

**62nd Meeting of the NOAA Science Advisory Board
July 17-18, 2018**

Location: Hugh Gregg Coastal Conservation Center
93 Depot Road
Greenland, NH.

Presentations for this meeting have been posted on the Science Advisory Board (SAB) website:
<http://www.sab.noaa.gov/SABMeetings.aspx>

SAB members in attendance:

Ms. P. Lynn Scarlett, Managing Director for Public Policy, The Nature Conservancy (Chair); Dr. Susan Avery, President Emeritus, Woods Hole Oceanographic Institution; Dr. Michael Donahue, Vice President and Director, Water Resources and Environmental Sciences, AECOM Corporation; Dr. Robert Grossman, Frederick H. Rawson Professor and Jim and Karen Frank Director, Center for Data Intensive Science, University of Chicago; Dr. Everette Joseph, Director, Atmospheric Science Research Center, University at Albany, State University of New York (SUNY); Dr. Eugenia Kalnay, Professor, Department of Atmospheric and Oceanic Science, University of Maryland; Mr. W. Christopher Lenhardt, Domain Scientist, RENC University of North Carolina Chapel Hill; Ms. Jean May- Brett, STEM Partnership Coordinator, Louisiana Department of Education (ret.); Dr. Denise Reed, Professor Gratis, Pontchartrain Institute for Environmental Sciences, University of New Orleans; Dr. Robert Rheault, Executive Director, East Coast Shellfish Growers Association; Dr. Martin Storksdieck, Director, Center for Research on Lifelong STEM Learning and Professor, College of Education and School of Public Policy, Oregon State University; and Mr. Robert S. Winokur, Consultant (ret. NOAA, Navy)

NOAA senior management and Line Office representatives in attendance:

RDML (ret. USN) Timothy Gallaudet, PhD, Assistant Secretary of Commerce for Oceans and Atmosphere and Acting NOAA Administrator; Mr. Neil Jacobs, Assistant Secretary of Commerce for Environmental Observation and Prediction; Mr. Craig McLean, Performing the Duties of NOAA Chief Scientist; Dr. Paul Doremus, Deputy Assistant Administrator, National Marine Fisheries Service (NMFS) Dr. Cisco Werner, Chief Scientist, NMFS; Dr. Louis W. Uccellini, Assistant Administrator for Weather Service; Mr. Eric Kihn, Director, NESDIS National Centers for Environmental Information, Center for Coasts, Oceans and Geophysics; Steven Thur, Director, National Centers for Coastal Ocean Science, National Ocean Service (NOS); RDML Nancy Hann, Deputy Director for Operations for the NOAA Corps

Staff for the Science Advisory Board in attendance:

Dr. Cynthia Decker, Executive Director and Designated Federal Officer; Ms. Elizabeth Akede; and Ms. Mary Anne Whitcomb

July 17, 2018

Opening Statement of the Chair and Self-Introductions by Science Advisory Board (SAB) Members

Lynn Scarlett, The Nature Conservancy and Chair, NOAA SAB

Lynn Scarlett welcomed the attendees to the meeting and asked SAB members to introduce themselves. She reminded the members of the purposes of this meeting: to receive presentations by NOAA and others, to get work plan updates and review next steps for the topics, and to revisit work plan topics 7 and 9.

Welcome to the Great Bay National Estuarine Research Reserve

Cory Riley, Reserve Manager

Cory Riley welcomed the SAB and discussed NOAA's National Estuarine Research Reserve System (NERRS), which consists of 29 place-based programs around the country that own and manage land and estuarine/water resources for the purpose of expanding the understanding of estuaries to inform coastal management. In New Hampshire, the program directly manages over 2,000 acres of land and 7,000 acres of water and estuarine resources. Most of the Great Bay NERR research is on water quality, habitat protection, and the dual challenges of land use change and climate impacts.

SAB Consent Calendar

Lynn Scarlett, The Nature Conservancy and Chair, NOAA SAB

- April 2018 SAB Meeting Minutes
- May 2018 SAB Teleconference Meeting Minutes
- Working Group Status Reports

Jean May-Brett made a motion to accept the items on the consent calendar; Walter Faulconer seconded the motion and it passed unanimously.

Advancing the NOAA Research to Operations Pipeline

Neil Jacobs, Assistant Secretary of Commerce for Environmental Observation and Prediction

Summary

Neil Jacobs presented on the research to operation (R2O) strategy for the Next Generation Global Prediction System, which will be a unified modeling system spanning everything from short-term convective resolving to general circulation dynamic climate models. The three critical components for numerical weather prediction (NWP) are observations, model code, and computational resources. Deficiencies in any of these will diminish forecasting abilities.

The key to NOAA's approach to improve their observing systems is extracting more and better information from existing observing systems, particularly satellite data. New observation systems include Unmanned Aerial Vehicles (UAVs), gliders, and pressure measurements from smartphones. NOAA will be quantifying the impact of their observing systems to help determine their future strategic investments. Better data assimilation is needed to improve forecast skill and performance, the most critical step of which will be building the initial conditions of the start file. Significant progress has been made here but there is a long way to go to catch up to the European Centre. Transitioning to the new dynamic core will also be a big step, which is just one of the many components in the global modeling system. The Next Generation Global Prediction System Strategic Implementation Plan is a good strategy that was inherited from the previous administration and NOAA is working to accelerate. Code efficiency and optimized hardware are other aspects of the plan to improve forecast skill and performance; Dr. Jacobs was concerned

that NOAA's code configuration is going to lead the agency down a path inconsistent with the future of where high performance computing (HPC) vendors are headed. Moving all of the code over to a new architecture is going to be very tricky, but there may be novel solutions.

NOAA's operation strategy is improving, though the status quo still presents several barriers. The HPC procurement process makes little sense and is prohibitive of on-demand purchase of cloud-based virtual machines and HPC. The security clearance process for visiting scientists is an impediment to having external expertise come work on NOAA's machines. The "us-versus-them" culture that exists within scientific communities is getting better, but still exists in certain pockets and can slow down progress. The funding allocation process disincentivizes collaboration. The incentive not to fail far outweighs the incentive to improve, leading to risk aversion within the agency. Too many committees are involved with the global modeling program, several of which provide information contradictory to other committees.

Dr. Jacobs' ideas to accelerate research to operations included:

- Virtual machines (cloud HPC) for on-demand parallel development
- End-to-end community model (harness collective advancements)
- Expediting access for visiting scientists and for research access to models
- Modifying the R20 funnel (requirements, gates and transitions)
- Fast-tracking satellite data assimilation
- Drive up benefit in cost-benefit ratio
- Agile/nimble "skunkworks" sandbox
- Implementing a governance/funding structure to execute this plan

It is important to remember that not all cloud is the same. What NOAA needs is Remote Direct Memory Access (RDMA) through high-speed interconnect switching. This is consistent with NOAA's Big Data Plan (BDP). The more data, and the more recent the data that is assimilated into the model, the greater the positive impact in forecasting ability.

Dr. Jacobs concluded his presentation by requesting feedback and guidance from the SAB on the following issues:

- What do you think are our biggest challenges?
- Thoughts on how to solve them?
- Alternative ideas to our proposed path?
- Are we overlooking something?
- Unintended consequences?
- What do you need from us?
- How can we better engage the SAB?

Discussion

Lynn Scarlett asked what Dr. Jacobs perceived to be the most significant immediate obstacles, technical or legal, to moving this strategy forward. Dr. Jacobs said one is how far in advance the budget is determined; he is not even sure if this plan will be able to influence the FY2021 budget. Thus far, the strategy has been funded by moving money from various places in bits and

pieces, leading to a convoluted execution which won't be smoothed out until FY2020, if approved. The other issue is cloud procurement and the NOAA budget process. The way to solve this may be to have the management of the cloud procurement happen externally. Cultural impediments and others are largely solving themselves through a groundswell of people who are on board with this strategy. The Office of Oceanic and Atmospheric Research (OAR) and the National Weather Service (NWS) being siloed inherently means that there have to be hand-offs and to some degree there is a financial incentive not to hand off from research to operations. Dr. Jacobs would like to see a formalized process in place in case his eventual successor is someone unfamiliar with NWP.

Everette Joseph said the SAB should discuss how they can help with this strategy and how they can incorporate it into their own work plan. He felt that this strategy addresses many of the concerns that NOAA's partners have been raising for a long time, especially NWP. He asked if NOAA intended to pilot external cloud-based architecture. Dr. Jacobs said NOAA has not yet finalized the strategy, but there will probably be a new environmental center (which is not a physical location but an R2O strategy process) where the skunkworks will take place. A lot of the development will be housed within universities that NOAA will provide with code and architecture. Dr. Jacobs hopes that cloud service providers will at least partially fund the porting of the code to their architecture, since housing it would bring them a large customer base.

Dr. Joseph asked if NOAA is leveraging the radar pilot cooperative research and development agreement (CRADA) as part of this strategy. Dr. Jacobs said he is working with NOAA leadership on how to bundle the R2O strategy with the BDP strategy as it currently exists, in hopes of creating a seamless end-to-end solution.

Louis Uccellini, Assistant Administrator for the NOAA National Weather Service, said this is the first time he has seen someone in upper-level management embrace R2O to the extent to which Dr. Jacobs has, and thanked him for it. While he agrees entirely that there are challenges stemming from cultural issues in NOAA, he noted that these are on both the research and the operational sides. The larger research community, funded by other agencies, still likes to develop their own activities; they have the opportunity to build off of what NOAA is doing but choose not to. A large majority of funding for research in the U.S. goes to individual developments not working off of the operational infrastructure.

Walter Faulconer asked if NOAA has any coordination with the Department of Defense (DoD) in this area. Dr. Jacobs said they have met with the Department of Energy (DOE) trying to get them to return to a unified modeling approach. The National Aeronautics and Space Administration (NASA) has agreed to collaborate on this architecture. NOAA Acting Administrator Timothy Gallaudet has had discussions with the Navy who will be working with NOAA on ocean models; whether or not the Navy uses FV3 (Finite Volume Cubed-Sphere Dynamical Core) or Neptune is to be determined. Dr. Jacobs has also had discussions with Air Force officials about their willingness to get on board with this strategy versus running the United Kingdom Meteorological Agency (UKMET) model – they are open to the idea, but not totally comfortable with an open community code. NOAA will continue building relationships with the goal of interagency collaboration.

Christopher Lenhardt asked if encouraging academics to document their code and make it more sustainable is part of this strategy. Dr. Jacobs said it is. The strategy would bring software

engineers in early on to determine the logic of the code structure, rather than making tweaks on the back-end. In addition to maintaining a repository of upgrades, proposals will have to make a scientific justification for a modification to the code.

Susan Avery said that NWP is dependent upon not just observations, model code, and computational resources, but also process understanding. Research and operational communities have not exploited this component as much as they should, particularly as NWP moves to different scales for seasonal/sub-seasonal forecasting. Dr. Jacobs said that there are many new models that are not computationally intensive that demonstrate impressive forecasting skill while others are not using any dynamical models. There may be a much more intelligent way to derive that same information.

Dr. Joseph asked how to incentivize the community around this issue, both R2O and also new paradigms that are aligned towards fundamentally improving the NWP. Dr. Jacobs said that will be a challenge. Research funding is one avenue but he would like to find ways to incentivize the community without having to pay them. The code needs to be more user-friendly and scientifically functional. Well-aligned marketing and branding efforts may also be key to getting researchers on board.

NOAA Science Update

Craig McLean, Performing the Duties of NOAA Chief Scientist

Summary

Craig McLean reported that from August 2017 to July 2018, NOAA has spent 997 days at sea across 12 regions, including the Indian Ocean, logged 4,470 flight hours, been part of over 60 international conferences, produced over 60 congressional reports, and completed over 100 transitions. NOAA would like to hear back from Congress on the benefit of the agency having produced so many reports. Mr. McLean briefly discussed some of the NOAA transition highlights, including adding the Kilauea volcano to the operational set of U.S. volcano trajectories in the Hybrid Single Particle Lagrangian Trajectory (HYSPLIT) Model. NOAA's oil clean up and restoration efforts have given rise to a restoration industry and the agency is developing standards for consumers purchasing these services/products. Mr. McLean reviewed some of the international meetings NOAA has participated in over the last year.

Reduce the impacts of extreme weather and water events

NOAA's parts per trillion gaseous analysis has found that emissions from personal care products are now comparable in the gaseous space to tailpipe emissions, which have come down significantly. The Mauna Loa Atmospheric Baseline Observatory was the first site to record carbon dioxide levels averaging more than 410 ppm in April and May, surpassing another climate milestone. (Flooded Locations and Simulated Hydrographs (FLASH) and Advanced Quantitative Precipitation Information (AQPI) have transitioned into operations and are providing neighborhood scale forecasts for flooding, significantly improving operational skill. All of the sensors on the new satellites are operating/performing except for the Advanced Baseline Imagery, which is still under examination to determine the cause of its fault. NOAA is now getting radar-scale imagery for many attributes that have never been seen before with a refresh rate that is providing many new opportunities for forecasters. There has been a reduction

of ~10% in the velocity of tropical storm movement between 1949 and 2016 over land and water, meaning greater loitering time for the storms with additional moisture being deposited. Thanks at least in part to improvements in the science and dissemination, as well as public understanding and weather readiness, May and June saw no tornado deaths despite being a very active tornado season. The confidence of the community and responders in NOAA's improved forecasts, which are a result of new models, contributed to a significant reduction in reported traffic accidents and no injuries during a rare winter storm in central Florida. The National Blend of Models used by NWS now includes quantitative precipitation, aviation, and fire weather, among many other model additions. NOAA will be deploying 11 Saildrones this summer gathering fishery, ocean climate, and weather data – building and blending technology across a number of missions.

Increase the Sustainable Economic Contributions of Our Fishery and Ocean Resources

NOAA ocean exploration continues to discover new species. NOAA is working with the Bureau of Ocean Energy Management (BOEM) to pre-assess alternative energy installations and the National Centers for Coastal Ocean Science (NCCOS) has completed mapping the Hudson Canyon area and plans to begin ground truthing the New York Wind Energy Area. NOAA performing this work cuts the regulatory time and costs for industry to determine whether they can make a satisfactory installation. Deep-sea benthic surveys have been informing the Regional Fishery Management Councils' decision making in the Pacific and the Gulf of Mexico on whether or not to close fisheries. The new EcoCast model supports economically viable fisheries by helping fishers know where to go to avoid protected resources and where to go to economically extract resources without undue expense. Machine learning is now being used to collect fisheries data, including length frequency results for fish stocks. The Environmental Sample Processor (ESP) device's harmful algal bloom (HAB) forecast provided the necessary confidence to allow the Major Razor Clam festival to go forward; an estimated \$3.6 million of coastal community income are enabled by these types of forecasts ensuring the safety of the consumers. A socioeconomic study in Alaska has looked at how changes in the fishing community reflect down through the social structure. Environmental and geographic relationships among salmon forage assemblages are being better understood through research conducted at the Southwest Fishery Science Center. The world's largest aquaponics operation opened in Wisconsin – a commercial firm raising salmon and also growing leafy greens that can be marketed.

Discussion

Everette Joseph asked if the absence of tornado deaths was really attributable to the forecasting and dissemination or if it was a coincidence of frequency and location. Mr. McLean said good science, good modeling, and the public being attuned to know when, where, and how to find out what's coming certainly played a significant role; he deferred to NWS representatives on the role of frequency and location. Dr. Joseph said he would like to hear anecdotes on how decision making has been impacted by improved forecasts, particularly for the past convective season. Mr. McLean said NOAA could prepare a brief for the SAB describing the preparation and early work with responders.

Denise Reed said she would like more detail from the NOAA Science Update in the future, perhaps covering fewer topics in more depth.

Denise Reed asked if supporting BOEM's five-year offshore energy lease permitting process would drive NOAA to prioritize research and mapping to these areas of prospective economic opportunity. Mr. McLean said that the only way the U.S. will know what its resources are is to map its exclusive economic zone (EEZ), including the water. Following up on the President's declaration of June as National Oceans Month and getting congressional support for budgeting the mapping and resource inventory of the U.S. EEZ at the current scale will provide a starting point for a comprehensive campaign to cover the entire territory, rather than helping others do it piecemeal. The U.S. needs to know what can be extracted and what needs to be protected. Lynn Scarlett noted that BOEM's five-year leasing draft plan is not a plan for actual leasing yet, but a proposal for consideration of leasing. A key consideration for the proposal is "what is the state of information?" and might its absence be a reason for excluding areas until it is available.

Lynn Scarlett asked if better understanding Hudson Canyon's areas of significant sensitivity is part of NCCOS' effort there. Mr. McLean said that the attributes collected included environmental sensitivities as well as physical feasibility. A National Oceanographic Partnership Program (NOPP) proposal by NOAA, DOE, BOEM, and others, aims to look at alternative energy installations to determine what science questions there are, how they need to be answered, and what the threshold is for saying either yes or no to an application. If we could do this nationally, it would enhance our ability to protect the environment, utilize resource and financial opportunities, and do it expediently.

Christopher Lenhardt said his office handles most of NOAA's work with BOEM. Mapping is a large part of this work, but not the majority. They do environmental modeling and prediction, determining areas that are inappropriate for wind energy installation. He acknowledged that a lot of it is reactive to BOEM's desires and there is a need for NOAA to more systematically look at where and when they choose to engage, as well as how much NOAA wants to drive the process.

Lynn Scarlett will work with Cynthia Decker to get feedback from the SAB on teasing out a few topics for the Science Update at the next SAB meeting that can be discussed in greater depth.

Presentations of NOAA Science in the Northeast

The NOAA-University of New Hampshire (UNH) Joint Hydrographic Center (JHC) Andrew Armstrong, Co-Director, NOAA/UNH Joint Hydrographic Center

Summary

The NOAA/University of New Hampshire (UNH) Joint Hydrographic Center (JHC) is a national center for research and education in hydrography and ocean mapping. JHC is a partnership between NOAA and UNH and is congressionally authorized and appropriated, funded through a competitive cooperative agreement. The partnership is designed to bring the private sector and governmental agencies into close relationships with researchers without getting tied up in NOAA procurement issues or giving the impression of favoritism; the university can enter into a variety

of partnerships in addition to the NOAA partnership. JHC's goals are to be a world leader in the development of hydrographic and ocean mapping technologies and approaches, as well as expanding the scope of ocean mapping clients and constituencies through the development of innovative applications and collaborative work with both the private sector and government labs. Capt. Armstrong provided an overview of some of the facilities, research vessels, and technologies in use at JHC, including a telepresence center that provides direct access to the NOAA Ship *Okeanos Explorer* and the exploration vessel *Nautilus* while at sea, allowing JHC to run surveys from shore with only one or two techs on ship. JHC's focus is on applied research related to ocean mapping with an emphasis on research to operations. Some of the areas they work in include: underwater acoustics, lidar and coastal and ocean remote sensing, hydrographic data processing and analysis, the Electronic Chart of the Future, seafloor characterization, water column mapping, ocean data visualization, autonomous vessels, continental shelf mapping, crowdsourced bathymetry, and many more. Capt. Armstrong reviewed the specifics of some of the projects JHC has done over the last few years, including Combined Uncertainty and Bathymetric Estimator (CUBE), CUBE with Hierarchical Resolution Technology (CHRT), and the Geocoder for multibeam backscatter processing. JHC has previously done quite a bit of work with autonomous underwater vehicles (AUV), but recently NOAA's Hydrographic Office has shown more interest in autonomous surface vessels (ASV). JHC has a fairly large fleet of these, both large and small, and is using them in active surveys. JHC has come so far in their water column work that they are now applying it to improving seafloor mapping, tracing seafloor mapping anomalies to water column features. JHC offers a Master of Science (M.S.) and a doctorate (Ph.D.) track in engineering (ocean, electrical, or mechanical) and earth sciences/computer science/oceanography/natural resources, as well as certificate and training programs.

**New Hampshire Sea Grant: Making Connections, Supporting Partners,
Amplifying Impact**Erik Chapman, New Hampshire Sea Grant Director

Summary

The challenges New Hampshire is facing in their coastal environment are similar to other coastal states: warming conditions, increasing awareness of the threats to ecosystem processes presented by ocean acidification, communities' increasing awareness of vulnerability to sea level rise, and increasing intensity and frequency of storms. The state is also becoming aware that the population is struggling with scientific/environmental literacy and how to take what they do know and apply it to their decision making. New Hampshire is also experiencing opportunities similar to other coastal states: the aquaculture industry is beginning to take shape around the oyster farm in Great Bay, fisheries are changing dramatically, and more. In addressing these issues, the state is relying heavily on the Sea Grant program's organizational approach to R2O, combining research with extension, education, and communications, engaging stakeholders throughout projects, and incorporating partnerships in what they do. ~50% of NH Sea Grant's investment is in research, primarily distributed through a biennial competition. The theme of this cycle's grants is safe and sustainable seafood production and healthy coastal ecosystems. Projects they are currently funding include genetic markers of striped bass, Jonah crab life history research, pros and cons of eating fish from the Gulf of Maine, aquaponics, *Vibrio* research and the effects to the oyster industry, and an eDNA project in the Great Bay to better

understand species assemblage. This current funding cycle is attempting to advance the development of capacity in aquaculture at UNH, taking advantage of Sea Grant investments in aquaculture that have not yet been fully realized. As part of the Northeast Sea Grant Consortium, New Hampshire Sea Grant has done quite a bit of work regionally, including ocean acidification resiliency of populations of bivalves and vulnerability of larval and juvenile stages of sand lance and lobster. Sea Grant is well-positioned to tackle regional problems. A program that is fast becoming the model for how to leverage the potential of citizen science is the UNH Coastal Research Volunteer Program. In addition to increasing the capacity of doing science, great attention has been paid to managing the volunteers in such a way as to allow them to serve the science in a way that is defensible and usable in scientific analysis. The Marine Docent Program is NH Sea Grant's flagship educational program which includes over 150 trained docents working 9,000+ volunteer hours annually to improve environmental literacy in K-12 schools. In response to the dramatic decline in the number of groundfish boats, NH Sea Grant has worked with restaurants, fishermen, and volunteers to open new fisheries and markets, add revenue to fishermen, and find ways to reduce environmental impact of introduced species, such as green crab. Aquaculture in New Hampshire mostly consists of oyster farming in Great Bay, but they also support integrated multitropic aquaculture at the mouth of the Piscataqua River. NH Sea Grant supports resilient communities and economies, helping them prepare for living under the Municipal Separate Storm Sewer System (MS4) permit requirements and offering training to professionals on landscaping for water quality. Disaster preparedness and ocean and energy are going to be major issues for the whole Sea Grant network in the future.

Discussion

Martin Storksdieck said he had previously seen a much longer presentation on JHC's work and was unclear on why some objected to enhanced visualization for improving professional practice. Capt. Armstrong said that some users have a long acquaintance with certain ways of visualizing seafloor mapping and nautical charting and don't want to change the way they interact with it. In some applications, there is concern about providing too much information, particularly for mariners that might lose track of the key items. Still others believe showing everything about the seafloor invites overactive exploitation of resources. JHC's approach is that it is better to show what's there and trust other systems to protect the resources.

Jean May-Brett commented that sometimes docents can be more activist-oriented than science-oriented and asked what kind of training NH Sea Grant provides. Dr. Chapman said they have a year-long training program for licensing docents where they are steeped in being an honest broker before making any contact with students.

Total Water Level Initiative and Probabilistic Snowfall Forecasts

Joe DelliCarpini, Science and Operations Officer, National Weather Service Forecast Office (NWSFO), Norton, MA

Summary

When discussing coastal storms, there are two types: tropical cyclones (tropical storms, hurricanes) and extratropical cyclones (nor'easters). Coastal flooding impacts from both are due

to water level (astronomical tide and surge) plus wave height. Flooding impacts are the same for both types. New England has an inexperienced population when it comes to coastal flooding, the last destructive nor'easter being in 1992 and the last land falling major hurricane in 1954. There were a large number of water rescues during the January 2018 blizzard. Threats to property and infrastructure are very serious; frequent salt water inundation from minor events can damage shoreline roads. The region is seeing more minor events having significant effects on coastal communities and the Boston metropolitan area. NSWFO's total water level (TWL) forecast combines the astronomical tide, storm surge and wave run-up, which is then used to provide decision support services for coastal inundation in multiple formats. Some recent forecast improvements include studies of past events to improve forecaster awareness and refine location-specific impacts, providing daily TWL forecasts and wave run-up forecast, and the development of a Coastal Hazards web portal. Future research and development will include working with NOAA Coastal Services Center to improve mapping visualizations that incorporate real-time TWL forecasts and wave run-up and updating lidar maps along the Massachusetts/Rhode Island coastline with a goal of having all of the weather forecast offices along the east coast producing these in real time. Providing coastal inundation forecasts in a graphical format is very valuable. Probabilistic snowfall forecasts are now the standard in the eastern region of NWS and are being expanded nationally. Due to the significant impacts of snowfall, there has been increased demand for more accurate snowfall forecasts. Small changes in snow forecasts make a big difference, particularly where the rain/snow line will be in relation to densely populated areas. Probabilistic snowfall forecasts include new web-based forecasts with a minimum, most likely, and maximum snowfall forecast conveying the range of possibilities and forecaster confidence, the probability of exceeding certain thresholds, and location-specific tables that allow users to drill down to their community. Users across a wide spectrum have had a very positive response to the probability products and they have demonstrated cost savings among partners.

Discussion

Christopher Lenhardt asked if users reported how decisions were made using this data. Mr. DelliCarpini said it gave users (City of Boston and State of MA) more confidence in positioning their equipment in particular areas that were forecasted to receive the most impact, ultimately being better prepared.

Everette Joseph asked if there is any opportunity to evaluate and improve the product and how it is delivered. Mr. DelliCarpini said that has been done. Last year, a social scientist held several partner meetings to get feedback from partners and this will continue as the programs evolve nationally.

Lynn Scarlett asked how they define success when they say the tools are "highly successful." Mr. DelliCarpini said cost savings are one way and another is whether it continued to be used in decision making. Also internally: does the process work in Forecast Office? Is it efficient? The tools have performed well under all these considerations.

Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) and Northeast Coastal Acidification Network (NECAN)

Ru Morrison, Executive Director, NERACOOS

Summary

Ru Morrison stated that NERACOOS is part of the Integrated Ocean Observing System (IOOS), a national-regional partnership of 17 federal agencies and 11 regional associations (RAs), with a program office within NOAA's National Ocean Service (NOS). 79% of NERACOOS funds go toward ocean observations, modeling, and data management. They collect the information necessary to address regional issues and use data management and communications to deliver useful products and services to stakeholders. Dr. Morrison walked through the steps of developing the NECAN project as an example of this process. NECAN represents a nexus of scientists, federal and state resource managers, and marine industry partners dedicated to coordinating and guiding regional observing, research, and modeling endeavors focused on ocean and coastal acidification. Other projects NERACOOS has been involved with include the Integrated Sentinel Monitoring Network (ISMN), Regional Harmful Algal Bloom (HAB) workshops, and regional partners meetings. NERACOOS is now a certified RA, which means their data management practices, observations, and governance all meet a high standard and can be treated just like federal data. NERACOOS has developed one of the largest nutrient observatories and has provided observations that have helped HAB managers better understand water dynamics in the region. Dr. Morrison reviewed some of the other products and services NERACOOS offers, including hourly buoy data, wave run-up forecasts, and work with school groups.

Discussion

Lynn Scarlett asked who establishes the evaluation and certification of RAs. Dr. Morrison said NOAA is the certifier and the process is done through the IOOS program office. Lynn Scarlett said that this presentation and the previous one may provide insights for decision support and decision support efficacy; perhaps the SAB could look further into how they are evaluated and the success metrics.

Jean May-Brett asked how many of the RAs have achieved certification. Dr. Morrison said all 11 RAs have now effectively achieved certification, but not all of the paperwork has been completed.

Aquaculture Research at the Northeast Fisheries Science Center (NEFSC) Lisa Milke, NMFS Northeast Fisheries Science Center, Milford, CT

Summary

The Northeast Fisheries Science Center (NEFSC) has five research labs from New Jersey to Maine and since 1931 have predominately focused on shellfish and aquaculture research. The Milford Microalgal Culture Collection contains over 250 strains, has a 51' research vessel, and three ocean acidification research systems. In 2013 (the most recent dataset available), aquaculture product in the Northeast was worth ~\$219 million and comes in third in value compared to single species landings. NEFSC's mission is to conduct science that serves industry, managers, and the science community. Services they provide to the aquaculture industry include:

perpetuating their microalgal collection and providing starter cultures to constituents, convening the Milford Aquaculture Seminar and microalgal culture workshops, and providing insight and troubleshooting. Local municipalities have a keen interest in nutrient removal by shellfish as a way to improve water quality. An Oyster Best Management Practice expert panel recommended nutrients in oyster tissue harvested by growers be counted towards their required reductions. A pilot scale ribbed mussel installation in New York City successfully demonstrated that a fully stocked mussel raft would clear 12 million liters daily, removing 63 kg of nitrogen from the waterway annually. These findings are being used by local and state governments. Some of their other research activities include using video to compare fish interactions with oyster cages to fish activity in natural habitats, physiological responses to ocean acidification, offshore mussel siting, and new probiotic bacteria for use in shellfish hatcheries.

Discussion

Susan Avery asked what is holding aquaculture back from being done sustainably and at scale in the U.S., particularly given its success in other countries. Paul Doremus said there are three things that NOAA and industry typically point to: the regulatory environment, social perception issues, and building out scientific and technical capabilities to sustain and advance aquaculture. Given the environmental benefits of seafood production relative to other forms of protein production, as well as the growing population nationally and globally, NOAA thinks the U.S. needs to look hard at finfish production, which still has many unresolved technical issues. NOAA's current capability is strong in some areas, but not at the scope that it needs to be to sustain aquaculture growth.

Bob Rheault noted that the Milford lab lost about half of its full-time employees in the last decade. Milford is the only lab doing this kind of research and he asked about the prospects going forward. Dr. Milke said there has been a new hire and a staffing plan is in place. Craig McLean said the NOAA budget increase sounds like a lot, but spread across so many areas it is essentially nominal for each. Aquaculture is one promising area. The SAB is well-positioned to make recommendations on issues related to funding and prioritizing.

The National Environmental Satellite, Data, and Information Services (NESDIS) Engagement and Assessment in the Northeast

Eric Kihn, NESDIS National Centers for Environmental Information (NCEI)

Summary

The National Environmental Satellite, Data, and Information Service (NESDIS) serves other NOAA line offices by providing secure and timely access to global environmental data and information from satellites and other sources. NCEI is the entity within NESDIS with a consumer-facing and output focused mission. There is a rising demand for information with regional perspectives. NOAA looks at this through societal challenge areas (coasts, climate, water, and seasonal-to-subseasonal forecasts) as well as by sector (agriculture, energy, health, transportation, and the sustainability of marine ecosystems). NCEI stewards the nation's largest archive of environmental data, collecting information from around the world. Dr. Kihn discussed some of NCEI's tools, including the Deep Space Climate Observatory (DSCOVR) spacecraft

which measures the properties of solar wind. Power grids in the northeast are at a high enough latitude that they are vulnerable to magnetic storms. The Space Weather Prediction Center uses DSCOVR data to help predict and alert operators to protect power grids. He also discussed the new Geostationary Operational Environmental Satellite – R (GOES-R) series satellites. NCEI has teams that work on sector and regional engagement. Their sector-based strategy consists of determining what sectors they can serve and how best to prioritize their response. Priorities are decided based on three criteria: (1) alignment with the NOAA/NEDIS/NCEI mission, (2) potential environmental impact of the sectors; and (3) the readiness of the sectors to make use of environmental products and services that NCEI can offer. Real estate is a sector that NCEI believes could potentially have a lot of use for environmental properties but they have not developed an ability to ingest the data and make use of it. Key NCEI products for the Northeast Region include Quarterly Climate Summaries/Outlooks, monthly webinars, and sectoral information dashboards. NCEI's Northeast Region works extensively with the Department of Energy on grid sustainability and critical infrastructure security, providing them with information on icing, extreme weather, wet bulb temperatures, wind speed and duration, water availability, and sea level rise. The Northeast Region just launched an early warning drought system, the U.S. Drought Monitor, which has become one of NCEI's most popular products. NCEI has partnered with the Centers for Disease Control and Prevention (CDC) and the National Integrated Heat Health Information System on Building Resilience Against Climate Effects (BRACE) framework, a five-step process that allows health officials to develop strategies and programs to help communities prepare for the health effects of climate change. The Infrastructure and Climate Network (ICNet) is dedicated to climate science and engineering research in the Northeast Region as additional precipitation and extreme weather increasingly wreak havoc on transportation infrastructure. Their Cumulative Freezing Index uses historical data to help localities determine when roads are passable. NCEI data is also used for NMFS work related to altered water temperature regimes. Poleward shifts in biomass and increases in depth distribution have been correlated with large-scale warming and climatic conditions for 24 of the 36 stocks examined in the Northeast.

Discussion

Martin Storksdieck asked for more information on customer engagement and if NCEI offers formal assessments of the way in which they present data for decision making. Dr. Kihn said they have very strong assessments with some sectors, such as energy where they host summits with many stakeholders. With more diverse sectors, like health and real estate, it is more challenging because the services may be competing with a commercial interest. The conferences help to balance where NCEI focuses their scientific effort and what they are trying to take from the research side into operational products.

Walter Faulconer asked what the current thinking/planning is in space weather beyond DSCOVR. Dr. Kihn said Space Weather Follow On (SWFO) is supposed to launch in 2024. The big question in the community now is where the coronagraph is going to sit.

Work Plan Updates

Oversee Development and Implementation of the Environmental Information Services Working Group (EISWG) Work

Everette Joseph, State University of New York at Albany and SAB Member
Bob Winokur, Consultant, SAB Member and EISWG Liaison

Summary

Everette Joseph reported that the EISWG has not met since the last SAB meeting; their next meeting is scheduled for July 27th. They will be focusing on EISWG's role in statute of evaluating NOAA reporting on Observing Systems Simulation Experiments (OSSEs), HFIP (Hurricane Forecast Improvement Program), Hazard Simplification Project, and improving seasonal-to-subseasonal forecasts. Bradley Colman said that this meeting was supposed to be the start of EISWG's review of various NOAA reports required by the Weather Act, but since those are not yet available, they are meeting with NOAA to have face-to-face dialog around the topics stated above. They will have much more to report after the meeting, including a work plan and next steps.

Discussion

Craig McLean said NOAA can do more in terms of briefing EISWG when reports are not available. NOAA needs to fulfill this obligation whether the reports are done or not and must figure out prospectively how to do that each year. Lynn Scarlett requested that EISWG consider a mechanism for linking the briefings back to the SAB.

Review the Use of Observing System Simulation Experiments (OSSEs)

Bradley Colman, The Climate Corporation and Co-Chair, EISWG
Eugenia Kalnay, University of Maryland and SAB Member

Summary

Eugenia Kalnay discussed the advantages and disadvantages of OSSEs and the Work Group's proposed solution. OSSEs allow for testing the forecasted impact of future instruments and finding their optimal design before investing billions of dollars in constructing them. In an OSSE, researchers know the complete truth, or "Nature," so they can test anything they want. OSSEs are, however, computationally very expensive and inefficient, requiring a year or more to get forecast impacts that are statistically significant. This is because there are already many observations and the new observing system has to compete with the others. It is very difficult to prove the new instrument improves the forecast in a statistically significant way even with long-term experiments. The solution to these issues is proactive quality control (PQC), which is based on Ensemble Forecast Sensitivity Observations (EFSO). For each observation, EFSO allows researchers to estimate how much it improves or worsens the analysis before the forecast mixes the impacts of all the observations, making it very precise. Deleting the most detrimental 10-20% of observations for every analysis cycle has a beneficial effect that accumulates with time and improves forecasts substantially by more than 5%. Robert Atlas, Director of AOML, is supporting Sean Casey in combining PQC with the AOML OSSE system to obtain the advantages of both systems.

Bradley Colman, EISWG Co-Chair, said that EISWG is looking at OSSEs through two lenses: (1) how could EISWG support the SAB in developing a plan for moving forward with recommendations on OSSEs, and (2) how does it relate to overall review and actions related to the Weather Act. They are focusing on building work groups with dialog from domain expertise so that EISWG's advice and recommendations are well-informed. EISWG is also looking for domain expertise from working groups in other areas to ensure coordination between their efforts. At EISWG's next meeting they will be formulating taskings and milestones and will report back to the SAB at their next meeting. EISWG wanted to be sure they are well-informed on the full scope of what SAB expects from the working group's work plan. Given their current understanding, EISWG believes they can finish up their report by the first quarter of 2019.

Discussion

Lynn Scarlett said the SAB is looking for the leads of each of the work plan items to lay out their suggested timelines and recommendations; the SAB expects different work plan elements to have different timelines depending on their nature. A report by sometime in 2019 is not outside the bounds of the timeframes the SAB has in mind. The EISWG should plan to tell the SAB what they have in mind, what kind of product they can deliver, and when. Once they can provide that kind of detail, then the SAB can weigh in on whether they agree.

Bradley Colman asked if the SAB had reporting requirements on the work plan or anything else that might be a driving factor in terms of timelines. Lynn Scarlett said that their work plan will be ongoing and mid-way reporting is fine. She added that some things would be more useful sooner rather than later in order to inform NOAA's thinking and investments.

Bob Winokur said that EISWG has an obligation by way of the Weather Act to submit an annual report to Congress. It is worth keeping in mind that they should try to be in a position to show positive movement in respect to the Act.

Everette Joseph said OSSEs may be a good area to focus on for demonstrating the cost-benefit of data, as Dr. Jacobs mentioned earlier.

Coastal and Marine Transportation and Support Infrastructure

Denise Reed, University of New Orleans and SAB Member

Summary

Denise Reed reported on Topic 8 in the Work Plan. Molly McCammon from the Alaska Observing System Office, who is also on the ESMWG (Ecosystems Management Working Group), has expressed an interest in working on this topic and will be presenting to NOAA's Hydrographic Service Review Panel (HSRP) at their next meeting. The HSRP is also interested in collaborating and their Co-Chair, Ed Saade, took part in a teleconference with Dr. Reed and NOAA and NOS staff to discuss where the intersections of the SAB and HSRP might be. They identified three issues: (1) value of information – how tide gauges and water levels are put in place for navigation support but are used for many other purposes by local communities and are foundational for coastal resilience around the country; (2) data assimilation – observations and

point measurements that are of critical import to navigation and how that information could be put into more of a forecast mode in addition to static observing/delivery; and (3) surveys and extensive data collection being done in nearshore and shelf environments and how the data generated could actually serve several other purposes across the agency, especially multibeam backscatter. Data assimilation and hydrodynamic OSSEs were singled out as a topic to focus on primarily. The discussion EISWG is having on this topic will stay in the EISWG space, but the Topic 8 task group is eager to hear their findings to see how it could be applied to this area. The other areas received less interested feedback. Cisco Werner said NMFS uses multibeam backscatter data, particularly to identify different substrate types. The data is all publicly available and well-documented, but if it is not known that it is available it should be advertised better. Denise Reed said that a presentation on what data is available and its utility might be a good idea. She will be having follow-up conversations with Mr. Saade and Ms. McCammon.

Discussion

Ed Saade said there is a tremendous amount of multibeam data being collected that is not being fully taken advantage of. There is no end to what could be done with the backscatter relative to applications beyond soil characterization. Multibeam data with backscatter, along with sidescan, is being collected for offshore wind farms along the east coast.

Craig McLean said that Dr. Kihn's team is responsible for the repository for much of this information. NCEI doesn't get enough attention for the excellent work it does in terms of cataloging, recovering, and making available very important information. There are cells within NOAA that are aware of the information that is available, but they still have the ability to maximize utilization of it inside of the agency.

Lynn Scarlett asked for more clarity on what the task group's ultimate product would be and what it provides back to NOAA by way of observations, recommendations, etc. Denise Reed said that is yet to be defined. Some of the overarching aims of the work plan include private partnerships and telling NOAA what the next lift is, not how to lift it.

Cisco Werner said reexamining biological OSSEs in shallow water environments might be useful. Denise Reed responded that this is intriguing but may be outside of the scope of Topic 8. If NOAA is going to invest in a sophisticated hydrodynamic tool it should be a platform to build on for other purposes. Craig McLean said that if NOAA could get a vision from the SAB of what this could look like in an integrated way across multiple disciplines that NOAA has responsibility for and how these tools can blend, it may spill over into some of the additional objectives of the work plan, but it could be a very important opportunity.

Susan Avery asked if the issue of OSSEs is getting too big, as it is not just atmospheric sensors and observations being considered, but also the ocean. Eugenia Kalnay said that anything in NOAA that already incorporates observations and a model of the system can be made much more useful by doing data assimilation. Combining OSSEs with PQC can improve the data assimilation and the forecasts and should be explored by NOAA. Bradley Colman said that the next meeting will be a good opportunity to frame the approach.

Review Improving Collection, Management, Dissemination and Decision Support Using Machine Learning, Artificial Intelligence (AI) and Data Science

Robert Grossman, University of Chicago and SAB Member

Christopher Lenhardt, RENCI, and SAB Member

Summary

Christopher Lenhardt reported that, as a first step, the task group decided to focus on citizen science and data science, which ties in to analytics and big data. Data quality is one of the most important considerations for citizen science. Questions for the task group to explore include curation requirements, what activities are better suited to citizen science than others, and how citizen science can be used in the near-term and longer term. Citizen science has been around a while and it is not clear which items, listed as "active projects," are still ongoing. A lot of educational resources are tied up with citizen science as well.

Robert Grossman discussed the data science aspect of Topic 4. The group is working with an accepted definition of data science: the intersection of mathematics and statistics on one side, and computer science and engineering on another, and applications to the domain on the third – here the domain would be atmospheric, oceanic, and environmental science. From that viewpoint, the task group is splitting up Topic 4 into advanced analytics (including AI and machine learning) and the rest of computer science and information science (including data integration and specialized computing architecture). They have scoped the topics and will be presenting a proposed action plan to the SAB. There is advanced analytics work being done scattered throughout NOAA, but no large scale focused effort. This is a competitive area with a lot of potential, but it is also overhyped right now. There are a number of infrastructure challenges, many of the platforms are easy to use but hard to use well. There are also potentials for biases in algorithms. The NOAA BDP puts data from NOAA into cloud environments which have very sophisticated tools that are easy to use, such as image recognition tools. Next steps include engaging with potential partners over the rest of the summer and parsing out some work for working groups. They will begin to dialog with DAARWG this summer on not just the topics, but what the implications of the topics are for data management, curation, and information product needs.

Discussion

Eric Kihn said that it would be interesting for Dr. Grossman and Mr. Lenhardt to do a data call within NOAA because there are some very interesting efforts underway that are applying advanced analytics, though he was not sure how much of it has gotten to operations. Both of these topics are crucial to NOAA and they will need guidance on how to appropriately use crowdsourced data, particularly for Seabed 2030. Data management is also an area where NOAA would benefit from recommendations.

Mike Castellini, Co-Chair of Ecosystems Management Working Group (ESMWG), said that by the November 1 meeting they will have their first report on citizen science, and will share it with SAB members in advance of the meeting. They have been approaching the topic from the biological aspect, not the big data aspect.

Martin Storksdieck said that a National Academy report will be coming out on citizen science soon. There is a lot of work going on at the intersection of how to get good quality data and how to understand people's engagement with it.

Craig McLean said the Board could ask the NOAA Research Council and they would be happy to make a data call and bring back the information on NOAA's use of advanced analytics. NOAA has two things going on in this area: tactical implementation and process studies. The SAB's guidance on additional training at the journeyman levels to understand this and make better use of it would be helpful.

Social Sciences and Decision Support in NOAA

Lynn Scarlett, The Nature Conservancy and Chair, NOAA SAB

Summary

Lynn Scarlett reported that Richard Moss has been steeped in his work supporting the National Climate Assessment, which has a very firm deadline. Once he becomes available, they will regroup on this topic and discuss next steps. Cynthia Decker has provided them with a lot of information on what has been done in the past to evaluate social sciences in NOAA. The next step is to find out what became of those recommendations. The topic is vast, and they will come back at the next meeting with more scope and plans.

Lynn Scarlett thanked everyone for working on these topics. It will be important in the next iteration of this to have the next level of specificity on scope, timeline, and the envisioned product.

Unmanned Systems (UxS): Revolutionizing NOAA Missions RDML Nancy Hann, Deputy Director for Operations and the NOAA Corps

Summary

RDML Nancy Hann provided an overview of how unmanned aerial and marine systems are being developed and applied to meet NOAA airborne and at-sea requirements. There is an Unmanned Aerial System (UAS) Program Office that resides within OAR that is a research arm, but there is currently no operations arm for UAS. Unmanned Marine Systems (UMS) do not have a centralized framework in the agency, nor is there talk of standing up an equivalent center for UMS right now. Having a body within NOAA that oversees the use of UMS to ensure its use is being maximized and meeting requirements would be important. Unmanned Systems (UxSes) support missions across many areas. For NMFS, they assist with stock assessments and marine mammal observations, as well as sonar surveys. For hydrographic surveys, UxSes have been used for gathering multibeam sonar, backscatter, and water column data. For weather and climate science, they are used in helping to understand the genesis of severe weather events and creating track and intensity forecasts. UxSes are largely force multipliers and are not replacing many of the manned systems; NOAA continues to explore the recapitalization of their ships and aircraft. UxSes have expanded surveys into areas where it is not safe to send manned vessels. RDML

Hann discussed several of the UxS types currently being used by NOAA for work across many mission areas. As NOAA looks at the structure of UAS operations in the future, the SAB's recommendations on a balance between corporate assets and field assets would be helpful. UxSes require several things: the development of new enabling technologies, skilled personnel to operate and maintain them, unique infrastructure, and supervision. NOAA will be hosting a symposium on unmanned marine systems later this year. The agency did a data collection survey and assembled a consolidated dataset of inventory and requirements across NOAA. They expect to keep doing this as long as the requirements continue to evolve and the datasets can be made available to the SAB if they are interested.

Discussion

Bob Winokur said he was pleased to hear that NOAA is holding the symposium but said that a whole of NOAA approach is lacking. NOAA is not developing systems; instead, they are early adopters of technologies. In that sense, they have been ahead of other agencies, so the coordination with Department of the Interior (DOI) and the United States Navy is really important. He asked if the SAB could help NOAA with respect to putting together some kind of strategic plan for UxSes. Craig McLean said a strategy was put forward in 2012, designed to help create a funding stream to have a consolidated approach across NOAA. RDML Gallaudet may be getting close to creating an operational component for UMS. Some of the challenges NOAA could use help with include getting more people within the agency that use these systems to participate. Until NOAA has a recognized program with a budget, they will be lacking. He welcomed any critique or contribution the SAB would have for NOAA, and stressed that he is not asking them to write the strategy, but rather identify the challenge that NOAA should be rising to in order for the agency to work more effectively.

Robert Grossman said that the time to do a data science component is at the beginning when lots of these smaller vehicles are coming out. Maybe this could be part of the strategy.

Ed Saade said this is an area of overlapping effort between the SAB and the HSRP. The two panels should explore this as an area for collaboration.

Martin Storksdieck said he was still missing what the barrier to better coordination is. He asked if anyone has systematically looked at all of the experience NOAA already has from utilizing these vehicles in order to gain expertise from within.

Walter Faulconer said strategic planning would fold back into the budget process. He asked if NOAA sees any technological gaps that would be helpful to close to allow them to do more with this capability.

Mr. Winokur said that moving forward with strategic planning is largely about capability/capacity and what is really needed. He did not feel NOAA needs a centralized program. One thing to consider is that NOAA will need a cadre of people who are trained to operate these systems. There also needs to be a public-facing document that says what NOAA is doing with respect to UxSes because a lot of money is going into them.

RDML Hann said that there is an UxS Executive Oversight Board that has a representative from every Line Office. This body is situated to bring issues to a decision. Perhaps, if this board works well, it may be all the management framework that is needed. If UxSes are viewed as operational platforms, should they be part of the Fleet Council and fleet allocation plan?

Mr. McLean said NOAA has not defined the scope of how far they should look in the domain of autonomous gear. The real challenge is how you get these technologies to that transition into operational enterprise. Typically the Line Offices do not have the money to operationalize a new sensor package when they already are short on sea days – Office of Coast Survey is doing a good job of this, a model that should potentially be repeated across other Line Offices. Mr. Winokur noted that it is not just about the platforms, but about the sensors that fly on them and how well the different sensors are integrated. A lot of data is being collected as these systems proliferate, so there is a data management aspect to this as well.

Bob Rheault said there is a role for enforcement with UxSes, noting the large amounts of money spent on restored oysters in the Chesapeake Bay that end up stolen.

Denise Reed said that she didn't hear anything about data management that is unique to UxSes and felt that anything the SAB produces on this topic should be tailored specifically to autonomous system challenges. Bob Winokur said that most of the work being done with these systems is very project-specific, so the data management is done in the context of the project. There is a certain amount of data sharing that people could learn from if the data are shared in a much broader way, including lessons learned. It's possible to collect an inordinate amount of information from these systems. Also, unless the SAB forms a task force to do a deep dive into this, there is not much more that the SAB can do than provide advice on what should go into a strategic plan and then review the plan. Robert Grossman said there is something unique about the data collected by UxSes and it's something that is important from a strategic point of view for NOAA which the SAB can provide some general guidance on. The incremental cost of producing large volumes of data is coming down, and with many different groups collecting data in many different ways, strategically approaching this is essential.

Bob Winokur will meet with RDML Hann, Craig McLean, and others, to iterate on this.

Public Comment

There was no public comment.

July 18, 2018

Welcome

Lynn Scarlett, The Nature Conservancy and Chair, NOAA SAB

Lynn Scarlett welcomed everyone to the second day of the meeting. She announced that this will be Mary Anne Whitcomb's last SAB meeting and thanked her for her incredible support over many years. Members expressed some concern about the amount of information presented during SAB meetings that there is not enough time for discussion. Denise Reed added that some of the information the SAB is presented with seems like a press release version and she would

like NOAA staff to really tell the Board what their challenges are so the SAB can provide meaningful advice. Craig McLean said he was sympathetic to this idea and felt NOAA needs to meet the SAB on that level. Cynthia Decker asked if the Board preferred to not have regional NOAA science presentations at their out of town meetings. Lynn Scarlett said these are useful, but fewer and more focused presentations may be more valuable. Going forward, a draft agenda will be circulated and SAB members will have an opportunity to provide input.

Update on the National Oceanographic Partnership Program (NOPP)

RDML Timothy Gallaudet (USN, ret.), Assistant Secretary of Commerce for Oceans and Atmosphere and Acting NOAA Administrator

Summary

The President's Executive Order (EO) Regarding the Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States refers specifically to NOAA's core missions of observational technologies, forecasting, observations, and preserving and protecting the environment for current and future generations. RDML Gallaudet will be meeting with the White House Office of Science and Technology Policy (OSTP) on August 1 and OSTP is looking for NOAA to take the lead on fulfilling this EO. NOAA has been earning the support of the Department of Commerce (DOC), Congress, and the White House. NOAA wants to reinvigorate the National Oceanographic Partnership Program (NOPP) program by expanding the role for partnerships with the private sector resources, who are taking a big interest in the work NOAA does. In addition to interagency and private sector partnerships, NOPP will include academic and philanthropic partners. Funding for NOPP-solicited activities held steady at around \$15 million between FY15 and FY17. NOPP priorities are open to modification as opportunities are identified, but currently include aquaculture, ocean exploration, marine debris, underwater acoustics, and air-sea interactions.

Discussion

Bob Winokur said a potential partner in the NOPP context is the National Academy of Sciences (NAS), who has a major program in the Gulf of Mexico following up on the Deepwater Horizon oil spill. Given the interest NOAA has in the Gulf, it may be worthwhile to meet with the Academy to see what they are doing with their thirty-year plan. RDML Gallaudet said he had a discussion with Admiral Gaffney on the Loop Current work in the Gulf of Mexico and fully agrees about the potential value of such a partnership. The Gulf of Mexico is an area where NOAA's work overlaps with so many other seemingly competing interests and is a model for balancing interests. He will make a point to meet with NAS. Jean May-Brett said the fall meeting of the board for the Gulf Research Program is scheduled for September 25-26 in the D.C. area.

Lynn Scarlett said she appreciates the emphasis on innovation, but wants to avoid having that be circumscribed to technological innovation. It is important for NOAA to include innovation in processes, particularly decision support and procurement processes, and natural infrastructure. RDML Gallaudet agreed and said that NOAA is pursuing an innovative acquisition approach for ships. Natural infrastructure is important and the agency is doing work in this area. He also discussed other innovative ideas for capturing data in clever ways and said that he would like to see more of this across NOAA.

Martin Storksdieck said these innovations are encouraging, but asked how NOAA is managing conflicting goals and ensuring everyone involved knows where things are going. Partnerships can be a great help or they can frustrate the parties years down the line because the human and institutional dimensions have not been managed. RDML Gallaudet said he is applying two approaches to these partnerships to sustain and reinforce them: active leadership at the highest levels and listening to and advocating for the workforce at the deckplate level.

Finalization of the SAB 2018-1019 Work Plan – Discussion of Topics Proposed in May 2018

Lynn Scarlett, The Nature Conservancy and Chair, NOAA SABRDML Timothy Gallaudet (USN, ret.), Assistant Secretary of Commerce for Oceans and Atmosphere and Acting NOAA Administrator

Summary

The SAB work plan Topic 7 (Evaluating Coastal Sciences) was originally drafted with respect to supporting the blue economy, healthy ecosystems, and future economic resilience. The SAB was then asked to modify this to a two-phase effort where they would first evaluate NOAA coastal sciences in order to assess the current state of play, better understand duplications, gaps, and opportunities for coordination. RDML Gallaudet reassured the group that abandoning the original scope was not the intent, but that the evaluation would be valuable as a predicate to the original conception of Topic 7. Three options have been proposed for approaching this work: (1) narrowly configured to HABs, aquaculture, and water quality across NOAA; (2) these three plus sea level rise and integration of ocean observations across NOAA to identify redundancies and gaps; and (3) looking at the entire coastal science portfolio to identify redundancies and gaps.

Discussion

The SAB was not inclined to go with the most narrowly configured option (option 1). They will need to consider what has already been undertaken by the SAB or other entities and how to proceed regardless of which option they chose. Craig McLean agreed with the SAB that this could become a very broad topic and the timeframe for delivering results to NOAA, given the election cycle, would need to be pretty swift. This may mean that narrowing the scope to redundancy in one or two areas of coastal science is the best choice. NOAA's Ocean Council or Research Council could assist the working group to narrow scope. Mr. McLean suggested focusing on either the coastal observing community or process understanding. RDML Gallaudet said he would like the group to decide on a focus area that identifies ways to improve what NOAA does and how they do it in the near-term as well as what longer term organizational realignment efforts the agency could aim for.

Denise Reed asked for clarification on what is meant by "soon" and said that in order to provide advice on redundancies, it would be extremely important for the objectives to be clearly laid out. The implications of this are significant and need to be done deliberately. A two-day meeting is unlikely to be sufficient for formulating a substantive recommendation from SAB. Mr. McLean said NOAA would only be asking the SAB to review, digest, and offer advice on what they should be working on further and what needs refining, not how it should be done. He commented

that the SAB offers its advice to the Assistant Administrator and if RDML Gallaudet has asked for advice on specific areas that is where they should be turning their attention. Resilience and observations are two areas where NOAA could use the SAB's review for redundancies.

Bob Rheault said looking at the entire coastal science portfolio is well beyond the SAB's ability to tackle. His group of shellfish experts, the Shellfish Breeding Consortium, has spent about eight years looking at how to move this issue forward and it would be a small task for them to come forward with a document describing the state of the art, what needs to be done, and if there are areas of redundancy that could be evaluated. The experts that were involved in the new desk reference compendium on HABs may also be interested in contributing. If the subject were narrowed to specific issues, Dr. Rheault believed a work group with him as lead could produce something in 3-6 months.

Martin Storksdieck said he was still struggling with what exactly the research question is. How this is framed will depend on whether this is going to be a series of sounding board meetings that will inspire NOAA or recommendations on specific things to be implemented.

Steven Thur said three separate line offices are involved in one coastal science aspect, aquaculture, and so there may be redundancies, but it might be more likely that the capabilities and capacities are being used by partnerships across the agency to work on the same issue. It would take some effort to understand how NOAA Line Offices partner internally for a work group to be able to evaluate the agency's capability and capacity. He felt it would be more useful to have the board's recommendations on a narrow topic that is more actionable rather than a broader subject.

Dr. Reed suggested focusing on HABs because it keeps coming up and is more defined and she suggested a process for moving forward. RDML Gallaudet said he would like the SAB to look broadly and felt the SAB could use NOAA's help in defining which areas of coastal science they should explore. Lynn Scarlett suggested that, given the SAB's supportive role for NOAA, they accede to the Assistant Secretary's suggestion. Everette Joseph said that is reasonable, but there has been a lot of work by the SAB and they have developed some definite opinions on how to move forward; providing this perspective to NOAA would be important. Recognition of the work and the expertise of the SAB is important.

NOAA leadership will meet, come back to the SAB with a clearly defined focus taking into account the observations and input the SAB has had over the last several meetings related to this topic (both in terms of content and what is perceived to be achievable), do this in relatively quick order, then the SAB will decide who will be the lead, with what set of people, and move forward from there.

The other already approved items in the work plan and the champions that gave their updates on the previous day of this meeting all are tasked with the next step in their process, which includes developing clear timelines for what they are doing, determining their participation and collaboration, what their work product will be, and providing that back so the SAB. Lynn Scarlett encouraged task groups to amplify their groups with other participants.

Response to NOAA's Science Advisory Board's Review

of the High Arctic Program in NOAA David Kennedy, Senior Advisor for the Arctic Program, NOAA

Summary

NOAA provided its response to the SAB as the agency works to improve and build its Arctic Program internally as well as continue collaborations with external partners. There has been a lot of change since the inception of the program in 2014. As a result, responding to some of the SAB's recommendations is difficult. NOAA's efforts in the Arctic need further improved coordination and enhanced platforms, including fleet replenishments, in order to fulfill the agency's mission and provide international leadership. Mr. Kennedy reviewed five SAB recommendations to NOAA and discussed specifically how the agency has acted on them.

Recommendation 1: NOAA should develop and coordinate, across multiple line offices, a comprehensive, five-year High Arctic Research Program, including both field and modeling efforts.

- NOAA instituted a NOAA Administrative Order (NAO) which lays out a plan to create cross-Line Office coordination including several Headquarter Staff offices with Senior Level leaders on an Executive Committee with the full support of the Assistant Administrator's and Staff Office Directors. The NAO also created a cross-Line Office Action team comprised of high level staff to support cross-Line Office coordination on various requests and necessary feedback as well as providing a mechanism to coordinate information relevant to NOAA's work in the Arctic Region. The NAO created this cross-Line Office Arctic program to coordinate NOAA's efforts in the Arctic but not funding or directive to conduct a program as recommended by the SAB. Currently, the NOAA Arctic Senior Advisor is leading the effort to update NOAA's current Action/Implementation plan and it is slated to be completed by the end of the summer 2018.
- NOAA-OAR-Arctic Research Program would be a foundational piece of this effort, but has been zeroed in the current President's budget.

Recommendation 2: Increased and focused investments are needed in order for NOAA to fulfill its identified responsibilities within national and international observing programs that are the front line of detecting change in the Arctic ecosystem.

- OAR Arctic Research Program plays a critical role in current investments as do other lines. Focus (NOAA, interagency, international) is being developed through current investment in US AON, as well as other lines of efforts within NOAA's Arctic Research Program such as IASOA, DBO, IABP.

Recommendation 3: NOAA should continue to strengthen its international efforts and science-based leadership through the working groups of the Arctic Council, e.g., Circumpolar Biodiversity Monitoring Program (CBMP) and Emergency Prevention, Preparedness & Response Subcommittee (EPPR).

- Support for U.S. scientific leadership in international efforts and the CBMP is provided by several Line Offices and successfully coordinated utilizing the NOAA Arctic Executive Committee as well as the NOAA Arctic Action Team.

Recommendation 4: NOAA should systematically estimate the impact of science partnerships (both in kind efforts and monetary support) through cross-Line Office, U.S. interagency and international partnerships supporting its High Arctic Program.

- NOAA has taken several steps in order to systematically estimate the impact of science partnerships across the Line Offices.

Recommendation 5: NOAA should develop a clearer vision and statement of its strategic role and scientific research activities in the Arctic, both nationally and internationally.

- NOAA has indicated a desire to update its Vision and Strategy as well as NOAA's Arctic Action Plan and will have a draft version by the end of summer, 2018. It will include an emphasis on NOAA's role in supporting national security. NOAA has been meeting with Department of Homeland Security (DHS), Air Force, Navy, and Coast Guard who are all revisiting their strategy, to ensure they are on the same page and share a common language to the extent they can. DHS has called out NOAA as a key partner in their strategy for securing the northern border.

The administration does not currently have an Arctic policy, but there is interest in the Arctic within OSTP and there are a few Arctic activities that NOAA is participating in. An Arctic Science Ministerial (ASM) will be held in Berlin in October. This is strongly supported by OSTP. OSTP has also released a proposal asking agencies to work jointly on an Arctic research project that would demonstrate emerging technology. Budget and resources are very much an issue.

Discussion

RDML Gallaudet said he will be participating in the ASM. The administration has been focusing on other priorities and they are now coming around to the Arctic. If the administration does decide to redo its strategy, NOAA will definitely follow suit. There is a lot of good work going on that could offer many opportunities, particularly for the blue economy. Whether this translates to more funding is to be seen, but given the support in Congress, RDML Gallaudet expects the appropriators to come through.

Mike Castellini said that, while the President's budget has zeroed out OAR for Arctic Research, he hopes that the negotiations will bring some funding back to the programs. He asked what the likelihood is that NOAA would get the funding to pay for its own research rather than relying on others. Craig McLean said that for FY18 and FY19, the OAR Arctic Research Program was zeroed out; for FY20 they are still open for what might be put back in the budget but DOC and OMB (Office of Management and Budget) acceptance is needed for some of RDML Gallaudet's visionary notions for going forward. By various calculations, there is over \$100 million being spent in the Arctic; whether it is being spent as a coordinated program or not is the challenge that Mr. Kennedy faces. Removing \$9 million from the OAR program does not eliminate NOAA's presence in the Arctic. If NOAA doesn't have those funds to invest (particularly for an observing

system) then it would be a question of how to redirect/recharacterize existing dollars being spent in the Arctic in order to make that work. Mr. Kennedy noted that the >\$100 million number may be skewed given that 50% or more of that money is spent on fishery management in the Bering Strait, while the observation components are a pretty small part of the spending. Dr. Castellini said the NMFS work was removed from the discussions in their report.

Susan Avery expressed some concern about the focus being on what NOAA is doing in the Arctic, rather than on what NOAA is doing in the context of what the U.S. is doing in the Arctic. She did not sense that the U.S. has a really integrated research plan for the Arctic. Mr. Kennedy said there is the Interagency Arctic Research Policy Committee (IARPC) that develops an Arctic strategy every five years. A new one was approved as the new administration came in and NOAA was deeply involved in the development of the plan and progress reviews. Lynn Scarlett asked Cynthia Decker to provide a link to SAB members of a summary of the nine components of the IARPC strategy. Mr. Kennedy said the link is publicly available and he would get it to Dr. Decker.

Current NOAA Activities on Aquaculture and Coordination with SAB Work Plan

Bob Rheault said that when the SAB was discussing the blue economy, he thought that the board could review the science involved in aquaculture. He was just made aware that Mike Rust is wrapping up a two-year review of this and is hoping to get a report out by the end of the year. Perhaps the SAB's role will be to comment on that report or incorporate it in their recommendations. This does change the direction Dr. Rheault had intended to take things.

Paul Doremus made some introductory comments to the session. The aquaculture strategy is a central piece to the seafood production and competitiveness component of the blue economy initiative. It has captured a lot of attention in Washington and in the stakeholder community. The U.S. is at a major inflection point on where we stand and what we can do with farmed seafood products in the country. 90% of the seafood consumed in the U.S. is imported and more than half of that is farmed product. NOAA's contribution to the potential growth of aquaculture production includes regulatory streamlining and supporting the adequacy of the nation's science and technology base that the industry needs. He asked that the SAB review the NOAA Science Plan coming out this fall.

Overview of NOAA Aquaculture and NMFS Office of Aquaculture

Jonathan Pennock, Director, NOAA OAR National Sea Grant College Program

Summary

Jonathan Pennock stated that the NOAA National Marine Fisheries Service (NMFS), OAR/National Sea Grant, and National Ocean Service (NOS) National Centers for Coastal Ocean Science (NCCOS) have been working together to deliver the NOAA aquaculture portfolio. NMFS is more involved in the regulatory and management side. The Science Centers are very involved and manage the Saltonstall-Kennedy and SBIR (Small Business Innovation Research) grants. Sea Grant manages the largest of the extramural investment that NOAA makes and also has an extension program that connects industry with university researchers. NCCOS supports one of Sea Grant's laboratories and does a lot of the siting activity that is becoming increasingly important. NOAA's total aquaculture program funding was \$15.394 million in

FY15 and has risen to ~\$32,250,000 for FY18 (~\$20M of which comes from NMFS) but there is significant investment beyond this core number. The Sea Grant Network reported over \$200 million in economic impacts for 2012-15 and ~8,000 jobs created or sustained in the industry as a result of Sea Grant's work. The impact of Saltonstall-Kennedy grants, labs, and SBIR has not been determined, but Dr. Pennock believes it would be just as significant as Sea Grant's metrics. The changing economic, political, and societal drivers make it a timely period to talk about where NOAA needs to be in order to deliver good science to industry and regulators and ensure it is being used optimally. Permitting issues are going to be a significant focus of NMFS work moving forward. This is one of the bottlenecks, and progress needs to be informed with good science. The changing context around aquaculture includes DOC's desire to address the \$15 billion seafood trade deficit, congressional appropriations increases in FY17 and FY18, the introduction of the Aquaculture Bill to Congress, DOC's Aquaculture and Seafood initiative, environmental non-government organizations' interest turning positive, and industry growth. Science is key to increasing sustainable seafood production through aquaculture. There are many aquaculture plans across several federal agencies, industry groups, and others, but there is also a great deal of congruence on what needs to happen. NOAA's guidance documents (Sea Grant's ten-year vision and NOAA's Aquaculture Goals) are aligned and will be informative to the work of the SAB. A year and a half review of the NMFS and NOS Science Centers found that there are productive programs in NOS, Northwest Fisheries Science Center, and Northeast Fisheries Science Center but they are at minimum levels of funding and staffing. Smaller dynamic programs at the Southwest Fisheries Science Center and Alaska Fisheries Science Center need to be encouraged. There are no programs in the Pacific Islands Fisheries Science Center or the Southeastern Fisheries Science Center despite industry need. Key expertise and programing are particularly lacking in economics and social science, as well as animal and plant health (epidemiology and modelling). The report urged NOAA not to decrease funding at NOS, the Northwest or the Northeast Centers to build new programs due to issues of critical mass. The reviewers concluded there is a lack of geographic and topical coverage and the Science Centers are underresourced for their needs. The Strategic Aquaculture Science Plan (SASP) is an effort led by Mike Rust to develop a NOAA vision and strategic plan for research and development.

Office of Oceanic and Atmospheric Research/Sea Grant Program

Jonathan Pennock, Director, NOAA OAR National Sea Grant College Program

Summary

Jonathan Pennock provided an overview of NOAA's integrated aquaculture program as it stands today with particular focus on OAR/Sea Grant and discussed how NOAA's integrated aquaculture program partners can assist the SAB in developing their aquaculture work plan. Sea Grant, the NMFS Aquaculture Program and NOS/NCCOS work closely to deliver NOAA's aquaculture investment. The Sea Grant network includes about 100 place-based aquaculture experts. Sea Grant has a ten-year stakeholder-driven aquaculture vision developed in 2016. Dr. Pennock presented examples of recent research and extension grants, including Enhancing Commercial Sustainability in the Hatchery Production of Eastern Oysters and Clams, pilot-scale grow out of sablefish by the Jamestown S'Klallam Tribe, and Enhancing Peer-to-Peer Learning Opportunities for Southern Oyster Farmers. Sea Grant aquaculture experts train and provide assistance to growers by holding workshops, maintaining online business resources, and offering

legal research on local permitting processes. Dr. Pennock reviewed some recent Sea Grant success stories, including seaweed aquaculture.

National Ocean Service/National Centers for Coastal Ocean Science Programs

Steve Thur, Director, NOAA NOS National Centers for Coastal Ocean Science

Summary

Understanding why NOS is involved in aquaculture will help lead the SAB to offer guidance on the effective deployment of the science support for marine aquaculture. NOS does not have a PPA for aquaculture and contributes far less than NMFS and OAR. NOS views aquaculture no differently than other use of the coastal ocean. NOS has a long history of supporting science-based siting, which is extremely important for sustainable aquaculture expansion. Aquaculture's intersection with ecological forecasting (e.g., HABs and pathogens), environmental interactions (modeling, monitoring, forecasting), and ecosystem Services (e.g. habitat, water quality, C sequestering) make NOS a necessary partner. NOS/NCCOS provides the science that streamlines the regulatory process, providing neutral advice to regulatory and permitting agencies while making those same tools available to industry. An example of this is the Gulf AquaMapper. The second component of what NCCOS provides is environmental modeling. Finfish caged aquaculture, in particular, can have adverse environmental impacts, but if they are sited appropriately the effluent can be diluted to the point where it is not measureable meters from the operation. Wave modeling is another tool that is used to inform siting. DOE is currently the largest source of funding for aquaculture work, which is paying NCCOS to develop an Ocean Reporting Tool. DOE is interested in large-scale offshore aquaculture for energy development. BOEM and the industry are very interested in this tool which will allow lay users to draw a polygon on a map and pull up all of the regulatory and permitting information on that area. Aquaculturists in the Chesapeake Bay are exploring whether their operations can be viewed as a best practice for nutrient removal from the system and therefore be counted in the enumeration of nutrient removal. NOS is the largest funder of HAB and pathogen ecological forecasting in the agency. HABs are a significant issue for aquaculture and NOS is providing advice on where to site shellfish aquaculture so it is in areas that are not prone to HABs.

The NOAA Aquaculture Program's desired outcome is a fully integrated and effective NOAA Aquaculture Program that builds on the strengths of current multi-Line Office efforts to advance domestic aquaculture production. This requires engaging the external research and technology development community on aquaculture, ensuring a robust NOAA laboratory backbone, initiating regional pilot projects with university, federal and industry scientists to address critical science gaps, and enriching workforce training and education.

The NOAA Aquaculture Program's specific requests of the SAB included their review and input on the first draft of SASP in January 2019, assistance in defining the most impactful investments of federal aquaculture funds and efforts to develop the most useful partnerships with industry, and assistance in communicating the role of NOS in aquaculture.

Discussion

RDML Gallaudet said it was his understanding that the Rose Canyon Project spent two years and millions of dollars attempting to do what AquaMapper could do in a day. Steve Thur said this is correct and is one of the reasons they are investing the time and energy to develop the tool.

Craig McLean commended the NOS team for what they are doing and how. It is worth considering how many steps of attenuation other agencies' funding goes through in order to make investments in marine siting, which is clearly in NOAA's authorization. RDML Gallaudet said this is the basis of his meeting with his counterpart in DOE.

Denise Reed asked which fiscal year the NMFS and NOS Science Center report reviewed. Dr. Pennock said FY17 would have been the active budget at the time the report was being drafted. Dr. Reed noted that there would be more funding now than when that committee was reviewing the program. Paul Doremus commented that the major growth has been in the use of certain funding tools for external R&D (research and development); the funding for internal R&D has grown very little. The committee reviewed internal science, not the external programs.

Jean May-Brett said it is known that for every dollar spent on Sea Grant, national and state economies get back a tremendous amount. It doesn't make sense that the President's budget zeroes out Sea Grant funding while the EO mentioned earlier prioritizes all of the work done by Sea Grant. RDML Gallaudet said the last two budgets (FY18 and 19) were a result of there being no political leadership at NOAA and the agency simply being told what to do by OMB and DOC. The FY2020 budget will be different; NOAA's submission to the Department reflects the agency's priorities and is consistent with the priorities of the administration. Paul Doremus said that whenever there is a lot of topline pressure on the budget, there is typically a disproportionately large focus on external grant programs because you can realize fiscal benefits of reductions faster than if you tried to modify more complex programs.

NOAA Marine Fisheries Advisory Committee (MAFAC) Aquaculture Review

Sebastian Belle, Executive Director, Maine Aquaculture Association and Member, NOAA MAFAC

Summary

Two trends are pushing the increase in aquaculture: population growth and the increasing standard of living around the world. This has significant implications for resources and particularly the growing of food. China flipped from being an exporter to being an importer, leading to a phenomenal change in the seafood market. American restaurant chains are looking to invest in domestic aquaculture because they don't think they will be able to outbid the Chinese in terms of sourcing product in the marketplace. Three other trends are also contributing: (1) 87% of the world's aquifers are being pumped in excess of their recharge rates; (2) about 100,000 acres of agricultural land are lost each year to urbanization and rising sea levels; and (3) world reserves of phosphorous at current use rates will run out in 2030. Taken all together, this means that we are coming to a very serious situation when it comes to food supply. Producing foods, particularly animal proteins, in aquatic environments is far more efficient in the use of resources. Yields coming from aquatic animals are much higher than land-based animals. Compared to other animal proteins in the marketplace, the U.S. produces a pathetically small amount of seafood domestically. America has some of the most diverse production methods and species mixes in the world because of the diverse set of ecosystems that we grow in. This means

there are unique and regional challenges, and regionalization should be a key consideration in research discussions. Research is only one part of the development business cycle. Other components that are at least as important in determining how businesses decide how to invest their money include market demand, tech transfer, business support, regulatory climate, and education/training. Competitors in other countries have the benefit of well-funded long-term research programs. Mr. Belle said that the National Strategic Plan for Federal Aquaculture Research from 2014 is a good plan and he does not believe it needs to be redone. From the perspective of the private sector, the role of research beyond regulatory and management concerns includes sparing capital, reducing risk and variability, increasing production efficiency and return on investment, product/method prospecting, innovation, and improving the public's understanding and perception. Industry aquaculture research priorities for 2018 include genetics, animal/plant health and welfare, nutrition, engineering/technology, species assessment, farm/environment interactions, product development, market dynamics and consumer preferences, risk analysis and management, farm/production planning and management, and regulatory costs and duplication. Mr. Belle urged NOAA to engage the private sector as they begin to develop research plans and analyze where assets go.

Discussion

Martin Storksdieck asked why the private sector doesn't just expand production if aquaculture is such a great economic opportunity. Mr. Belle said the U.S. exports very little aquaculture product but typically gets a price premium if it is domestically produced. The problem is essentially regulatory barriers. The industry has struggled with clarity on who the regulatory authority is and when applying for permits in public waters, this dramatically slows down the process. Aquaculture has made good strides in state waters.

Eric Kihn asked if Mr. Belle had any examples of where good science has actually changed public perception in the face of junk science, because they haven't found that to be the case in climate science. Mr. Belle said peer reviewed science has helped them rebut some of the junk science. The challenge is that things are getting through the peer reviewed system that should not be and industry is put in the position of having dueling scientists. Lynn Scarlett said there is a growing body of work on the sociology of science, how people learn and what is conducive to the uptake and embrace of knowledge. She suggested that the issue of social license and science battles is even more complicated than the existence and articulation of the science. This is a topic of keen interest for her work plan topic and there may be some opportunity for spill-over work that is germane to this. Mr. Belle said that there is a lot of this work going on and if the private sector could understand and communicate more with those researchers, industry could learn a lot. The private sector often does a very bad job of communicating.

Cynthia Decker asked how Mr. Belle sees issues like ocean acidification (OA) affecting the aquaculture industry. Mr. Belle said it is a big concern and some of his association's members were the first to raise flags about OA on the east coast. Farm-environment interactions is a very important research topic, not the least of which because those in the aquaculture industry don't control the environment they farm in, and instead have to find ways to farm in synergy with the changing environment.

Denise Reed asked how mobile the infrastructure investments are. Mr. Belle said they would be more mobile if the regulatory climate was easier to navigate. The private sector is trying to figure

out its investment strategy and is just beginning to grapple with the speed of change and what the timeframes are. Possible strategies include not changing locations but changing species, which requires regulatory nimbleness.

Dr. Storksdieck suggested the notion of framing – how consumers think about things changes how the entire system responds to any issue. He asked how farming is being perceived by the public. Mr. Belle agreed with Dr. Doremus' statement that the U.S. is at an inflection point. Public perception has clearly shifted even in the last five years. The National Aquaculture Association is having discussions of how to frame these issues and respond to public perceptions and Mr. Belle will reach out to Martin Storksdieck for further assistance.

Next Steps on Aquaculture in SAB Work Plan

Bob Rheault, Executive Director, East Coast Shellfish Growers Association and Member, NOAA SAB

Discussion

There is clearly an imperative to advance aquaculture production and many of the challenges are related to policy, budget, and sociology, which are all outside of the SAB's bailiwick. NOAA science has been tremendously valuable in helping the industry show that aquaculture will not lead to an ecological catastrophe, as well as helping to develop cleaner ways to produce their products and documenting the ecosystem services associated with some forms of aquaculture. The SAB will be more effective weighing in on the extramural science portfolio that is funded through NOAA since an internal review is already underway. The SAB should comment on the internal review when it is available.

Paul Doremus said that the SAB could be particularly helpful in the broader context of the characterization of needs that they heard from Mr. Belle and others. Given what they have heard about NOAA's Aquaculture Program, the SAB is uniquely capable to take a holistic view of all of these levers available and consider them along with the needs of industry.

Mike Rust provided some background on the internal review and asked for the SAB's help on the science of doing science, particularly with respect to the social science component. He asked the SAB to consider if the agency was doing the science properly as a one-NOAA organization.

Denise Reed asked if the regulatory needs are known. Mr. Rust said yes, and they have good lines of communication with the regulatory community. NOAA has a lot of work to do so that regulators can make objective decisions based on science. Because of Federal Advisory Committee Act (FACA) rules, it is more difficult to get industry input. Dr. Doremus said they could get this information for the SAB and noted that there is a substantial amount of overlap on what the regulatory community needs and what industry is asking for.

Bob Rheault said he felt the task group for Topic 6 is in a holding pattern until the review is available, which is several months away. He suggested they begin to look at the extramural aspects. Lynn Scarlett suggested undertaking other items in the interim, including those requested during the previous discussions. She suggested Dr. Rheault meet with NOAA to explore what they could undertake that would be constructive.

Jonathan Pennock said that an important step will be integrating the findings of the internal report with the findings of the SAB's review of the extramural portfolio.

Mike Donahue asked if the invitation from NOAA is only to comment on the draft once it is completed or if the SAB would have the opportunity to contribute to the development of the draft. Dr. Doremus said he would like to integrate the SAB's contribution along the way so the report reflects their perspectives. Mr. Rust said that the draft that will be available in January will be a very early version. There will be an opportunity to comment on terms of reference, the outline, and other elements sooner, but there will be plenty of holes to fill when it is released in January.

Dr. Rheault asked if anyone else on the SAB wanted to join the task force or had suggestions for domain experts that could be useful. Dr. Pennock said a member of Sea Grant's advisory board should participate in order to connect internally to this effort. Dr. Reed said that, to the extent there is any consideration of the transportation and onshore infrastructure needed to support this industry in 20-30 years, she would be happy to participate.

Lynn Scarlett said that making people aware of NOS and its relevance to aquaculture is important to the work on regulatory feed for "tools for rules" as well as resiliency, because one of the questions is whether the spatial planning and tools are anticipatory of future conditions. Steven Thur said that the tools are envisioned to be current data but they have discussed whether they could include forecasting elements once they are set up. The challenge with this is that there isn't a consistently available data source with that kind of model output. NOAA has looked at how this could be done on a regional basis and had discussions with permitting entities about longer term reviews, but it is not currently in the plan. Lynn Scarlett said this is an area where the SAB might be helpful, to consider what is needed and what it might look like with a future orientation. Bob Rheault said that 15-year predictions are way down the list of concerns for aquaculture farmers and there may be more pressing issues that NOAA could address. There is also a lot of uncertainty around the predictions on sea level rise and when projections keep changing, it shatters the industry's confidence in the people providing the advice.

Dr. Rheault is happy to engage with NOAA to figure out how to be most useful. Once that is done, the SAB would like him to lay out a timeline and set of actions that he would envision his team undertaking.

Next Steps on SAB Work Plan Topics and Plans for Next Meeting

Lynn Scarlett, The Nature Conservancy and Chair, NOAA SAB

Summary

Work plan topic champions need to own their task and take the next steps discussed during the updates, specifically to identify clearly what their actions are, what their deliverables are, what their timeline is, what methods they propose, and who their partners are. Lynn Scarlett will work with NOAA to create a sample template that will be sent out to each of the champions that indicates the type of information that the SAB needs clarified.

Discussion

Denise Reed asked if Cynthia Decker is the venue for questions about resources or support for this work, such as travel resources for bringing in an expert. Lynn Scarlett said Dr. Decker is the contact and has been a very good conduit for setting up meetings and suggesting who to meet with.

Robert Grossman asked if there was someone in NOAA that wanted to be their primary point of contact for advanced analytic data science. Craig McLean said NOAA staff will identify a liaison for each of the task groups and reach out to the champions with their contact information.

Discussion on Work Plan Topic 9 – New Technologies for Fisheries Stock Assessments

RDML Gallaudet said that NMFS is innovating all around and would like the SAB to comment on what the optimal focus area is for the suite of technologies to do sampling, surveying, and assessment. He specifically wanted their insight on the right mix, best organizational approach, and what provides the most opportunity. It is a broad area, but there are many scientific and technology opportunities to improve stock assessments.

Mike Castellini said that, from his discussions with Cisco Werner, his idea is that NOAA would provide to ESMWG a suite of reports and documents on what technologies they are using and what the programs are doing. The working group would review that, pull in specialists as necessary, and be able to produce something very quickly if what they are looking at is in terms of coordination and specific questions about future of stock assessments. They would also address how ecosystem issues are being balanced. Dr. Werner is ready to do this if the SAB agrees with the way forward. RDML Gallaudet said he would value the SAB's support in thinking about all of the next generation technologies. Bob Winokur said that he was on an independent review team that took a brief look at this in the fleet plan review. Lynn Scarlett said that one of the proposals for this topic is that the ESMWG would take this on and provide their findings back to the SAB. If the SAB agrees that this is the best way to proceed, they want to be sure that they utilize the work of the independent review team. Bob Grossman asked that he be kept in the loop since this is relevant to Topic 4.

Review of Actions

Cynthia J. Decker, Executive Director, SAB and Designated Federal Official

Dr. Decker reviewed the actions from the meeting, including:

- Each of the champions will develop a plan, which will include their deliverables, timeline, and who will be involved. Lynn will work with the NOAA SAB staff to develop a template to help with this.
- All of the champions will meet with NOAA liaisons to further refine their plans.
- Cynthia Decker will send SAB members the link to IARPC's research plan.
- NOAA will provide further information on "tools for rules."
- The execution of Topic 9 will be handed over to ESMWG who will work with NMFS and other Line Offices as appropriate.
- NOAA will provide the scope of areas of interest for Topic 7 back to the SAB.
- Bob Rheault will meet with NOAA to determine how to be most constructive in regards to the strategic plan coming out in January and what can be done in the interim.

- NOAA SAB staff will work with the Sea Grant advisory board to identify one of their members to work on the aquaculture topic.

The next SAB meeting will be November 1-2, 2018, in the Washington, D.C. area. There is also the prospect of meeting earlier telephonically if a topic group feels the need to dialog with the SAB, though this would not be a decisional meeting.

Adjourn

The meeting was adjourned at 12:57 p.m.