Fund Program may be worth mentioning right now. OCS is looking for funding partners.

Day 1 Meeting Recap and Round Robin with HSRP Members and NOAA Leadership

HSRP members provided comments on the first day of the meeting, including: general appreciation for the inclusion of Hawaiian cultural aspects, perspectives, and resources in the meeting; the PORTS issues raised would be a good topic for their next session; members were encouraged by the number of times Alaska was referenced during the meeting, as it plays right in to many of the issues that came up; also encouraged to hear about the potential for full VDatum coverage in Alaska in FY24 and a lot of the recent storm surge damage in Norton Sound would benefit from good VDatum models; encouraged to hear how the New Blue Economy concept continues to develop and where NOAA is going with it; would like to hear examples from Bill Thomas of the "inalienable responsibilities" that he mentioned; pleased to see NOAA's commitment to Seabed 2030; appreciation for the tide and current work along the Columbia River and incorporating the Columbia River Datum into VDatum; the statement "relationships move at the speed of trust" helped members to understand that public-private partnerships hinge on how the two sides trust each other to work together for the common benefit to both parties; the diplomatic importance of having NOAA ships having a scientific presence across the Pacific, including outside of the U.S. EEZ; the importance of getting the data into the products in a timely fashion should be addressed at a future meeting; the challenge for NOAA of local governments needing acutely local data; the problems with using cost-benefit ratios in addressing the needs of underserved communities; the challenges seen around the Pacific are also present in other regions, though often much more complex; NOAA is taking on more and more missions and members wondered if the budgetary staples are in place to continue to serve needed navigation services; federal agencies and partners should be optimizing their resources and making them available to other agencies for training and other purposes when not otherwise in use; appreciated Paul Scholz' encouragement for the HSRP members to be bold in their recommendations to NOS; formal coordination is needed for mapping the Pacific; the role of AI and machine learning is key for the amount of data collected for ocean exploration; and the Polynesian voyaging presentation highlighted the importance of understanding what is happening around the boat and the value of a mariner's physical connection to the ocean. Mr. Edwing said there are many commonalities between Alaska and the rest of the Pacific in terms of needs and size. Mr. Aslaksen said NOAA spends an inordinate amount of time trying to coordinate efforts and he did not want that to go unrecognized. He also commented on how many speakers mentioned using Navigation Services data. As they move forward, the Panel may want to look at who these users are and how they could provide support to expand those capabilities to meet common needs. Captain Armstrong said the Hawaiian cultural protocol got the Panel in the right mindset for everything they were considering throughout the day. Dr. Mayer said they saw the power and value of partnerships expressed in real terms and this will inform their discussions later in the meeting. RDML Evans said he wished he had heard more about the U.S. government diplomatic requirements, as this is a powerful driver that OCS will have to figure out how to navigate. Engagement with Indigenous communities is important across the various regions NOAA operates in and when they come into a community, they need to not only focus on building capacity but also building ownership of the process and the data. In response to members picking up on his comments about the importance of getting data into the products, he emphasized that sometimes the data is the product and

they want to get the data into the hands of users in whatever form is fit for purpose and this is a challenge at all levels. He asked how the Navigation Services community within NOAA should balance their domestic mandates with their forward-leaning requirements. This is an area where OCS would appreciate HSRP's comments.

Wednesday, September 21, 2022

Round Robin recap from Day 1 and continued HSRP discussion

HSRP members shared additional thoughts on the previous day, including: the importance of environmental justice considerations and the blue economy; the fragility of Hawaii's supply chain and the HSRP thinking about how they could assist in that space; the HSRP should recognize that NOAA is now talking about the coasts and there is some urgency in getting out recommendations while the agency is receptive; the administration's priorities line up nicely with the NOS strategic plan and they should consider how HSRP can capitalize on that with agenda items that coincide with those priorities; the need for members to come up with new ideas for issue papers that the HSRP can take up; the shortage of mariners in the U.S. and the need to encourage young people into maritime careers; how much interaction with the local communities brings to HSRP meetings; the need for stakeholders to be prepared for the NSRS modernization; and a better synthesis of all the observations is needed. Captain Armstrong said it is important for the HSRP and NOS to keep in mind the value of their work beyond its primary application and recognize the needs of other users, as was noted by Dr. Samson when discussing the need for high resolution seafloor mapping for fisheries management. Dr. Mayer said it is critical the HSRP not lose sight of the importance of NOAA maintaining its vessel capability. Ms. Blackwell complimented the staff on making the hybrid meeting work. Mr. Aslaksen said he hopes the Panel recognizes the value of airborne lidar bathymetry and of tying it into NOAA's operations and broader uses. Mr. Edwing commented on the need for more oceanographic observations and better geodetic controls around the Pacific.

Stakeholder Perspectives on Opportunities and Vulnerabilities: NOAA Precision Marine Navigation Data, Ports, Harbors, and Sustaining a Supply Chain in Hawaii

Captain Anne McIntyre, HSRP member, and Julia Powell, Chief, Navigation Services Division, OCS, NOS, NOAA, moderated the panel focused on Hawaii's reliance on its Marine Transportation System for delivery of day-to-day goods. Stakeholders discussed the vulnerabilities within this supply chain and how they rely on NOAA's navigation products, data, and services that will enable further economic growth of Hawaii's shipping industry. NOAA also provided an update on its Precision Marine Navigation Program's plans for the next 3-5 years and stakeholders addressed their perspectives on how to maximize the just-in-time supply chain.

Julia Powell, Chief, Navigation Services Division, OCS, NOS, NOAA, presented on NOAA's Precision Marine Navigation Program, which is a major component of the information infrastructure for the New Blue Economy concept. Precision marine navigation harnesses all the different types of data that NOAA has and disseminates them in a format that is suitable for navigation but can also be used for other applications. Multiple devices and systems being required to access the data, datasets spread across various websites and data servers, and datasets encoded in different formats that are not to navigation standards are some of the key challenges for users accessing and processing NOAA's navigation data. The IHO has developed the S-100 Framework Standard from which developers can build product specifications that standardize the implementation on navigation systems. The framework provides common portrayal and data formats, as well as interoperability that allows users to combine data layers. NOAA is building out their precision marine navigation data and dissemination services, which will

include machine-to-machine capability. As a demonstration of the various navigation considerations necessary for ship transit, Ms. Powell discussed the route planning for a voyage from Los Angeles to Honolulu and how depths/bathymetry in channels, surface current systems, water levels, and waves and severe weather hazards are factored in to route optimization using the S-100 framework. S-100 Discovery Metadata allows users to only download datasets particular to the chosen route, saving users money and bandwidth. Overall, the primary benefit of the Precision Marine Navigation Program is that it makes the data more accessible to enhance the decision making process, leading to increased efficiency (e.g., optimized routes for fuel savings and reduced CO2 emissions, reduced lightering offshore, reduced port wait times) and improved safety (e.g., reduced collisions/allisions/groundings, avoidance of hazardous weather conditions).

Eduardo Manglallan, Deputy Director, Harbors Division, Hawaii Department of Transportation, presented on how NOAA's products and services support Hawaii's just-in-time system for delivery of goods. The State of Hawaii DOT (HDOT) Harbors Division is tasked with the mission of effectively managing and operating the statewide commercial harbors system that facilitates the efficient movement of people and goods to, from, and between the Hawaiian Islands. Hawaii has ten commercial harbors statewide, located on six islands with Honolulu Harbor serving as the hub. About 80% of the goods consumed in Hawaii are imported. 98.6% of these goods are brought in through the commercial harbor system. Cargo shippers, passenger vessels, commercial fishing operations, vessel building and repair yards, marine research facilities, and military operations all utilize Hawaii's commercial harbors system. Without NOAA's charting, forecasting, and mapping, Hawaii's vessel operators would have tremendous difficulty navigating or getting to safe havens during inclement weather. The Honolulu Harbor ships about 320,000 forty-foot equivalent units per year. Cargo is transshipped to neighbor islands as well as Guam, CNMI, American Samoa, and Free Alongside Ship (FAS) ports. They also handle domestic and foreign containerized cargo, as well as berthing for fuel operations, cruise ships, and day excursion vessels. Mr. Manglallan presented the layout of the Honolulu Harbor, particularly focusing on the tourist pier configuration. The new Kapalama Container Terminal will offer 1,800 linear feet of berthing space and an 84 acre cargo area. The project aims to be completed by April 2024, though projections show that they will need another expansion by 2046 in order to meet demand. The many laws around biosecurity can lead to additional costs and delays for projects and NOAA needs to work with the other state and federal authorities in the area to create a one-stop shop that provides clarity on all the pertinent regulations.

Captain Ed Enos, Hawaii Pilots Association, presented a pilot's perspective on some of the challenges in and around Hawaii's ports and what NOAA could do to help. The Hawaii Pilots Association provides pilotage for seven islands and four different ports. Pilots rely on weather nowcasts and forecasts up to 48 hours out. When bad weather hits, cargo movements are interrupted, including deliveries of food, medicine, fuel, and other consumables. This also impacts military forces across the state and U.S. military readiness as their operations rely entirely on the civilian shipping industry in Hawaii. Mariners need easy access to NOAA information that is timely and accurate. They need to know water depths in the harbors, real time wind speed and direction observations, real time sea and swell observations, and easy online access from vessels offshore. Data gathering sensors must be at commercial harbor locations and the system must be robust and resilient enough to withstand heavy weather. It does not matter to pilots which agencies do the surveys, but they need to be done routinely and often. Good data today is better than perfect data next year. As an example of a successful public-private partnership, Captain Enos discussed a joint venture between the Hawaii Pilots Association, HDOT Harbors, PacIOOS, and Hawaii Stevedores to install a weather station for large cruise ships. The growing size of the ships coming into the Honolulu Harbor has presented many challenges in planning for the new terminal. The Hawaii Pilots Association wishes they had a chart that showed where the new pier is going to be so they could run berthing simulations for training pilots on what will be a very difficult job. Captain Enos concluded by playing a

video of high wind conditions around Kahului, Maui, to demonstrate some of the challenges pilots face transiting between islands.

Ethan Creps, Director, Vessel Operations and Engineering - Pacific, Matson Navigation, presented on climate and environmental considerations in vessel operations. One of the milestones of the UN Paris Agreement is a 45% emissions reduction by 2030 and net zero emissions by 2050. This is an ambitious goal and, as an international shipper, Matson has developed their environmental, social, and governance program to reflect many of these goals and are exploring a variety of ways to achieve them, including using real time data to make better decisions managing ships. NOAA's products and services could help in these efforts by allowing companies to fine-tune speeds to be most efficient through real time knowledge of currents and weather. Mr. Creps noted that Hawaii does not have a PORTS established, though one is expected to be installed in Pearl Harbor to support Navy operations. As was previously mentioned, civilian commercial shipping provides the support for DoD across the islands, so it is essential that the commercial harbors receive equal attention. Climate change impacts are real and shippers are dealing with them on a daily basis. Hydrographic data could help support these efforts by offering a better understanding of the increasingly frequent and powerful storms. Hurricane preparation in a just-in-time system presents challenges not seen in other areas. Matson has worked closely with the HDOT Harbors, USCG, and NWS to try to get more realistic estimates on storm timelines and safe margins for continuing to operate. Winter lows in the Pacific do not get much attention, but they can be severe systems. Mariners need to better understand these systems and PORTS data would be a big help.

Mikkel Roer, Port Captain, Manager, Marine Compliance, Young Brothers/Foss Maritime, Hawaii, presented on Hawaii's critical infrastructure and neighbor island lifeline. Hawaii's Public Utilities Commission has granted Young Brothers a regulated monopoly over intrastate maritime commerce. They have a fleet of eight barges towed by six tugs and do 12-16 weekly sailings from Honolulu. They move freight of all kinds, providing essential services for first responders, public safety vehicles, and other public utilities. Young Brothers and Foss Maritime transport containerized fuel to some islands that do not have bulk oil facilities and provide the only source of fuel for some islands. The island of Lanai only received half a barge load of goods per week; Molokai gets one and a half per week. The larger islands have harbor assist tugs available but not the smaller ports, which tend to be the most difficult to get into. Because the smaller islands receive so little service, they are the most reliant on getting their goods in a timely fashion. If the barge cannot make it in for a week, the shelves start going bare before the next one arrives. Real time current and wind data for these smaller ports would help make shipments more reliable and predictable. More frequent updates to the charting would also be valuable. Mr. Roer noted that a pier in Hilo Harbor that has been there for four or five years still does not appear on NOAA charts.

HSRP Q&A

Dave Maune asked if Young Brothers supplies the leper colony on the island of Molokai. Mr. Roer said they do and provide just one delivery a year. Captain Enos added that it is a big event that takes a lot of planning. Everyone in Kalaupapa has to plan ahead because they only have one chance to get what they need for the year. The north shore of Molokai where the colony is located requires perfect conditions to be able to make the delivery and the logistics are extensive.

Qassim Abdullah asked what level of detail the users expect to see on small port charts. He also asked RDML Evans if it was possible to add features that are not yet present. Captain Enos said the existing level of detail on a traditional NOAA chart is fine, but the issue is how often the harbors are surveyed and how that information is disseminated. RDML Evans said the pier is at a scale that would be appropriate for the chart and he will look into the specifics on why it has not been included. Ms. Powell commented that the NBS will serve as a consolidated database of all the latest bathymetric holdings from various sources from which the S-102 product is extracted and made available much more quickly than data could get onto a chart.

Captain Enos said there is no standard for portable pilot units (PPUs) and cited instances where this has led to serious consequences. NOAA needs to ensure that what they are providing is something that can be loaded on the equipment pilots are using. Mr. Gee said that PPU's in some foreign ports, such as Rotterdam, integrate the authoritative bathymetry with additions and edits made by the port. Ms. Powell said this was part of the thinking behind building out the NBS. There are questions of liability, but they are starting to see some of the benefits from adopting the international standards. Part of the project has been working with pilots and software companies to ensure that implementation is working.

Larry Mayer asked if the data NOAA will be delivering will be designed for PPU's and ECDIS systems or if it will be something that a user could navigate on a tablet. Ms. Powell said it will be for both. Dr. Mayer asked if NOAA will be offering an end product and if there has been any effort to understand how the information is ultimately portrayed in a way that is most useful for the end user. Ms. Powell said that the interoperability standard, S-98, is the key to ensuring that everything works together while meeting the user's particular specifications combining various data layers. Captain Enos shared some of his experiences of pilots in various regions and said that the data being displayed should all be to a common international standard. The challenge is often different systems not displaying the symbols in a uniform manner, not the underlying data going into the systems.

Anuj Chopra asked if NOAA expects to produce a tool that can run a dynamic under keel clearance (UKC). Ms. Powell said there is an industry effort in this area and an international standard, S-129. They did not standardize the algorithm to calculate UKC, but did standardize the inputs that are required for UKC and how it is displayed on the screen. Captain Chopra said there is a lot of confusion in U.S. ports when USCG declares a certain depth for a channel, because they add in a 2-3' safety margin and ports can lose commercial advantage, so more clarity would be very helpful.

Anuj Chopra asked if Hawaii allows virtual arrival, given their dedicated channels and desire to be more sustainable. Mr. Creps said virtual arrival has not been established in Honolulu because they do not have the volume of shipping that would make it necessary. Traffic continually flows through but is scaled so as to not overload the harbor. Captain Chopra said that because they are expanding the port, it may be worth including virtual arrival to avoid disputes where ships come in and there is a shortage of pilots.

Joyce Miller asked, in the event of a hurricane, (1) what happens to the Matson containers that sit on the edge of the port and (2) what are the state's plans if the bridge to Sand Island where all the island's cargo is stored was impassible following a storm. Mr. Creps said that in anticipation of a storm, they draw down on their inventory in the yard and get as much as they can to stores so that they are well-stocked following an event. This is where it is especially valuable to have the best information to make good decisions at the right cadence. Captain Enos said that a FEMA conference found that the more vulnerable piers are the ones where inbound foreign cargo comes in. DoD's plan for if the bridge becomes impassible or is destroyed is to activate vessels that could make a bridge over the course of several days, though the main ship that would be deployed with this equipment is stationed in Norfolk, Virginia. The U.S. government needs to be convinced that they have a vested interest in helping the State of Hawaii.

RDML Evans asked, in regards to route optimization and reduction of carbon footprint, what the operators view as the appropriate role for NOAA and the federal government and what the appropriate province is for the private sector. Mr. Creps said the information to make real time decisions has an economic component to it but also a safety component. There have been proposals for alternate port concepts, including reverse hub-and-spoke, that need to be given more thought. Where NOAA can help most is in the approaches to the ports. At basin scale, surface current predictions are important for route planning, but they rely on commercial services to ingest data and provide recommendations on how to operate the vessels. Drilling down on local data and streamlining the collaboration process for projects would be helpful for NOAA to do. Captain Enos said that every cargo carrier or cruise line has hired a routing system because commercial servers understand what a specific vessel or fleet is trying to do and

tailor their recommendations, whereas NOAA's data is more general. The advantage of having NOAA data is that it is an authoritative standard for justifying decision making.

Ann Kinner said the hardware that recreational boaters use is rarely up to ECDIS standards in scope or capability. Many plotters incorporate NOAA data in addition to the other sources a particular brand uses. She asked to what extent NOAA is connecting with the people who are manufacturing the hardware. Ms. Powell said there is a gap between the big ECDIS manufacturers that are governed by IMO, the pilots that use PPUs, and various recreational boater devices. NOAA does a lot of outreach to stakeholders and is now onboarding a Precision Marine Navigation Program Manager who can do more engagement, project planning, and program management. RDML Evans added that, because this is an unregulated market, the demand for continuously updated NOAA data has to come from the users. Electronic chart systems tend to be fairly nimble and in the past have been well ahead of ECDIS manufacturers on implementation of new standards. OCS anticipates engaging with software makers to incorporate newer S-100 product series as rapidly as NOAA can make them available. Captain Kinner asked if there has been outreach to other international cartography organizations to urge them to conform to the same data formats and capabilities. Ms. Powell said the IHO works to create these standardizations and RDML Evans said there are active international efforts in the U.S.-Canada transboundary waters to harmonize S-100 products to ensure seamless coverage.

Public Comment

RDML Ben Evans and Lynne Mersfelder-Lewis read the following comments received during the second day of the meeting:

Captain Jason Ledet, New Orleans Baton Rouge Steamship Pilot: We have several missing facilities (docks and buoy systems), that are not currently depicted on the most recent chart releases. These facilities were originally reported as missing on January 4th of this year. When will these facilities be placed on their respective charts? In light of the recent collision between a ship and an oil platform, and subsequent investigation, I would expect that these types of requests would receive priority from the Marine Chart Division going forward. What quality control and/or chart feature verification protocols are currently in place to avoid another incident like this?

We need NOAA and USACE to agree on a common datum for the Lower Mississippi River. Once an agreement is reached, we can utilize the data that was collected during the David Evans Survey conducted four years ago. We have precision clearance data for all bridges and high line crossings throughout the entire survey area. It has been sitting there collecting virtual dust. Ship Pilots and other mariners are currently utilizing decades old data for critical calculations to determine Air Gap clearances of ocean going ships as well as crane barges. As we all know ships are getting bigger, the clearances are getting smaller and the liability has increased exponentially. I regularly go through several bridges on large ocean going ships with sometimes as little as six inches of clearance. Just a few short years ago, the Sunshine Bridge was struck by a crane barge. The computerized navigation system that was used had a NOAA chart that had overstated the height of the bridge by about four feet. The NTSB has already recommended for NOAA to correct bridge heights on their charts. When can we expect an agreement to be made?

We have a critical need for more PORTS data and sensors. We currently have only two out of six bridges equipped with Air Gap Sensors leaving four bridges without that additional layer of protection. Our two current meters are not working and need to be moved to better locations that can accurately depict the extreme currents we are facing here during the frequent high water events. We currently have only one PORTS River Gauge sensor. USCG VTS and ships transiting more than 234 miles of the Lower Mississippi River are reliant on this one PORTS sensor. Mr. Duffy responded with some challenges this area is facing with its PORTS, including unanticipated costs associated with installation of a new air gap sensor on a bridge. He hopes to see NOAA come back to the Mississippi River and focus on some of their

products to address the problems they are seeing, such as datum alignment between NOAA and USACE. Ms. Powell said that the Lower Mississippi is still one of NOAA's top three priority areas. There are other dependencies that complicate resolving some of these issues but their project plan has resources freed up to start focusing in on how to produce the S-102 product for Lower Mississippi River starting in January. RDML Evans said that NOAA elevated the issue of datum harmonization issues with USACE and other authorities and this has been officially accepted as part of the Trident work plan for this year.

Rafeal Fernandez: Does NOAA have Navigation Response Teams on the mainland for surveys or are you working directly with the port response teams to share information prior to USCG Captain of the Port allowing shipping to commence?

Robert Sherer: Nobody seems to be aware that there already is a navigation program that provides the follow capabilities, namely Aqua Map that runs on Apple and Android products. USACE surveys are loaded from eHydro and displayed as a color coded overlay to 0.1' resolution over the NOAA charts. They are updated weekly from the eHydro database. The entire eHydro database is loaded into Aqua Map, including Hawaii USACE surveys.

Aqua Map accesses the Coast Guard digital file of ATON locations, updated weekly - all automatically. Base NOAA chart is updated four times a year, a bottoms-up update so nothing is missed.

Weather wind, waves, and currents (including estuary currents such as Delaware Bay, Chesapeake Bay, etc.) are overlaid on the chart with a 40 hour prediction slider. All data sources are from NOAA, it's just automated. The wind data is the latest NOAA model (HRRR).

All this is difficult to implement which is why no one else is providing USACE surveys to the recreational boater - although many people at USACE now routinely access Aqua Map since it's so convenient and displays their data better than their own instruments.

HSRP Discussion and Wrap Up

Julie Thomas, Co-Chair, HSRP Planning and Engagement Working Group, led the discussion. She suggested that two things be included in the letter to the Administrator: (1) advocating for continued work on the unification of datums and (2) advocating for the sustainability of NOAA's core programs in light of the large investments in new and expanded programs. HSRP members briefly shared additional thoughts on the day with an emphasis on what they would like included in the letter. These included: NOAA needs to work with technology providers to come up with intermediate solutions to make products easier and more useful for users to have access to NOAA data; the need for increased real time coastal monitoring; the possible need for a national gap analysis for limited inputs on hydrographic information; members were encouraged to hear how far NOAA has come with precision navigation; the HSRP needs to stay on top of what is happening in the commercial world to better justify NOAA's efforts and know where the differences lie between what NOAA provides and commercial providers offer; the standards are hidden from users but serve as the foundation to what everything else is built upon; virtual arrival needs to be explored as an opportunity for ports; pilots hands are tied to what manufacturers decide to produce for PPU's; and NOAA should not lose sight of the need for getting information out to the smaller boat fleet.

Thursday, September 22, 2022

Continued HSRP discussion

RDML Ben Evans discussed some of his thoughts from the previous day's panel and discussions, including on how to optimize use of waterways. The infrastructure associated with precision navigation products is essential to getting the maximum return on the huge investments the country is making on projects like dredging and port improvement projects. NOAA needs to get their data into users' hands as quickly as possible and increase the fidelity of their workflow. OCS is pursuing how AI could help in this effort but RDML Evans would appreciate further ideas on how it could be incorporated. Chair Thomas proposed including a bullet in the letter to the Administrator on promoting timely data delivery.

Juliana Blackwell and Mike Alsaksen discussed a recent issue on a potential GPS interference conflict. Ligado Networks was pursuing the establishment of a system in lower earth orbit that would have had potential for interference with high-performing geodetic receivers currently operating in the field. This could lead to many impacts to navigation and is a big concern for anyone doing high accuracy positioning or managing real time networks. Ligado has suspended their plans to build a site in order to do more negotiation with the National Telecommunications and Information Administration. Federal agencies, both on the civilian and Defense side, are working closely to address concerns about potential interference. NGS is preparing for any future rollout and are standing by to see what happens next.

The Role of the Pacific 'Ohana in Keeping Your Feet Dry on the Shoreline: NOS and NOAA's Flooding, Inundation, Sea Level Data, Products, and Services

Julie Thomas, HSRP Member, and Melissa Iwamoto, Director and PI, Pacific Islands Ocean Observing System (PacIOOS), moderated the panel on measuring, monitoring, and mitigating flooding and sea level change in federal, state, regional and local projects across Hawaii and the Pacific Islands and how NOAA's critical foundational data contributes to this effort. **Paul Scholz** provided opening comments on flooding and sea level rise, which is a high priority for NOAA and NOS.

Analise Keeney, Coastal Hazards Oceanographer, CO-OPS, NOS, NOAA, presented on NOAA's five-year plan for improving science, products and services and how the BIL will support advancing research, observations, modeling and decision support. There is currently no all-encompassing tool or easily accessible suite of products that allows users to understand and mitigate the impacts of sea level rise and coastal inundation. CO-OPS is working to connect the geographic continuum to what they are incorporating into their products across a variety of timescales. Ms. Keeney reviewed some of CO-OPS' inundation services on the weather-climate continuum. NOS' suite of high tide flooding and water level prediction products on the weather to climate continuum are currently disconnected. All of these products are connected to the NWLON and CO-OPS needs to fill the space between the gaps in that network. A white paper was provided to the HSRP that summarizes NOAA's approach to integrating all this authoritative data, making it accessible, and providing tools based on it in a timeframe that is helpful. This paper will guide the work on Provision 3 of the BIL concerning seasonal-to-annual outlooks. Ms. Keeney described several of the anticipated inundation products and enhancements that will be funded through the BIL. In FY23 and '24, CO-OPS will be working to connect not just the information between their observations but also to the suite of products they currently have. They are also working on bringing together the seasonal bulletin and annual outlook into one flawless GIS-based infrastructure. CO-OPS is working with NASA and OAR's Physical Sciences Laboratory, Geophysical Fluid Dynamics Laboratory, and Great Lakes Environmental Research Laboratory to expand global experimental sea level anomaly forecasts to tide stations and eventually to a grid system for predicting flooding and extremes between tide stations. Over the next five years, CO-OPS hopes to make the following improvements: establishment of an authoritative and nationally consistent suite of inundation data for hazard planning and mitigation; integration of models and observations to understand present and future coastal inundation risks; provide data between tide stations with 500m geospatial grids; and continuous stakeholder engagement for better product development. CO-OPS is also focusing on improving the accessibility of their data to better serve underrepresented communities.

Dr. Charles "Chip" Fletcher, Associate Dean for Academic Affairs and Professor, Department of Earth Sciences, School of Ocean and Earth Science and Technology, University of Hawaii; Vice Chair, Honolulu Climate Change Commission, presented on science in support of resilient community development. Modeling the impacts of sea level rise has provided local and state agencies in Hawaii the opportunity to develop new policies designed to improve community resilience. While the promises of the Paris Agreement put the globe on track for 2°C of warming, the policies and investments being made by nations in their fossil fuel infrastructure and expansion of agriculture are on track to raise the temperature of the earth by 3°C. As surface water absorbs heat from the atmosphere, it will take centuries to millennia of thermal expansion before our oceans are equilibrated to today's level of warming. Sea level rise is now a permanent human condition and today's coastal management regimes have not been conceived with this in mind. Thermal expansion represents 38% of global sea level rise, the melting of Greenland's ice sheets make up about 20%, Antarctic ice melt about 6%, and the melting of the world's alpine glaciers account for about 20% of global sea level rise. Anthropogenic groundwater mining accounts for about 10% of the remaining global sea level rise. The latest Intergovernmental Panel on Climate Change report states that global mean sea level will rise by about 6.5-10' at 1.5°C warming and 6.5-20' at 2°C and seas will continue to rise over subsequent millennia. The rate of rise had previously been 3.51mm a year but has recently accelerated to 4.43mm a year. At the current rate of acceleration, the world should expect over 70cm by the end of the century. King tides in Hawaii are getting higher and more frequent and modeling shows that there will be a rapid acceleration of king tide flooding in the next decade. Honolulu already experiences storm drain backflow and a loss of gravity drainage during high water events. The water table under Honolulu swells during inundations and rises nearly to the land surface. High tide, groundwater, and rain all need to be modeled in order to understand this problem. A collaboration between the state, counties, UH, and PacIOOS has led to the creation of the State of Hawaii Sea Level Rise Viewer, which models coastal erosion and summer wave run-up scenarios. UH's Climate Resiliency Collaborative has done a lot of modeling and has produced the Sea Level Rise Exposure Area, which has now been accepted in many local policies. With funds from the Office of Naval Research, the collaborative has plans to build a Sea Level Rise Viewer similar to NOAA's tool but which integrates additional data to simulate possible local events.

Jessica Podoski, PE, Coastal Engineer, U.S. Army Corps of Engineers, Honolulu District, presented on how NOAA data supports USACE's work in the Pacific Islands. Ms. Podoski provided a brief overview of USACE Civil Works and their military projects across the Pacific, including maintaining 27 deep draft and small boat harbors, 14 federal and 13 non-federal flood control projects, and 20 shore protection projects, as well as pier and shore protections for Army assets. A lot of the military projects are on the coast and provide critical infrastructure that needs to be protected. USACE's Climate Change Regulation and Policy requires them to factor climate change and sea level change into all of their projects, including inland hydrology projects. Ms. Podoski discussed each of the key NOAA data products that support USACE's climate change analysis, which come primarily from CO-OPS and NGS. USACE produces a sea level change calculator that is fed directly from NOAA water level calculations at each tide station. New regulations require USACE to plan for a 100-year adaptation horizon and the sea level rise calculator is very helpful for this. USACE's Sea Level Change Tracker is also fed by NOAA water level data to plot sea level curves and the moving averages of water levels. USACE relied heavily on NOAA data and tools for their site-specific studies of climate vulnerability and hydrology analysis. Ms. Podoski identified future needs for planning and adaptation that NOAA could provide, including topography and bathymetry in fringing reef environments, water level stations in remote locations to estimate sea level rise, a database for UAS imagery and elevation data, and measurement and analysis of water level interannual variability across the Pacific they could incorporate into design.

HSRP Q&A

Paul Scholz asked each of the panelists what their specific recommendations to NOAA would be and why. Dr. Fletcher said he would like NOAA to provide additional resources to local researchers. There are expensive datasets that only a federal agency can support the instrumentation to acquire. Drone-based topobathy lidar is an investment that would allow local researchers to better understand sand transportation and more monitoring to feed into models to provide a better understanding of how the natural coastal system is responding to sea level rise and changes to storm energy. Ms. Podoski agreed that additional topobathy lidar collection would be helpful, as well as more analysis further out into the Pacific Islands. Ms. Keeney said NOAA should do as much as they can do to support a more robust and broad-reaching geospatial infrastructure for the products they are developing. Mr. Edwing said CO-OPS' network in the Pacific has been shrinking as the military leaves certain islands. They are struggling even to maintain what they currently have and the small islands do not have the major commercial navigation drivers that help support other gauges.

Dave Maune said that many discussions on sea level rise assume that the land is holding still, but in many parts of the world subsidence is as great as sea level rise, essentially doubling its effects. He asked if subsidence is a problem in the Pacific Islands. Ms. Podoski said that subsidence is a major issue in earthquake exposed areas. The relative sea level rise in American Samoa has increased dramatically since the earthquake they experienced in 2009. Dr. Fletcher added that there is significant subsidence in areas of active volcanism. There are GPS networks that can help analyze this change, but it has mostly been done through inference based on sea levels.

Anuj Chopra said society is facing more climate-induced challenges than had been predicted. He asked why more planners are not using the academic projections and incorporating them into modeling. Dr. Fletcher said the commercial insurance industry relies on hindcasting, looking at trends over the previous 3-5 years and using that to project forward. They were, however, one of the first sectors to acknowledge climate change and sea level rise 20-30 years ago. They employ sophisticated models but are fundamentally tied to looking at the recent past. An act of Congress would be needed to allow FEMA to incorporate sea level rise into the National Flood Insurance Program. The insurance industry is often viewed as one of the controlling institutions for managing the coastline, but that may not pan out as commercial insurance has withdrawn from most open ocean coastlines. Ms. Podoski said USACE only uses actionable science, which requires a scientific consensus before they can implement projections into their policies, though they have pivoted to risk-informed decision making. Ms. Keeney said their recent interactions with PacIOOS and UH made it clear that there are other models NOAA can incorporate to serve communities.

Qassim Abdullah asked if the academic research is being communicated to FEMA and if there is any way NOAA or the HSRP could help push it through into their considerations. Dr. Fletcher said FEMA's staff is well aware of the issues, but he felt the problem rests with Congress.

Larry Mayer asked what calculations USACE adds to NOAA's products to come up with their sea level change tools. Mr. Podoski said they use the relative sea level rise rate provided by NOAA to calculate the low curve and base their acceleration projections on National Research Council's Curve Calculator. The curves they use differ from NOAA's curves. Dr. Mayer said this could potentially be a real source of confusion. He also asked how the panelists handle uncertainty when creating dashboards for public consumption. Ms. Podoski said USACE has put a lot of work into communicating risk to the public, emphasizing that their projects are not eliminating risk but reducing it. It is a challenge to make that understood broadly. Dr. Fletcher said their shoreline change data is used for managing where a house can be built or rebuilt and county and state planners have specifically asked that they not provide uncertainty on these rates. 80% of their rates are not distinguishable from zero because the uncertainty in Hawaii's shoreline is so large.

Ed Saade asked if USACE has considered adjusting the way they discuss extreme events given the frequency of 100/500/1,000-year events. Ms. Podoski said USACE is moving towards using joint probability statistics that capture the overlap of interrelated parameters, which is something they have not done in the past for their projects. Choosing words wisely is an important part of effectively communicating risk.

Nicole Elko said it takes a lot of time and money to apply higher resolution to the nation's coastline. She asked Ms. Podoski to discuss USACE's status on the Pacific version of the Coastal Hazards System and Ms. Keeney what she envisions for its implementation. Ms. Podoski discussed the evolution of USACE's Coastal Hazard System, which has been underway across the East Coast, Gulf of Mexico, and Great Lakes. USACE is now looking at doing a Pacific Basin study to provide local water levels and waves. It will start in the Pacific Northwest and work its way down the West Coast and eventually get out to the Pacific Islands. Modeling each individual island and maintaining the products is a big challenge. The system uses ensemble modeling to incorporate historical information for validation as well as future predictions. Ms. Keeney said CO-OPS is in the first year of their five-year funding and their pilot region is the Southeast, from North Carolina down to Miami. The 500m resolution creates the infrastructure for NOAA to be able to host other climatologies, such as wave predictions. By the end of the five years, they hope to be able to provide 500m coverage and information for all the areas between NWLON stations, including Pacific territories. All of their information is available in their Application Platform Interfaces allowing for accessibility on a variety of formats and continual updating.

Julie Thomas asked how receptive local agencies are to the information researchers bring them. Dr. Fletcher said Hawaiian agencies have been very receptive. Real estate groups are now on board after recent state requirements and policy developments. Mr. Saade said that officials in certain coastal cities in Southern California do not want to hear about these types of issues or discuss managed retreat because of the astronomical property values. In other areas the HSRP has visited, local officials have stated that they were prohibited by law from using the terms "sea level rise" or "global warming" in their official documents. The openness on display in Hawaii is encouraging and a great recognition of the importance of the issue. Dr. Fletcher said there are still problems in Hawaii, such as the defeat of a new setback law proposed for Oahu.

The Role of the Pacific 'Ohana in Keeping Your Feet Dry on the Shoreline: NOS and NOAA's Flooding, Inundation, Sea Level Data, Products, and Services (continued)

Ray Tanabe, Director, Pacific Region, National Weather Service, NOAA, presented on climate resiliency in the Pacific, which requires robust and consistent observations. He shared personal stories and provided context on the work that the rest of the panel is undertaking. NWS protects lives and property by forecasting extreme weather, water, and climate events and by providing decision support services. The UN's World Risk Index for 2021 found that a total of ten island states are among the 15 countries with the highest disaster risk. These include the Pacific Islands of Vanuatu (#1), Solomon Islands (#2), Tonga (#3), Philippines (#8), and Fiji (#14), and Kiribati was listed as number 19. Three key factors to resiliency in the Pacific are communication, resources, and traditional knowledge. Language can be a significant obstacle to resiliency efforts, particularly translating meteorological phenomena and scientific terminology into local languages and dialects. Communication is also tied to the connectivity challenges of remoteness and a lack of modern communication infrastructure. The extreme remoteness of some islands limits accessibility to supplies, presents difficulties for maintaining observation platforms, and there is a lack of trained meteorologists, forecasters, and technicians in these places. Mr. Tanabe described some of the specific limitations of meteorological services on Niue and shared a personal story of his visit to Kiribati. Traditional knowledge plays an important role in resiliency in the Pacific. Risk information is often found in proverbs, storytelling, legends, myths, songs, dance, and traditional place names. Communications and dissemination are often tied to traditional knowledge. Subsistence lifestyles can help increase the resiliency of local communities. Mr. Tanabe discussed the threat to seabirds in the

Pacific which have been traditionally used as meteorological harbingers. Much of the risk and vulnerability for Pacific Island Countries relates to water security - security through water and security from water. Observing systems that are simple and sustainable are needed, along with access to high resolution modeling. Improving meteorological and hydrological services would greatly benefit the water, agriculture, health, and tourism sectors that could drive island economies and provide resources to pay for communication and connectivity. Ultimately, this would improve resiliency for the islands and the people that inhabit them.

Tara M. Owens, Extension Faculty, Coastal Processes and Hazards Specialist, University of Hawaii Sea Grant College Program; Science and Technical Advisor, County of Maui Planning Department presented on bridging the gap between science and coastal management in Hawaii, describing some of the ways that sea level rise is already affecting Maui communities and providing examples of adaptation using science-based coastal management approaches. A common refrain on Maui is that they want tools and resources that are community-led and government-supported. Maui's beaches are experiencing the highest rates of erosion in the Hawaiian Islands, as well as the highest percentage of beach loss. Beaches also have high seasonal variability, which increases risks to visitors. The state legislature began taking action in 2014, mandating the creation of the Hawaii Sea Level Rise Vulnerability and Adaptation Report and work on the Hawaii Sea Level Rise Viewer. This localized tool provided a tangible basis for developing plans and policies, which models and maps the three ways sea level rise will affect Hawaii's coastline - passive flooding, annual high wave flooding, and coastal erosion. It is helpful to make the distinction between the different types of impacts because of how the appropriate response and solutions might differ. Local governments have made significant headway in application of this information, including vulnerability assessments, hazard mitigation plans, community plans, and shoreline setbacks. Collaborations between federal, state, and university partners have made this possible, though there is still a need to localize information to meet the needs of individual communities. One way they have begun to do this is making tailored tools for wave run-ups and wave flooding for West Maui utilizing crowdsourced data and information from NOAA. Ms. Owens would like to see more tide gauges across the Pacific, re-benchmarking in areas where subsidence has been significant, new or regularly updated topobathy data, and a regional map viewer of water level anomalies across Hawaii, given their interannual and seasonal variability.

Dr. Haunani Kane, Assistant Professor, School of Geographical Sciences and Urban Planning, Arizona State University (ASU), presented on assessing coastal change along rocky and remote shorelines. Future sea level estimates exceed the elevations of many low-lying islands in Hawaii. These islands have limited data and access and their remotely sensed data is poorly georeferenced. ASU has been using land and marine surveys, sediment sampling of the island and nearshore area, and aerial imagery and lidar surveys to gather information on the islands. The islands are inseparable from their reefs, which provide not only a framework that the islands sit upon but also provide sediment. Sources of erosion on these islands include not only physical storms and changes in water chemistry, but also urchins and fish that help naturally erode them and transport sediment. In 2018, a Category 3 hurricane impacted an island in Papahānaumokuākea and resulted in the complete loss of the reef and the near loss of East Island itself. The island was previously home to 95% of the Hawaiian green sea turtles and an important place for Hawaiian monk seals. By 2021, the island recovered 56% of its pre-storm size. Other islands, such as Tern, were not lost in the storm, but rather built up with .5m of sediment piled up on the island. This sediment deposition had significant impacts on the island ecosystem, such as sea turtles not being able to nest because they could not dig through the soil, though researchers have begun to see coral recruits restoring the reef. There is no coastal erosion or shoreline assessment for Hawaii's rocky and intertidal coastlines. They are often overlooked entirely because they are seen as stable features. These shorelines are important fisheries and access points to the ocean and there are gaps in knowledge as to how intertidal habitats will evolve with elevated water levels. ASU's lab is looking into this using land and marine surveys that employ a multiscaled approach to assess the impacts of sea level rise on Hawaii's

aquatic resources. The students have created a vulnerability assessment for Hawaii Island, done translation work, and mapped king tides using drones.

Edward Carlson, Pacific Region Geodetic Advisor, National Geodetic Survey, NOS, NOAA, presented on the National Geodetic Survey in the Pacific and the importance of water levels, mapping and charting, and assisting planners with sea level rise. Some of the work that NGS has done around the Pacific during Mr. Carlson's time included establishing a High Accuracy Spatial Reference Network, establishing a Geodetic Quality Leveling Network, and training island personnel in high accuracy GPS techniques and geodetic leveling. Knowledge of cultural protocols was essential before performing work on the islands. NGS is helping to improve the geospatial infrastructure of Guam and CNMI in order to assess the Pacific plate movement for the 2022 datum. GRAV-D collection is ~97% complete for Hawaii, 82% for Guam, and 40% for American Samoa, which they will be completing in FY23 or '24 if it needs to be done. NGS plans to improve the geospatial infrastructure for American Samoa in collaboration with partners. CO-OPS has installed a new tide gauge there and will be working with USACE to get tidal elevations from their temporary gauge in Ta'u. Also in American Samoa, NGS plans to re-level the ASVD02 network in FY23 or '24, as well as installing a new CORS and bringing back a station that has been out for two years. Mr. Carlson described some of the chart updates, water level stations, and height modernization projects he has worked on around the Pacific. Elevation information is very important for assessing wells on the islands, and proved particularly critical during the Red Hill disaster. Having accurate elevations and knowing how much water was in that aquifer meant they could achieve their water goals without requiring mandatory restrictions. Mr. Carlson discussed some of HDOT's projects, including Second Order Class II leveling and realigning the Lihaina Bypass to ensure the road is outside the tsunami zone. The Nature Conservancy has developed a tool built around NGS' work that enables planners and managers to visualize the impacts of future development and rising sea levels on anchialine pools to help prioritize restoration and conservation over time. The Guam Department of Planning has also leveraged NGS work to determine the mean high water for construction setbacks.

HSRP Q&A

Rich Edwing provided some recent history on the American Samoa tide gauge. The Pago Pago station was down for two years before being re-established in late 2021. It was up in time to record the Tonga tsunami. The temporary gauge USACE has funded for harbor projects they are doing was initially intended for three years, but there is now interest in continuing it because of tsunami concerns. If NWS wants to continue it for this purpose, they will have to come up with the funds to cover it. CO-OPS has reached out to JOA Surveys to upgrade the station if it is continued so that data can be transmitted more frequently and be accessed directly by the Tsunami Warning Center.

Larry Mayer asked how the collaboration on the West Maui Community Toolbox came about. Ms. Owens said it started with PacIOOS talking to people that work in the islands about what their needs are and some of the people in coastal zone management responded that it would be great if they had better constraints on wave run-up and impacts in West Maui. That led to PacIOOS reaching out when NOAA Coastal Resilience Grants were available and UH collaborated with them on a proposal.

Mike Aslaksen briefly described some of NGS' upcoming plans for lidar collection around the Pacific. NGS needs to get to Midway in order to finish the rest of the Marine National Monument and he asked for any assistance the panelists might be able to provide to help facilitate that.

Ann Kinner asked what it would take to get the attention of legislators, insurance companies, lawyers, or whoever might be able to stop reckless construction. There is ample history and data to demonstrate the hazards. This should be raised up to a national level because the rest of the country is paying to fund rescue agencies.

Public Comment

Lynne Mersfelder-Lewis read the following public comments into the record:

Robert Sherer: It was another example of a USACE survey displayed in Aqua Map. This one was closer to your meeting in Hawaii.

If one of the goals of NOAA is to provide sounding data quickly to end users, I would think that the example of putting USACE surveys in a useable format directly to the boating public on a timely basis would be a high priority. There are roughly 80,000 USACE surveys in the eHydro database displayed in Aqua Map for use by anyone with the app, all automatically loaded, updated weekly.

I have no financial connection with Aqua Map. I just think the USACE survey feature is revolutionary for a navigation app. For the shallow waters of the Atlantic Intracoastal Waterway, it's the difference between a successful passage and a grounding. A lot of taxpayer dollars are allocated to gathering USACE survey data, this program gets it into a usable format for navigation in a timely manner.

An action item could be to promote the use of USACE survey data in all navigation programs. The hard part is done, the database is already maintained in eHydro, it only has to be better used.

Jacque P. Kuchta, Metairie, Louisiana: I am steadfastly opposed to this proposal from a lack of evidence of occurrences, complete lack of potential enforcement, and a devastating economic impact to boat owners, marina owners, harbor side restaurants, fuel docks, shipyards, boat manufacturers, tackle shops, charter boat operators - essentially the key American outdoors industries. This proposal was quietly put forth on August 1st without consulting stakeholders whatsoever in the above groups, which in and of itself, is a travesty.

Boaters and fishermen and fisherwomen have never been more sensitive to species issues like these, but slowing everyone to 10kts is highly impractical and will shut down a vital source of American recreation- just look at the boating data and economic impact during and post pandemic. Freedom to roam the waters of this country at comfortable speeds, most largely in excess of 10 kts was/is a recreational mainstay.

I am a boater and inshore and offshore fisherman of 50 plus years, impact many facets of the marine recreational economy and have never had a whale strike, never witnessed one, and never (recall) reading of one. I belong to the New Orleans Big Game Fishing Club, CCA of La., The Billfish Foundation, IGFA, and more, and all strongly oppose this ill-conceived proposal. If the 1980's 10% boat luxury tax pertaining to certain size vessels was crippling (it was devastating), then this proposal would be catastrophic economically for essentially unproven minimal benefits, if any at all. I beg you to use common sense and logic and don't kill our aquatic recreational freedoms and industries. RDML Evans recommended providing comments in response to the Federal Register Notice to ensure it gets to the people running this regulatory process.

Captain Ed Enos: To Rich Edwing's comment about "maintaining remote data collection stations" around the Pacific - please consider looking at commercial maritime businesses based in Honolulu that do voyages around the Pacific islands. They are not well known or do 'regular' service. But they go around often enough to "help" carry equipment and maybe even persons to these places to conduct work on these stations. Many businesses would be okay with providing this service "in kind" or free or at very low cost, since they are going there anyway.

Jeanne Ferrer: The Lower Mississippi River timely charting needs continue to rise. In response to the NTSB MIR-22/18 issued on Aug 9, 2022, the necessity for accurate ENC's has never been more of a priority. 3 new docks have been requested in February 2022 to be added to charting and has yet to be

addressed. NOAA Chart 11364 has seen requested change through Final Rule 87FR29668 and it has yet to be addressed since it was approved on 6/15/22.

Please provide accurate timelines to up to date charting on the Lower Mississippi River.

Starla Robinson: Data goes stale.

Short presentations/discussions: HSRP ongoing interests and priorities

Darren Wright, National Marine Services Program Manager, Marine, Tropical and Tsunami Services Branch, National Weather Service, NOAA, provided an update on two new products and services in marine weather. The Weather-Ready Nation Ambassador Program partners NWS with businesses and organization to be force multipliers for training people on how to handle hazardous weather. The Marine Program creates a marine layer to this program to provide training videos, safety information, and provides a feedback mechanism to NWS. The Weather-Ready Nation webpage has more information and allows users to sign up to become Ambassadors. Another update concerned NWS' RadioFAX. NWS creates weather maps and converts it into a fax signal that can be transmitted out to ships. The contractor that does the conversion went out of business, so NWS is currently doing an inventory to see who still uses RadioFAX as well as looking for alternate solutions for creating that signal again. Preliminary results from their survey show that American-flagged ships have alternate solutions for weather but use RadioFAX as a back-up, while some international shippers and smaller ships use RadioFAX as their primary source of getting this information. Mr. Wright played a video on an experimental product, an addition to their Coastal Waters Forecast that leverages the Nearshore Wave Prediction System's ability to capture wave systems that contribute to significant wave height.

Public Private Partnerships

Gary Thompson, HSRP Member, introduced the panel on public-private partnerships (PPPs) which provided examples of successful partnerships and encouraged the NOAA to undertake more. The National Geospatial Advisory Committee produced a report on PPPs that assessed their effectiveness and highlighted them as a tool to advance the nation's spatial data infrastructure. Not all partnerships fit in with the definition of PPPs, but PPPs are an innovative way to bring people together to work as a team.

Tony LaVoi, NOAA Chief Data Officer, discussed what NOAA is doing to build their data foundation. NOAA is actively involved in building an open data enterprise across the organization. The Evidence Act requires federal agencies to create the position of Chief Data Officer. The vision for the NOAA Data Strategy is changing the culture within the organization, of valuing data and thinking about it throughout the entire lifecycle, from requirements through archiving. NOAA Administrator Rick Spinrad has been working very hard on outreach to the commercial community and has held over 130 meetings with private sector, government, and philanthropy leaders. NOAA has been working with cloud service providers (CSPs), providing full and open access to more of their data which has allowed CSPs to build their ecosystems and communities, spur on the economy, and generate new innovation. Originally this was called the Big Data Program but is now referred to as the NOAA Open Data Dissemination (NODD). The CRADA used for this is one of the mechanisms by which NOAA can enter into PPPs and led to NOAA partnering with Microsoft, Amazon, Google, IBM, and the Open Commons Consortium. In this PPP, NOAA provides access to its data and its scientists, while the private companies offer their cloud platforms and models. The CSPs provide free access for users that want to download it, but benefit by having more people staying on their platforms and doing their computing, data development, and service delivery there. There are now almost 23 petabytes of NOAA data available and to-date 1.85 petabytes of data have been accessed. Mr. LaVoi mentioned that NOAA's Science Advisory Board also has a PPP working group developing a report on non-monetary PPPs, including: shared technology development; transition of technologies NOAA develops into routine application; clarifying NOAA's role, empowering

private investors to fill available niches; collaborative data collection; engagement in public decision processes; and workforce development. There is an opportunity for collaboration between the two advisory panels on this topic.

Ed Saade, HSRP Member, provided some background on PPPs. As they dig further into the topic, the panel has found out more about how much of this is already going on within NOAA. PPPs have been a topic of discussion for the HSRP for several years and many of the presenters at this meeting have discussed successful examples. There is now serious momentum building to act on or expand the PPP concept and goals to help achieve a significant increase in activity in projects, a significant level of true partnership and participation, and a much broader application of the PPP format across many NOAA offices. PPPs are a conduit for using data many times across many disciplines and many applications.

Lindsay Gee, HSRP Member, said PPPs need to be defined for both the government and for private partners. PPPs can include monetary arrangements but when they do, the parties must carefully define between a partnership and a contract. This is especially important for building trust between the parties. Business planning to see where the benefits are and how to quantify them will be a challenge. Mr. Gee's experience with CRADAs has been that they can be very successful if done properly. He recommended not getting too tied up in trying to define PPPs, but recognize there are many ways of doing it and set guidelines for what might qualify as a PPP. He also did not want these to be driven by the technology but by trying to meet the mutual goals of the parties. The government can have the long-term view of what they are trying to do and industry can be more nimble in implementation. Early engagement is essential to successful PPPs and that can be difficult for the government side.

Qassim Abdullah, HSRP Member, conveyed the industry perspective on PPPs. There are many forms of PPP that represent all different types of long-term contracts between public and private institutions. PPPs must combine the best of the public and private sectors with an emphasis on value for money and delivering quality services. It is important to define and clarify the terms for each PPP arrangement such as the risk allocation for all parties, funding and revenue arrangements, transparency requirements, intellectual properties protection, and conformance to a performance standard. Dr. Abdullah presented various definitions in use for PPPs, but focused on how the National Oceanographic Partnership Program describes its role: "To facilitate partnerships between federal agencies, academia, and industry to advance ocean science research and education. Through this collaboration, federal agencies can leverage resources to invest in priorities that fall between agency missions or that are too large for any single agency to support." The reasons for using PPP arrangements include: Partnerships between private companies and the government is a win-win situation for all parties; PPP goals are to lower costs for taxpayers and consumers and/or offer improved services; private sector technology and innovation help provide better public services through improved operational efficiency; the public sector provides science resources, financial support, and incentives for the private sector to deliver projects on time and within budget; PPP contributes to economic diversification resulting in a stronger economy; and when PPPs are aimed towards utilizing assets, government and private alike, significant cost savings can be realized along with higher productivity in acquisition efforts. Dr. Abdullah outlined some successful PPPs NOAA is already engaged in, including the Brennan Matching Fund and several informal PPPs like multibeam surveys in remote Alaska and the opportunistic utilization of already deployed private aircraft and sensors. Dr. Abdullah recommended broadly transitioning some of the routine work NOAA does, while retaining internal expertise. Increasing outsourcing will improve relationships with private industry. Private industry feels strongly about NOAA's role and the value of their data and services.

Dave Maune, HSRP Member, discussed some of USGS' formal and informal PPPs that could serve as models for NOAA's partnerships. For USGS' 3DEP initiative, the agency sought to collect Quality Level 2 lidar nationwide starting from scratch. They issued a Broad Agency Announcement and approved 74% of the 259 responses for cost-sharing for high accuracy and consistent standards. To-date, about 90% of the country has been mapped through this successful program. As an example of an informal PPP, Dr.

Maune discussed a Dewberry project for USGS using aerial IfSAR for mapping as part of the Alaska Statewide Digital Mapping Initiative. Dewberry brought on two subcontractors, Fugro and Intermap, and assigned areas of responsibility. They could map the entire state in two years using four planes if USGS provided the money to map in large continuous blocks. The funding, however, was received in a piecemeal manner over 11 years for small unconnected blocks. The subcontractors went with their original plan and acquired large areas efficiently on speculation that USGS would eventually want it and provide funding for all of the data. Dewberry also subcontracted to acquire 50% of IfSAR checkpoints for QA/QC on speculation. Together, the three private companies risked about \$21 million acquiring data on speculation but ended up saving the government about \$30 million, getting the project done far more quickly than USGS would have and a higher quality product. USGS ended up funding 54.2% of the project and other public partners, including the State of Alaska, paid 45.8%. This was a completely informal agreement based on trust. If NOAA can talk to contractors and let them know what areas they intend to map as funds become available, private companies would likely be able to come up with ways to acquire the data more cost effectively.

Commander Brianna Hillstrom, Chief, HSD, discussed some of the challenges for OCS using PPPs more extensively. She highlighted some of the existing partnership mechanisms that OCS uses to engage with industry, academia, and state and federal agencies. NOAA has the Technology Partnership Office and National Oceanographic Partnership Program to help support PPPs, as well as having prize authority for moonshot objectives and Other Transaction Authority that they are exploring. The three primary challenges for expanding PPPs are: (1) Authorizing statutes of hydrographic services/ocean and coastal mapping; (2) Subsequent NOS survey and mapping contracting policies, including 2010 policy based on 2009 HSRP Recommendations; and (3) Exercising maximum flexibility of current NOAA contracting policy. Pursuing PPPs will require finding the available flexibilities while staying within the bounds of the law. Commander Hillstrom reviewed several authorizing statutes and amendments that govern how 95% of NOAA's hydrography funds are to be spent. The Hydrographic Services Improvement Act includes very specific definitions for "data" and "services" and has provisions for how the data should be acquired, known as the Brooks Act. NOAA's Hydrographic Contracting Policy has evolved over the years into five-year indefinite delivery/indefinite quantity contracts with a \$250 million ceiling and seven prime contractors. They have tried to maximize their flexibilities to the greatest extent they can, but there are many other considerations that come into play. Whether this is still the right model for NOAA's work is worth reflecting on. OCS seeks to create an open environment where legal communications can flow to convey priorities and ensure that there is no part of the hydrographic capacity left idle. Commander Hillstrom highlighted some tools NOAA currently uses to enable this, including SeaSketch.

HSRP Q&A:

Dave Maune noted that all of the USGS PPPs he discussed were done under the Brooks Act. USGS acquired the raw data and processed it to their specifications then made it publicly available.

Anuj Chopra provided an example of what DoD is doing responding to the supply chain disruptions. He asked what NOAA's supply chain is for future prime contractors. DoD has a requirement for all of its prime contractors to take on small businesses and mentor them into getting innovative contracts. NOAA should look at what other agencies have done and learn from them, then look over the horizon to what will take the agency to the next level.

Larry Mayer observed that they have heard many examples of partnerships at this meeting and felt that every organization that makes constructive use out of NOAA data represents a successful partnership. Mr.

LaVoi said the feedback they have gotten during the meeting is what makes it a partnership, which NOAA does not necessarily get when they are simply putting data out for others to use.

Julie Thomas discussed her experiences partnering with NOAA on the CDIP Wave Program, which would not exist without the partnership. They have had many meetings over the years to acquire feedback and make things work more smoothly and have come up with ways to make the program a real contributor to NOAA data.

RDML Evans said he needs to dig into the legal side of this more fully. The open data concept that NOAA follows is not the case in many parts of the world. This enables partnership in a different way than the panel discussed, but deserves to be recognized. The important tenets of the PPP concept are shared risk and shared reward. It is probably unrealistic to say these cannot involve the exchange of funds. Even with the exchange of funds, a partnership is distinct from a contractual relationship and this is where NOAA needs to be careful. It is very important to define PPPs to some level in order to avoid misunderstandings and legal issues. Within the rules that OCS has been given, it is difficult to see how they could engage in an informal PPP similar to how the Alaska Statewide Digital Mapping Initiative played out. OCS can be more transparent about their long-term priorities, though coordination and expectations become a challenge because priorities can change for a variety of reasons.

Lindsay Gee said that with hydrographic services, NOAA has to allocate and get a certain contract at a certain time and assign areas. Perhaps instead they could say these are our priorities for this year and then the contractor can do it when it suits them and in a way that is most efficient. This would also open up the possibility of people coming forward with data they already have. Mr. Saade suggested NOAA state what they need in an area for five years out, as opposed to going through the contractual obligations every year.

Nicole Elko said there might be space within NOAA's constraints to expand on this more. She wanted to hear more about the data versus service contracts. Further exploring data contracts might offer some additional opportunities than are currently being taken advantage of.

Captain Armstrong said the contracting program was established with considerable conflict, anxiety, negotiation, and accommodation on multiple people's parts. It was a significant struggle and has proven good for the agency and industry. This is not to say NOAA shouldn't think about partnerships that fall outside of that policy. There may also be ways to modify the contracting mechanism that can improve the function of that service and make it more efficient. Mr. Saade said NOAA has been contracting in its current way for 28 years, so it may be worth revisiting whether there is a better way. He noted that it has become significantly more difficult to deal with the Contracting Office in the last several years.

NOMEC and an overview of the draft Standard Ocean Mapping Protocol (SOMP)

Paul Turner, Acting Director, Integrated Ocean and Coastal Mapping program, NOS, NOAA, provided a brief overview of the NOME Council and strategy, as well as the Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM). The establishment of the SOMP was an element of one of the NOME Council goals, specifically for mapping the U.S. EEZ. The SOMP is a standardized technical protocol for ocean and coastal mapping data that provides national standards and best practices to guide all ocean mappers in data acquisition, processing, and archiving. The main goals of the SOMP are to facilitate the widest access to, use of, and integration of data; minimize duplication of effort; and maximize the efficient collection, processing, publishing, preserving, and stewardship of as much ocean and coastal mapping data as possible into publicly-accessible archives, repositories, and databases. The SOMP is organized into the following seven chapters: Data Management, Bathymetry, Seabed and Lakebed Backscatter, Water Column Data, Side Scan Sonar, Sub-bottom, and Magnetometer, each of which Mr. Turner went through in some detail. The Science and Technology Policy Institute (STPI) will

provide an editorial and formatting structural review during October 2022. Following the STPI revision, the SOMP will be reviewed by the NOME Council and Office of Science & Technology Policy (OSTP). A Federal Registry Notice for open public comment period of 60-90 days will be released following approval and clearance of the NOME Council and OSTP. The HSRP will be asked for their input, review, and feedback on the SOMP when it is released. This will be a discussion topic during their Winter 2023 meeting.

HSRP Q&A

Qassim Abdullah asked if this team is working with JALBTCX and USACE on the bathy lidar chapter and if any private industry or academic institutions are involved in this effort. Mr. Turner said they are working with JALBTCX on the bathymetry chapter. Academia and industry were not involved in the initial draft but once it is cleared through OSTP, they will be seeking comment outside of the federal government. Dr. Abdullah said public comment has very slight influence if any on the direction projects take. Academia and sensor manufacturers should be engaged earlier in these efforts. Other HSRP members reiterated this sentiment, adding that early engagement can really help build trust. NOME requires industry participation and should have been worked in from the start. It would have taken far less time to get their input in the development process than it will to have industry review it after and provide comments. Mr. Turner said that they have not rewritten how to go about doing data acquisition, but rather pulled existing industry standards together into one document. Their focus was how to pull this together in a way that is more accessible in a common agreed upon framework, while also recognizing that there will be mission-specific operations that they do not want to detract from.

HSRP working groups updates: issue papers, recommendations, priorities

DRAFT HSRP coastal resilience issue paper

Nicole Elko presented a revised version of the issue paper. The paper is an edit of a previous HSRP issue paper that incorporates significant changes while trying to preserve the spirit of the original. The paper now includes short- and long-term impacts and encourages NOAA to play a more active role in addressing the threat of resilience-related issues through prioritizing investment in coastal hydrographic data gathering and dissemination. Dr. Elko also included insights from this meeting, particularly the coastal resilience panel discussion. Members made minor editorial comments, including ensuring the terminology used is consistent throughout. The HSRP members approved the paper and further edits will be sent to Dr. Elko and Lynne Mersfelder-Lewis.

Technology Working Group

Qassim Abdullah and Anuj Chopra, Working Group Co-Chairs, discussed the concept of digital twins and their potential applications. Digital twins are often thought of as static 3D models, but are actually dynamic, up-to-date replicas or representations of a physical object, asset, or system with a complete collection of data that, when in place, evolves with the flow of real time input from sensors and more. This allows users to manage things virtually with the replica of the physical environment and they can continue to evolve with additional information. Connection between digital and physical worlds offers enhanced lifecycle, informed decision making, and predictive capabilities. This applies well to hydrographic projects and ensures that data does not sit unused. The challenges facing digital twins include insufficient outreach and education highlighting the collective benefits of the concept to convince potential users to invest. NOAA has a great opportunity to offer their services in a digital twin format for coastlines and oceans for better data accessibility, better decision making, and asset management. After the Costa Concordia disaster, passenger ship companies are now trying to replicate live bridges and manage them from the shore with safeguards. Digital twins have many practical applications, but NOAA

may want to approach it one piece at a time. From Ms. Keeney's presentation it is clear NOAA is almost there, they just need to transition what they are already doing into this conceptual framework.

Tony LaVoi said that the NOAA Center for Artificial Intelligence held recent workshops on the digital twin concept, specifically looking at NOAA's role, and the development of international standards to ensure digital twins are interoperable and easily integrated into other digital twin systems for different economic centers. This idea is currently being discussed within NOAA and if they are interested, Mr. LaVoi could arrange for a briefing in a future working group meeting. Chair Thomas said the HSRP would also like to include this on the agenda for the next public meeting. RDML Evans said NOAA is closer to this in some respects than they realize, they just have not been calling it a digital twin. He has seen simulated situations in which this has been largely implemented.

Arctic Working Group

Nathan Wardwell said he has reached out to the two previous chairs of the Arctic Working Group and will be meeting with them soon to get background on the previous activities of the group and suggestions for future directions.

P&E Working Group

Julie Thomas acknowledged Dr. Maune's eight years on the HSRP and his work as Co-Chair of the Planning & Engagement Working Group. This was his last HSRP meeting and RDML Evans added his appreciation for Dr. Maune's focus on issue papers and helping the Panel to be more output-oriented. The other Office Directors also recognized his contributions to the geospatial community. Dr. Maune discussed the concept and history of developing issue papers as a way of making recommendations to the NOAA Administrator. The value of the HSRP is in going from community to community to get perspectives on local issues and what NOAA can do to help. In the evaluation of Federal Advisory Committees, the HSRP was found to be one of the most productive in the entire government. Dr. Maune is looking for volunteers to take the lead on initiating and moving issue papers along. The P&E Working Group will also be looking for a new Co-Chair.

Julie Thomas led a discussion on the status of the HSRP priority matrix items and took suggestions for changes to update it. Members were encouraged to send additional thoughts to Chair Thomas and Lynne Mersfelder-Lewis to be discussed at the next P&E meeting.

Ideas for agenda items for the next HSRP meeting include: PPPs, navigation in the Caribbean, coastal resilience, and digital twins. Members were asked to send any additional suggestions to Chair Thomas and Lynne Mersfelder-Lewis.

HSRP meeting recap and closing comments

Members shared their thoughts from the meeting and proposed ideas for inclusion in the Panel's letter to the NOAA Administrator. These included: the importance of the NOS' core services and encouraging increased investment in the offices that provide foundational data; prioritizing how to address known data gaps; the need for a clear definition of "underserved communities" and how that factors into prioritizing projects; the need to ensure that NOS' base services do not suffer as new funding comes in for other projects; how NOAA can take advantage of the resources that underserved communities have to offer; HSRP members should visit Congress members and pass along the Panel's issue papers; the need to look at how sea level rise will impact port infrastructure around the country; the huge advances made in the precision marine navigation space; the need to develop a concept of operations for the Pacific to better understand risks and what is being done to address them; and AI and deep learning need further focus.

Closing Hawaiian cultural protocol

Kilo Ka'awa performed the closing mele.

Next Meeting

The next HSRP meeting will be in Puerto Rico in February 2023.

The meeting was adjourned at 5:13 p.m.

HSRP VOTING MEMBERS IN ATTENDANCE:

Qassim Abdullah, Ph.D.	Vice President and Chief Scientist, Woolpert, Inc.; Adjunct Professor, Penn State University and University of Maryland Baltimore County
Capt. Anuj Chopra	CEO, ESGplus LLC
Capt. Alex E. Cruz	Owner, West Inies Marine Services, and Vice Chairman, Couth Coast Harbor Safety Committee, Puerto Rico
Sean M. Duffy, Sr., Co-Chair	Executive Director, Big River Coalition
Nicole Elko, Ph.D.	Science Director, American Shore and Beach Preservation Association; Executive Director, South Carolina Beach Advocates; President, Elko Consulting
Lindsay Gee	Hydrographic and Strategic Development Consultant
Capt. Ann Kinner	Owner, Seabreeze Books and Charts; Chair, San Diego Harbor Safety Committee
David Maune, PhD	Associate Vice President and Senior Remote Sensing Project Manager, Dewberry Engineers, Inc.
Capt. Anne McIntyre	Business Manager, San Francisco Bar Pilots
Dr. H. Tuba Özkhan-Haller	Acting Dean and Professor, College of Earth, Ocean, and Atmospheric Sciences, Oregon State University
Edward J. Saade	President USA, Fugro Inc. and Group Director Americas (ret.)
Julie Thomas, Co-Chair	Senior Advisor, Southern California Coastal Observing System; Program Manager, Coastal Data Information Program, Scripps Institution of Oceanography (ret.)
Gary Thompson	Deputy Risk Management Chief and Chief, North Carolina Geodetic Survey, North Carolina Department of Public Safety

Nathan Wardwell

Managing Partner, JOA Surveys LLC

NOAA and NOS LEADERSHIP PRESENT:

Paul M. Scholz

Deputy Assistant Administrator for Ocean Services and Coastal Zone Management, National Ocean Service (NOS), NOAA

RDML Benjamin K. Evans

Director, Office of Coast Survey (OCS), NOS, NOAA, and HSRP Designated Federal Officer

Capt. Andy Armstrong (NOAA, ret.)

Co-Director, UNH-NOAA Joint Hydrographic Center, University of New Hampshire

Juliana Blackwell

Director, National Geodetic Survey (NGS), NOS, NOAA

Richard Edwing

Director, Center for Operational Oceanographic Products & Services (CO-OPS), NOS, NOAA

Dr. Larry Mayer

Director, Center for Coastal and Ocean Mapping, and Co-Director, Joint Hydrographic Center, University of New Hampshire

NOS AND NOAA STAFF PRESENT:

Lynne Mersfelder-Lewis

HSRP Program Coordinator

Mike Aslaksen

NGS

Virginia Dentler

CO-OPS

Chrissy Hayes

PCAD

CMDR Briana Hillstrom

OCS

Analise Keeney

CO-OPS

Gabriel McGann

OMAO

Dr. John Nyberg

OCS

LCDR Hadley Owen

OCS

Amanda Phelps

OCS

Galen Scott

NGS

SPEAKERS:

CAPT Hector L. Casanova

Commanding Officer, NOAA Ship Rainier

Edward Carlson

Pacific Region Geodetic Advisor, NGS, NOS,
NOAA

Dr. Malia Chow

Branch Chief, PIRO Habitat Conservation Division,
NOAA Fisheries

Ethan Creps

Director, Vessel Training Operations and
Engineering - Pacific, Matson Navigation

RDML Michael H. Day

Commander, 14th U.S. Coast Guard District

CAPT Ed Enos

Hawaii Pilots Association

Malia Evans

Papahānaumokuākea National Marine Monument

Sarah Falzarano

Chief, Technical Integration Branch, Honolulu
District, USACE

Dr. Charles "Chip" Fletcher

Associate Dean for Academic Affairs, Professor,
Department of Earth Sciences, School of Ocean and
Earth Science and Technology, University of
Hawaii; Vice Chair, Honolulu Climate Change
Commission

Dr. Ashton Flinders

Research Geophysicist, Hawaiian Volcano
Observatory, U.S. Geological Survey

Matthew Gonser

Executive Director, Office Of Climate Change,
Sustainability and Resiliency, City and County of
Honolulu

CDR Briana Hillstrom

Chief, Hydrographic Services Division, OCS, NOS,
NOAA

David Y. Ige

Governor, State of Hawaii

Melissa Iwamoto

Director and Principal Investigator, Pacific Islands
Ocean Observing System

Kilo Ka'awa-Gonzales

Papahānaumokuākea National Marine Monument

Dr. Hauani Kane	Assistant Professor, School of Geographical Sciences and Urban Planning, Arizona State University; Member, Polynesian Voyaging Society
Tony LaVoi	Chief Data Officer, NOAA
Eduardo Manglallan	Deputy Director, Harbors Division, Hawaii Department of Transportation
Joseph D. Martin, SES	Director, Center of Excellence in Disaster Management and Humanitarian Assistance, U.S. Indo-Pacific Command
Joyce Miller	Former HSRP Chair
Randy Navarez	Papahānaumokuākea National Marine Monument
Tara Owens	Extension Faculty, Coastal Processes and Hazards Specialist, University of Hawaii Sea Grant Program; Science and Technical Advisor, County of Maui Planning Department
Jessica Podoski, PE	Coastal Engineer, U.S. Army Corps of Engineers, Honolulu District
Julia Powell	Chief, Navigation Services Division, OCS, NOS, NOAA
Mikkel Roer	Port Captain, Manager, Marine Compliance, Young Brothers/Foss Maritime
Dr. Jennifer Samson	Archipelagic Research Program Lead, Ecosystem Sciences Division, Pacific Islands Fisheries Science Center, NOAA Fisheries
Jose E. Sanchez, SES	Director of Regional Business, Pacific Ocean Division, U.S. Army Corps of Engineers
Dr. John R. Smith	Oceanographer, Hawaii Undersea Research Laboratory and Department of Oceanography, University of Hawaii at Manoa (ret.)
Ray Tanabe	Director, Pacific Region, National Weather Service, NOAA

Bill Thomas	Senior Advisor for Islands, Indigenous and International Issues, Office of Coastal Management, NOS, NOAA
Paul Turner	Acting Director, Integrated Ocean and Coastal Mapping Program, NOS, NOAA
Dr. Daniel Wagner	Chief Scientist, Ocean Exploration Trust
Stephen White	Remote Sensing Division, NGS, NOAA
Darren Wright	National Marine Services Program Manager, Marine, Tropical and Tsunami Services Branch, National Weather Service, NOAA

ATTENDEES:

Name

Ryan Adams
William Anonsen
Melvin Baum
Colin Becker
John Bravender
Christi Brooks
Sinclair Brown
Samantha Bruce
Dana Caccamise
Brian Connon
Jon Dasler
Sarah Falzarano
Colleen Fanelli
Daniel Garatea
Heather Gilbert
Megan Greenaway

Kristen Hahn

Samuel Hiratsuka

Kimberley Holtz

Nyla Husain

John Ide

Megan Julian

Carla Kirby

Aja Kirksey

Marta Kumle

Jason Leonard

Anita Lopez

Audra Luscher

Andrew McGowan

Laura Nunnemaker

Casey O'heran

Tara Owens

Nicole Raineault

Starla Robinson

Jackie Rolleri

Tim Schierenbeck

Suwan Shen

Daniel Simon

Chadrick Skyberg

John Smith

Mark Smits

Helen Stewart

Wade Thomson

John Titchen

Nicky Verplanck

Collin Walker

Robert Walker

Jordan Watson

Neil Weston

Lorne Williams

Joshua Williams

Katrina Wyllie

Wen Zhong