NOAA SCIENCE ADVISORY BOARD

2018-2019 Work Plan

INTRODUCTION

In 2016, the NOAA Science Advisory Board (SAB) developed a Concept of Operations. As part of this document, the SAB and NOAA agreed that every two years in conjunction with the renewal of the SAB Charter, a work plan should be developed, based on the agency's mission and priorities and grounded in research and development plans of the agency, line offices, and program levels, as appropriate. This plan is the first such biennial work plan to be developed.

NOAA MISSION

Science, Service and Stewardship

1. To understand and predict changes in climate, weather, oceans and coasts;
2. To share that knowledge and information with others; and
3. To conserve and manage coastal and marine ecosystems and resources.

NOAA PRIORITIES

1. Reduce the impacts of extreme weather and water events
2. Increase the sustainable economic contributions of our fishery and ocean resources (blue economy)

SAB ROLE

The SAB may serve different roles in providing advice to NOAA.

- It may serve as a "think tank" to give high-level thoughts on "blue sky" or "over the horizon" topics that are just emerging in science or society.
- It may delve into specific topics that cut across all or much of the agency and require in-depth consideration.
- It may react quickly to issues that come up on an *ad hoc* basis and due to unforeseen circumstances.

Each of these situations may require different interactions with NOAA, use of different member structures and processes, and varying types of "products" to address them. This work plan covers short-term topics of interest and several that will require more in-depth analysis over the next 18 months. Issues that arise in the third (*ad hoc)* category will be addressed as they arise.

The SAB, in the past, created working groups (WGs) consisting of additional experts to address ongoing issues (standing WGs) and short-term questions raised by NOAA (*ad hoc* task forces). The SAB Work Plan is not intended to preclude such options, but they should be used to enhance the ability of the SAB to provide NOAA with the best advice possible. The SAB may determine that delivery of some elements of the workplan may best be generated by a WG, or significantly informed by inputs from WGs. For example, work proposed by the Environmental Information Services Working Group (EISWG) under Priority 1 illustrates this sort of approach.

NEXT STEPS

To develop a set of potential projects, the SAB convened two subgroups, one for each priority area, to further develop work plan options for those priority areas. They reviewed the draft document, refined, revised and/or added to those topics identified in each of the two priority areas, reflecting on NOAA priorities, topics raised by members, and ideas coming from SAB working groups. The subgroup(s) formulated a set of potential projects for the SAB with appropriate timeframes, level and types of expertise needed, and a notional plan for addressing each one.

Topics discussed with RDML Tim Gallaudet included ocean exploration, the water cycle, aquaculture, autonomous systems, and decision support, but there could be others within the context of the NOAA priorities.

NOAA PRIORITIES—WORKPLAN OPTIONS

PRIORITY 1:* *REDUCE THE IMPACTS OF EXTREME WEATHER AND WATER EVENTS.

- **Oversee Development and Implementation of the Environmental Information Services Working Group Work (list from WRFIA):**

The Environmental Information and Science Working Group was established by the SAB in 2009 and made permanent by provisions in the Weather Research and Forecasting Improvement Act of 2017 (Public Law 115-25), hereafter referred to as WRFIA. The primary task of the WRFIA is to reduce the impacts of extreme weather and water events to save lives and protect property. The WRFIA specifies certain activities where the EISWG is to advise and assist NOAA line offices in meeting the terms of the Act. These include to:

1) prioritize weather and climate research and development initiatives in NOAA
2) advise on existing or emerging technologies from the private sector and academia for better monitoring and analysis of weather and climate events and improved weather and climate forecasting:

    - Earth system (ES) modeling. ES prediction capability, coupling, data assimilation, computation. Elements of modeling. Current focus on the dynamic core: what should the priorities be after that? What is the next missing key element(s) (e.g., different physics implementations)?
3) Observing component: how to apply new technologies (such as improved data assimilation) for a more comprehensive and cost-effective local, regional, national, and global weather and climate monitoring system; advise enhanced communication between NOAA weather forecasters and decision; makers at national, state, and local levels, e.g., city and county emergency managers
4) enable improved communication among NOAA, the private sector, and academia.

The EISWG is talking with the National Weather Service (NWS), Ocean and Atmospheric Research (OAR), and National Environmental Satellite, Data and Information Service (NESDIS) to address these topics. The NWS has asked for advice on how to include the academic and commercial weather communities to address the challenges of improving weather and climate monitoring, analysis, and forecasting and the innovations needed for such improvements. The EISWG is prepared to respond to OAR's call for advice on how better to position itself to prioritize its research and development efforts in this context. Because this is such a large and potentially daunting task, the EISWG has asked the line offices to provide it with their best options to which the WG can react in a timely and specific way.

In addition to the above, the EISWG is responsible for assisting NOAA (via reports and recommendations passed through the SAB) with reviewing and updating policies for interacting with the private sector (i.e., the partnership policy).

Oversight of the EISWG's work is a HIGH priority activity that will be ongoing. The SAB will implement this by supplementing the SAB liaison with additional members of the SAB who will meet with the EISWG co-chairs on a regular basis by teleconference/webinar. In addition, EISWG will provide verbal updates on its activities at in-person SAB meetings.

- **Review the Use of Observing System Simulation Experiments (OSSEs)**

An OSSE is a modeling experiment used to evaluate the impact of new observing systems on operational forecasts when actual observational data are not available. OSSEs are done: 1) to find out if a new observing system will add value to NWP analyses and forecasts; 2) to make design decisions for a new observing system; and 3) to investigate the behavior of data assimilation systems in an environment where the system's behavior is known (paraphrased from Prive & Errico PPT, 2015). NOAA uses OSSEs in many of its programs for a number of purposes related to its observing and modeling activities. The SAB will refer this topic to the EISWG as well; it would fit under their mandate from the WRFIA.

This is a LOW to MEDIUM priority topic that will take 6-12 months to complete with the help of additional experts consulted by EISWG (external and internal to the agency).

- **Social Sciences and Decision Support in NOAA**

In July of 2015, the NOAA Social Science Committee released Vision and Strategy: Supporting NOAA's Mission with Social Science, a document that set the agency's social science vision and strategy for the next 3-5 years. The document provides opportunities to align office and program efforts with the goals, objectives, and strategies outlined within. Some examples of NOAA social science programs aimed at presenting NOAA data and information tools in a usable format to both private and public partners include: Weather-Ready Nation Ambassadors Program; Impact-Based Decision Support Services (IDSS); SKYWARN Storm Spotter Program; Storm Surge Program; and the Climate Program Office Communication and Education Program (CommEd).

Given all of NOAA's Social Science programs, what criteria does NOAA use to evaluate these programs to make sure each program meets the Social Science Vision and Strategy goal to strength societal decision-making? Are any goals missing from the initial three goals set by NOAA? How can NOAA evaluate each goal? Are there areas of social science not addressed in the document? The SAB can review one of NOAA's Social Science programs to see how it meets the goals set forth by the Social Science Vision and Strategy document. The SAB can also provide comments for consideration on the next iteration of the Vision and Strategy: Supporting NOAA's Mission with Social Science document.

- *Assess NOAA Social Sciences Projects* (from Monica Grasso and NOAA Social Sciences Committee).

Per the request from the NOAA Chief Economist Monica Grasso at the SAB meeting in October 2017, the SAB will review these projects and provide comments. (Timeframe determined by completion of reports but likely 3-6 months after that).

1) Cooperative Research and Development Agreements (CRADA) Economic Impact Study
2) Economic Value of Marine Vessel Observations
3) Economic Impact of Space Weather

- *Enhance Use of Decision Support Products, Processes, and Tools for NOAA Social Science Projects*

The SAB can recommend what science is needed in order to enhance, develop, and facilitate effective use of the basic products; create a robust process for working with academia, the commercial sectors, and others to develop what is needed; engage with decision support tool users and related stakeholders to identify needs, test products and iterate on tools and systems;

and develop an evaluation protocol that is embedded as an ongoing process within the spiral creation of the products and tools. Specific projects could include machine learning and working with the Social Sciences Committee to evaluate their progress on the Mission and Strategic Vision. Enhancing the relevance and utility of decision support tools involves technical, scientific, and communications expertise, as well as understanding the processes and ways in which users frame problems, define needs and use information.

- **Review Improving Collection, Management, Dissemination and Decision Support Using Machine Learning, AI and Data Science**

While NOAA has expanded its observing and prediction systems, it also needs to continue improving its ways of collecting, managing, and disseminating data to respond to changing science and technology. These data are coming in not only from the satellites and the variety of platforms and sensors that are already deployed but also from new sources, including the analyses of physical samples, e.g. 'omics, and from social science sources such as analysis of economic and human decision-making behavior. NOAA needs to explore ways of integrating all these data. In addition, the use of: 1) citizen science to enhance a shrinking workforce and; 2) advanced analytics, e.g. machine learning and AI techniques, to increase the speed and efficiency of processing the data should be considered as well. Technology drivers include distributed computing trends, cloud technologies, and new computing architectures. More broadly, NOAA should also pay attention to the emerging discipline of data science and its applications to domains of interest relevant to NOAA. These considerations will apply across both of the NOAA priorities.

With all of the recent advances in machine learning and AI, it is timely to review whether these technologies can help NOAA when creating tools for decision makers in the fisheries, ecosystems, climate, weather, and other oceanic and atmospheric discipline areas. What kinds of research should NOAA do to be able to incorporate machine learning into its decision-support services and tools? What kinds of data, data sets, and technology are needed for NOAA to engage with machine learning tools? An example of the relevance of this type of technology is the Weather Company, an IBM business, and the National Center for Atmospheric Research (NCAR) recently formed a partnership to enhance the weather and climate prediction capabilities of IBM's Watson. More broadly, if data gathering and analysis about fisheries, ecosystems, climate, weather, and other oceanic and atmospheric information is thought of as *environmental intelligence*, how can data science, machine learning and AI, advance NOAA's production and delivery of environmental intelligence to improve public-sector management and private-sector decision-making and result in improved outcomes for the citizens of the U.S?

This is a HIGH priority item that will take 6-8 months to complete and will use existing expertise on the SAB and its standing working groups.

- **Enhance Strategic Investment and Use of Unmanned and Autonomous Systems**

NOAA has a broad set of observing requirements to address its operational and research missions. Unmanned and autonomous systems (exclusive of satellites) have become an important element in augmenting traditional approaches to collecting environmental data, including weather, coastal, marine and polar observations. Underwater, surface and aerial versions of these systems have already been incorporated into many of NOAA's observing systems. The recent expansion and application of these systems and their sensor payloads have been particularly successful in addressing various NOAA Earth System and Weather Prediction observational needs. For example, unmanned aerial systems, such the Global Hawk, have been used to collect data to support forecast of high impact weather and respond to major natural and environmental disasters.

NOAA has been a leader in the application of unmanned systems and technologies in challenging environments: however, NOAA seemingly lacks and overall strategy for the cross-cutting use of unmanned systems. While there are numerous important applications of autonomous systems across the agency, it is not clear there is a coherent agency-wide rational for investments, priorities and partnerships in these systems. Each line office has its own rationale and specific priorities for investments in unmanned systems. While these investments have been important and addressed key needs in each line office, an overall strategy could further enhance investments and applications of unmanned/autonomous systems, and could identify efficiencies and eliminate redundancies, especially in times of constrained funding. As an example, a subset of an overall strategy could be the enhanced application of unmanned aerial systems for data collection and observations related to forecasts of high-impact weather, which could be an element of an observing system strategy identified in the WRFIA. There are numerous other applications in the marine and polar environments as well.

This is a HIGH priority item that should take 6-8 months to produce a brief report. The SAB could address either by forming a subcommittee supplemented with some experts or by handing this off to a task force created to address this.

PRIORITY 2: INCREASE THE SUSTAINABLE ECONOMIC CONTRIBUTIONS OF OUR FISHERY AND OCEAN RESOURCES (BLUE ECONOMY)

I. Overview

A comprehensive understanding of the ecological and economic contributions of our nation’s coasts and oceans includes, but goes beyond, extraction-focused considerations. This is

illustrated by the six sectors typically used in assessments of the US ocean and Great Lakes economies: living resources; marine construction; marine transportation; offshore mineral extraction; ship and boat building; and tourism and recreation. Currently, NOAA's Office for Coastal Management, using data from the Bureau of Labor Statistics and Bureau of Economic Analysis, annually values the ocean economy with "Economics: NOAA Ocean Watch (ENOW)", an online tool used to streamline the task of obtaining and comparing economic data, both county and national, for these six sectors dependent on the ocean and Great Lakes. ENOW's annual time-series data are produced for 400 coastal counties, 30 coastal states, eight regions, and the nation. Thus, tools are in place to track economic contributions – an important context for NOAA's work to see increases in this area.

II. Science Advisory Board Focus

The SAB will develop science-based concepts and recommendations to support NOAA in the enhancement of the ecological and economic contributions of coastal and ocean resources and coastal communities and their sustainability by focusing on several critical, related areas: 1) coastal and marine aquaculture; 2) long-term and large scale ecosystem restoration activities, and 3) coastal and marine transportation and support infrastructure, including working waterfronts. In so doing, The SAB will be in a position to answer such questions as "How might NOAA research best support the industries reliant on a sustainable fishery?", "What scientific research can NOAA undertake to support sustainable development of marine aquaculture?", "How do large scale ecosystem restoration activities undertaken by NOAA, contribute to sustainable economies?", and "What can NOAA provide to support marine transportation needs to ensure sustainable coastal communities?"

1. *Sustainable Marine Aquaculture*

Diminishing the gap in imports of fish to the US is a priority for the Secretary of Commerce. NOAA's Marine Fisheries Advisory Committee (MAFAC) has prepared several reports on this topic in the recent past. The MAFAC work has focused on topics related to management of fisheries and management of aquaculture, such as data and science-based decision making and the regulatory and business environment. However, the science and technology aspects of the import gap have yet to be explored in depth. The SAB will address these unmet needs, working in conjunction with the MAFAC, National Sea Grant Advisory Board and other entities, as appropriate.

2. *Benefits of Long-term and Large-scale Ecosystem Restoration*

Building upon its previous ecosystem restoration work (with a short-term focus), the SAB will focus on the long-term protection and restoration of large coastal and marine ecosystems in the context of sustainable coastal and marine economies. Toward that end, numerous questions must be addressed, such as "What is the state of our knowledge regarding ecosystem restoration, and how do we best determine benefits to society?", "How does one set and quantify large-scale

ecosystem restoration goals (e.g., scale, attributes)?" and "How can we best prepare for and adapt to changes in environmental conditions and potential disturbances?" The SAB will address these and related questions in the interest of providing NOAA with science-based advice to guide its ecosystem restoration efforts and support its goal.

3. *Coastal and Marine Transportation and Support Infrastructure*

US ports and harbors support all sectors of the marine economy. NOAA's role in supporting coastal and marine commerce is spread across the agency from weather forecast and hydrographic survey to sea-level rise projections and fisheries management, among others, with ports and harbors being an area where many of these interests intersect. The SAB will address such questions as "How can emerging technology be used by NOAA to integrate information to address immediate needs such as navigation and emergency response, as well as long-term planning for coastal communities that enables continued economic development in the face of global change?", and "How can we better project future infrastructure and port access needs of the marine transportation in the context of the fisheries and aquaculture industries?"

III. Methodology

The SAB will address this topic through a five step methodology culminating in a concise report and set of science-based recommendations for consideration by NOAA. These steps are as follows:

1. *Project Organization and Scoping:* The SAB will assign a Task Force to prepare a detailed scope of work in consultation with NOAA leadership. In addition to the SAB, this could include members from MAFAC, the National Sea Grant Advisory Board, the Hydrographic Services Review Panel and other entities, as appropriate. The scoping process will include an explicit statement of project goals and objectives, as well as approach, timeline and deliverables. The Task Force will be supported by NOAA staff from various line offices (Months 1-2)

2. *Literature and Data Gathering and Analysis*: The Task Force, with the help of NOAA staff, will identify and review key recent publications, reports and documents that inform the focus areas. This effort will focus in parallel across the three focus areas. For each, recommendations or key findings of existing studies and reports will be compiled to provide context for the work of the SAB. In addition, the Work Group will seek to identify as yet unconsidered cross-walk issues among the focus areas that could be an additional focus of SAB attention. The material reviewed will include, but not be limited to, work previously completed by the SAB and others, including, for example:

- *May 2014: SAB Report on Restoration of Coastal Habitats*

- *August 2016: SAB Issue Paper on "Potential Impact on NOAA of Emerging Genetic Technologies*
- *November 2016: SAB Report on Emerging Technologies for NOAA Ocean Research, Operations and Management in an Ecosystem Context (Ecosystem Sciences and Management Working Group).*
- *December 2012: Marine Fisheries Advisory Committee: Vision 2020 (v2.0) Charting a Vision for Marine Fisheries.*

Review of these papers will be augmented by an in-depth examination of emerging technology (e.g., robotics, 'omics, advanced and miniaturized sensors, and informatics) that are increasingly critical for NOAA and other agencies operating in the marine environment. These technologies have the potential to enhance efficiencies in the use of large infrastructure assets, increase coverage in time and space, and result in cost-savings. (Months 2-4)

3. *Expert Consultations*: The Task Force will convene three expert consultations; "by-invitation" workshops featuring presentations and facilitated discussion focused specifically on the project goals and objectives. These will be focused on the marine aquaculture, long-term ecosystem restoration, and marine transportation in the context of a sustainable coastal economy. The first goals will be to address a shared understanding of the state of the science and the identification of unmet needs. The second goal will be to develop science-based advice drawn from the outcomes of the first goal. Outcomes will be incorporated into the project final report and associated advice/recommendations to NOAA. (Months 5-8)

4. *Report Development and Review*: Outcomes of the literature review, data/information analysis and expert workshops will be incorporated into a draft report and series of science-based recommendations. A draft report outline (with estimated length of the various sections) will be shared with the SAB in the early stages of the project (and refined on an ongoing basis) in the interest of ensuring that all parties have a shared understanding of content. An initial draft will be shared with the SAB for review and comment. (Months 7-10)

5. *Report Refinement and Presentation*: Comments received from the SAB (and other parties, as appropriate) will be considered/incorporated as the draft report is finalized. It will then be presented to the SAB and NOAA leadership, with an emphasis on science-based advice and recommendations. Toward that end, the report will include a concise Executive Summary that highlights advice and recommendations. (Months 10-12)

IV. Timeline:

The project will be completed in a 12 month time frame, as noted in the preceding section.