

Report of the External Review Panel for the Northern Gulf Institute



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Summary

An external science review of the research, education, and outreach programs of the Northern Gulf Institute (NGI) based at Mississippi State University (MSU) was conducted virtually on 11-12 May 2020. The Northern Gulf Institute was established as a NOAA Cooperative Institute (CI) in October of 2006 as a regional enterprise joining Mississippi State University, the University of Southern Mississippi, Louisiana State University, Florida State University, and the Dauphin Island Sea Lab to focus on major issues affecting the northern Gulf of Mexico. The University of Alabama Huntsville was invited to join NGI in 2016 in competing for a new award. MSU is the lead university. The scientific vision for NGI is to provide research-driven transformations in regional ecosystem-based management (EBM) that enables managers and communities to improve the resilience and health of ecosystems that will sustain the economies of people in the Gulf of Mexico.

The panel report described many impressive aspects of NGI. Some of the key observations and findings include:

- The NGI research portfolio shows strong fidelity to its vision, particularly for its alignment with NOAA decision making priorities in storm prediction, ecosystem-based fishery management, and coastal habitat quality.
- The Cooperative Agreement is an important mechanism to ensure that cutting edge expertise among NGI academic partners are adding value to how NOAA implements its mission.
- The scientific work of NGI is high quality, topical and strongly linked to the NOAA mission and NGI is poised to contribute to several of NOAA’s Science and Technology Focus Areas.
- The NGI is “hitting its stride” in terms of striking the balance between support for NOAA’s operational needs and forward-looking research, but also identifies the need for continued vigilance in nurturing this balance.
- The social science investments made by the NGI are timely and relevant considering the hazards facing the Gulf of Mexico region.
- The panel commends NGI for playing a leadership role in serving the educational needs of underserved communities.
- The Panel observed that NGI has been responsive to new opportunities to apply their work in many instances.
- Developing metrics to quantify diversity goals and outcomes would provide NGI important information to demonstrate its impact on local communities and regional economies.
- The current leadership structure of NGI with a Director and three Associate Directors, with varied research backgrounds and interests, is well suited to guide the CI forward.

Overall, the Panel agrees that NGI is worthy of a rating of **Outstanding** and has consistently demonstrated achievement of agreed goals, making NGI an on-going resource commitment that enhances NOAA’s resources to support collaborative research.

To further the work of NGI moving forward, the Panel offers the following recommendations:

- 1. The NGI leadership should continue to be vigilant in encouraging engagement from its academic partners and enabling the embedded NGI scientific staff to influence the implementation of the NGI science mission. The review panel views this as an important linchpin in terms of NGI adding value to the NOAA mission.***

- 2. Additional metrics should be developed that highlight the effectiveness and application of NGI research and development, e.g., citations, joint publications with NOAA researchers, application of results in NOAA operations, use by other agencies (e.g., models, model results, data sets, measurement methods, training workshops).**
- 3. NGI leaders should continue to focus on integration of climate and global change into new project development.**
- 4. The NGI should position itself to further the vision of regional ecosystem-based management through direct contributions to NOAA EBM efforts, as well as EBM-specific outreach to external partners.**
- 5. The NGI should be proactive in promoting awareness of the Institute's expertise and increase their influence on how the NOAA science mission is implemented.**
- 6. The NGI should develop education and outreach metrics to track over time to determine the overall impact of the education and outreach program.**
- 7. The NGI should undertake focused engagement with potential end users of NGI products outside of NOAA (e.g., other agencies, private sector, municipalities) to identify priority stakeholder needs and justify additional investments necessary to fully address the stakeholder defined topics.**
- 8. Metrics should be developed to quantify diversity goals and outcomes that would provide NGI important information to demonstrate its impact on local communities and regional economies.**

Introduction

An external review of the research, education, and outreach programs of the Northern Gulf Institute (NGI) based at Mississippi State University (MSU) was conducted virtually on 11-12 May 2020. Guidance for conducting the review was provided by the Cooperative Institute Program Office within the National Oceanic and Atmospheric Administration (NOAA) Office of Oceanic and Atmospheric Research (OAR). The review was conducted under the auspices of the NOAA Science Advisory Board (SAB). A list of review panel members is provided in Appendix I. The agenda for the review panel's virtual meeting is provided in Appendix II.

The NGI was established as a NOAA Cooperative Institute (CI) in October of 2006 as a regional enterprise joining Mississippi State University (lead university), the University of Southern Mississippi, Louisiana State University, Florida State University, and the Dauphin Island Sea Laboratory (the State of Alabama's marine sciences institute) to focus on major issues affecting the Northern Gulf Coast. The University of Alabama Huntsville was invited to join NGI in 2016, when the consortium competed for a new award.

The NGI consortium of universities are geographically distributed and collectively bring broad expertise to the NOAA partnership. The NGI focuses on four major scientific and societal issues of importance to NOAA: Climate Change and Climate Variability Effects on Regional Ecosystems, Coastal Hazards, Ecosystem Management, and Effective and Efficient Data Management Systems Supporting a Data-driven Economy. Although the original focus was the northern Gulf of Mexico (GOM) this has been expanded to the whole Gulf of Mexico. The NGI is not co-located with an OAR laboratory but works closely with OAR's Atlantic Oceanographic and Meteorological Laboratory (AOML). At the time of the review, including funding under the CI award, competitive awards, and non-competitive awards, NGI has received \$76M to assist in NOAA's research and service enterprise since July 2016.

This review report is structured around the four sections required by the SAB: 1) strategic plan; 2) science review; 3) education/outreach; and 4) science management. A specific set of questions under each section is also provided and the NGI team provided background information organized around these questions. This report does not address each of the questions directly, rather the focus here is on findings and recommendations that were deemed most important and relevant by the review panel.

Strategic Plan

Vision and Mission

The scientific vision for the institute is to provide research-driven transformations in regional ecosystem-based management that enables managers and communities to improve the resilience and health of ecosystems that will sustain the economies of people in the Gulf of Mexico. The science must be top quality, credible, reliable, and respected. It should be validated through peer review, yet it should be timely so it can inform policy and decisions in weather, climate, hydrology, and coastal issues. This vision was clearly stated in the NGI scientific plan and clearly linked to NOAA priorities. This vision sets up the NGI research activities to be integrated across disciplines, closely linked to ongoing NOAA needs, and directly applicable to decision making. ***The NGI research portfolio shows strong fidelity to the vision, particularly for its alignment with NOAA decision making priorities in storm prediction, ecosystem-based fishery management, and coastal habitat quality.*** There is an emphasis on application-oriented research at NGI centered on improvement of data availability through

development of remote sensing and unmanned technology and improvement of existing forecasting platforms. The latter is particularly focused on integration of issues across disciplines through the inclusion of novel data in forecasting storms and other extreme events. This includes a strong commitment to capacity building, communication, and workforce training.

Importance to NOAA

The review panel was given detailed presentations of NGI's collaboration with the NOAA scientists at the National Centers for Environmental Information (NCEI). The review panel engaged in detailed discussions with NGI leadership on how the collaboration functions in practice. The NCEI – NGI collaboration is largely rooted in NGI scientists embedded with NCEI federal scientists at the NASA's Stennis Space Center (SSC). The NGI facilities at SSC are focused in a single building shared between MSU and NOAA National Environmental Satellite, Data, and Information Service (NESDIS) NCEI scientists. This shared building is adjacent to the University of Southern Mississippi's (USM) Marine Science complex and is an ideal rallying point for robust collaboration.

The mission of the Cooperative Agreement (CA) between NGI and NCEI is to develop environmental information products and services that serve the needs of scientists, managers, and the public in general. Overall, the review panel found that collaboration is working well, and noted several successful projects where NGI scientific expertise not only informed the research mission, but served to shape how the mission is implemented (e.g., oxygen dynamics in the global ocean, hypoxia trends on the Northern Gulf of Mexico Shelf). In the collaboration, NGI leadership emphasized the importance of developing new data sets and analytical tools but such development needs to also yield scientific publication. The review panel agreed with the need to ensure peer-reviewed publication of the data sets and tools and that publication is particularly important for young scientists developing their career trajectories.

The review panel noted that the Cooperative Agreement is an important mechanism to ensure that cutting edge expertise among NGI academic partners is adding value to how NOAA implements its mission. The review panel applauds NGI's efforts in this regard and offers the following recommendation:

Recommendation 1. The NGI leadership should continue to be vigilant in encouraging engagement from its academic partners and enabling the embedded NGI scientific staff to influence the implementation of the NGI science mission. The review panel views this as an important linchpin in terms of NGI adding value to the NOAA mission.

The scientific work of NGI is strongly linked to the NOAA mission. Research conducted under the four scientific themes supports both NOAA and society. NGI presented their work in relation to the 2010 NOAA Next Generation Strategic Plan (NGSP); the work of NGI continues to be relevant to NOAA missions of science, service, and stewardship. The four scientific themes mesh well with the NGSP long-term goals. The panel was presented with examples of recent and ongoing work related to coastal hazards, ecosystem management, and data management systems that are all active and relevant areas for NOAA. Less work was presented directly related to climate change and this theme seems to be pursued more indirectly than others (see discussion under Science Review). From understanding weather-related hazards and how that is communicated to the public, including those with physical disabilities, to work on sawfish movement that can be used in fisheries management, there are many examples of how the work of NGI scientists intersects directly with the NOAA mission. However, in only

a few cases, is the broader impact to society of NGI's work obvious. Members of the review panel could understand the utility of much of the work, but it was often unclear whether end users were directly involved in shaping or guiding the research and how the path from research to operations was being pursued. NOAA conducts research to serve the Nation's businesses, communities, and people, and a greater emphasis on stakeholder engagement would benefit NGI and NOAA in ensuring more of their products are timely and relevant to NOAA's diverse user groups (see Recommendation 6 below).

Measuring Progress

Performance of NGI science is tracked mainly through peer reviewed publications. NGI researchers are very productive, publishing research and development (R&D) results through technical journals, conference presentations, seminars/keynotes, and reports. Some of the journals are very high quality (including Nature, J. Geophysical Research, J. Physical Oceanography). Journal publications make up a good mix of the total publications at approximately 30 percent. However, the review panel makes the following recommendation and observes that it would be useful for NOAA to develop guidance on useful metrics that can be applied consistently across CIs to track their roll in NOAA's focus on 'research to operations'.

Recommendation 2. Additional metrics should be developed that highlight the effectiveness and application of NGI R&D, e.g., citations, joint publications with NOAA researchers, application of results in NOAA operations, use by other agencies (e.g., models, model results, data sets, measurement methods, training workshops).

Science Review

The panel finds that the scientific work of NGI is of high quality, is topical, and is directly relevant to NOAA. This was exemplified in the quality of the presentations provided during the review and the ability of the investigators to respond to panel member questions. As discussed above, the most obvious measure of the quality of the research is in the list of publications provided to the panel, which shows scholarly papers in high profile journals, presentations at major conferences, and publications of data sets and data products.

Further observations are provided for each of the science themes of NGI.

Theme 1: Climate Change and Climate Variability Effects on Regional Ecosystems.

Based on the project summaries provided, several of the ongoing projects include a focus on climate. The work on surface wind fields at Florida State University (FSU) is important to forcing models that are used for understanding the effects of the El Niño–Southern Oscillation (ENSO) and associated regional weather patterns. The ENSO has also been the subject of numerical experiments using the biogeochemical model of the Gulf of Mexico developed by USM researchers working in collaboration with AOML. There appears to be little active work directly related to climate change, and the panel offers the following recommendation so that this important aspect of NOAA's work can be furthered using the expertise of NGI scientists.

Recommendation 3: NGI leaders should continue to focus on integration of climate and global change into new project development.

Theme 2: Coastal Hazards.

NGI's theme of coastal hazards focuses on both physical and biologic systems. The Florida State University tropical cyclone research including air-sea interactions, microwave radiometer measurements, and data assembly shows excellent collaboration with NOAA and contribution to the NOAA mission; collection, archival, and dissemination of critical data; and very strong R&D publications. The team excels in transition of products to users. Hypoxia research spans both coastal hazards and ecosystem management. NGI is designated by NOAA as the CI for Gulf of Mexico hypoxia. The Hypoxia National Office Technical Assistance, Observations, Monitoring and Coordination project supports critical data collection and 3D modeling to aid decisions within the Mississippi River/Gulf of Mexico Hypoxia Task Force, as well as supporting NOAA hypoxia research. The project excels in coordinating and collaborating across organizations and plays a key role in improved understanding, forecasting, and communicating hypoxia hazards. Increasing technical publications on hypoxia hazards should be a goal. The Coastal Data Development (NCEI) project is developing key databases to support R&D related to oxygen dynamics, microplastics in the global ocean, harmful algal blooms, hypoxia, ecosystem classification, and bottom mapping. The effort goes well beyond storage of data but focuses on unified data storage, framework for processing large data sets, and efficient ingestion and retrieval by users. Such data archives are extremely useful for Artificial Intelligence and Machine Learning (AI/ML) approaches, model verification, and community testbeds. The capability to communicate across databases/data types should be a goal. This effort shows strong partnerships and has the potential to support significant science advances in coastal hazards and beyond.

Theme 3: Ecosystem Management.

Ecosystem-based management is best supported by research and tool development that crosses disciplinary boundaries and enhances utility of data for model-based assessments. The NGI research plan supports regional ecosystem management through a diverse portfolio of projects across integrated management themes (e.g., fish/habitat interactions, fishery/climate interactions, land-sea modeling) and involving novel data useful for enhancing integrated decision making. For example, hypoxia research in the Gulf of Mexico is being integrated with coastal fishery habitat assessment to develop predictive tools potentially useful for guiding oyster management in the context of changes in habitat quality (19-NGI3-80). Spatial data products and visualizations developed for NCEI can be used to relate climate and coastal land use to important shifts in coastal water quality such as harmful algal blooms (HABs) (19-NGI3-64). Models that relate fish and fishery production to climate variability and coastal habitat quality can be used to improve NOAA's efforts with ecosystem-based fishery management in the GOM (19-NGI3-76, 19-NGI3-73, 18-NGI3-41, 18-NGI3-52). Modeling land use and its effects on eutrophication in coastal systems provides a pathway for connecting coastal land use to public use of coastal waterways including fishing and recreational opportunities (19-NGI3-69). Development and use of the habitat classification standard in the GOM can support ecosystem modeling by connecting habitat data to relevant management questions such as the impact of ocean circulation on deep-water productivity (19-NGI3-79). Models examining climate effects (e.g., ocean acidification) on marine productivity in the GOM directly support ecosystem-based fishery management through assessment of the link between climate and trophic processes that support fishery productivity and coastal water quality (17-NGI3-28). These data will be useful for the prediction of habitat effects from shifts in severity and extent of coastal hypoxia, which potentially links fishery management to climate variability and coastal land management. Ecosystem management is also supported through a sustainable coastal

economy. NGI-supported research fosters the blue economy through data access and training, as well as coastal hazard mitigation products that further public access to coastal resources. A lot of NGI funding streams that can also support ecosystem-based management (EBM) will require longer term support to bear fruit, such as omics database, high-performance computing (HPC), and support for unmanned data gathering programs. Ecosystem management is a major research theme for NOAA, and it would be beneficial to both the NGI and NOAA if NGI efforts in this area were more directly aligned with NOAA EBM. The panel offers the following recommendation:

Recommendation 4: The NGI should position itself to further the vision of regional ecosystem-based management through more direct contributions to NOAA EBM efforts, as well as EBM-specific outreach to external partners.

Theme 4: Effective and Efficient Data Management Systems Supporting a Data-driven Economy

The NGI Review presentation included several examples of how NGI activities have enhanced data accessibility and usage. Accurate, robust, and accessible data describing environmental conditions are critical to understanding changes and dynamics of coastal ecosystems. These data are also essential for productive management, conservation, and restoration of natural resources that are the foundation of local ecologies and economies. The FOCAL WE-CP buoy has been collecting oceanographic measurements approximately 20 km southwest of Mobile Bay, Alabama for over 13 years and represents the longest running time series of coastal hydrographic water column data in the Mississippi Bight. However, the support for the observations has been cobbled together based on multiple investigators and funding sources leading to gaps in data processing and organization. To maximize the benefits of this data set, NGI partners completed a data management project that organized the historic data collections from the mooring system, providing direct access to these historical data in conjunction with the real-time data from the FOCAL WE-CP buoy. The existing historical data set required several data management actions and are now available at NOAA NCEI (<https://accession.nodc.noaa.gov/0203749>) making these data much more accessible to key stakeholders.

Relevance to NOAA

As noted earlier, the review panel found the CA between NGI and NCEI is working effectively. This is largely a result of NGI leadership managing the delicate balance between supporting NOAA's operational needs and infusing NOAA with forward-looking research in both the physical and social sciences. For example, NGI scientists and academic partners support many operational NCEI data management and distribution needs (e.g., marine microplastics distribution in the global ocean, coastal ecosystem data assembly center, among many others), but, equally important, NGI scientists and academic partners also provide a scientific vision that complements NOAA's. ***The review panel finds that NGI is "hitting its stride" in terms of striking the balance between support for NOAA's operational needs and forward-looking research, but also identifies the need for continued vigilance in nurturing this balance.***

In addition, ***the NGI is poised to contribute to several of NOAA's Science and Technology Focus Areas.*** NGI has a strong foundation with **Unmanned Systems**. This includes work with the Lower Mississippi

River Forecast Center through the SHOUT4Rivers project. For example, the NGI used a runway launched "Group 3" Unmanned Aircraft System (UAS) over flooded areas near Greenwood, MS, in February 2019 to provide forecasters with critical information on water level heights and locations of inundation. The resulting data were transmitted in near real-time to the forecast center. Subsequent campaigns included streaming and archiving real-time video directly from the platform. NGI staff also participated in a NOAA strategy to promote the use of UAS at National Estuarine Research Reserves (NERR) with some early work at Grand Bay NERR in Mississippi. There is clear potential for this collaboration to increase the application and use of UAS to support the NOAA mission.

Investments in **omics research** through NGI have involved database development, investment in new analytical and statistical tools, as well as novel data collection efforts. This work has focused on capacity building in cooperation with an existing NOAA research lab (AOML) and represents direct support of NOAA research activities. In particular, the data collection and advances in analytical throughput represent an important investment in the future use of omics techniques for research. International partnerships have also been established, most notably the Earth MicroBiome Project, which positions both NGI and NOAA to participate in global omics studies that can benefit the NOAA mission. The presentation of this work during the review did not state explicitly how omics data may be used by NOAA. Rather, it focused largely on development of capacity. This was also reflected in the publications which focused on advances in approach rather than findings that are directly applicable to decision making. As this work develops further, the NGI should make it a priority to develop and communicate applications of this capacity within NOAA. An example of application might be the use by NOAA Fisheries of eDNA data collection and rapid throughput techniques to inform species distribution and biodiversity at the regional scale as a part of ecosystem-based fisheries management.

Artificial Intelligence and Machine Learning (AI/ML) techniques can be productively applied to large datasets of physical measurements or physics-based simulation datasets. Several of the NGI projects are collecting and archiving extensive data, so AI/ML are promising growth areas. AI/ML can provide fast calculation methods and reveal new relationships to solve complex problems. NGI's extensive HPC resources would additionally provide a backbone for processing large datasets. The Coastal Science Research, Data Development and Information Services project, in particular, lends itself to AI/ML methods. Additional NGI projects are applying AI/ML to improve forecasting to support the NOAA missions:

- *Transition of Machine-Learning Based Rapid Intensification Forecasts to Operations* (not briefed) focuses on machine learning to improve operational prediction of rapid intensification of hurricanes based on NHC data.
- *Bayesian Merging of GLM Data with Ground-Based Networks* (not briefed) is applying AI to predict lightning using satellite data.

These endeavors are productive routes for efficient transition from R&D to NOAA operations. Lessons learned from these projects should be shared with other teams within the NGI.

Despite these strong skills within NGI, the types of work and initiatives pursued seem largely driven by NOAA program managers, who may use competitive research solicitations to find novel ways to address questions, rather than looking to the skills and expertise available within the CIs. Rather, CI work is better defined up front within NOAA, giving the CI, in this case NGI, limited opportunity for creativity.

Improving this situation requires NOAA to increase its awareness of NGI expertise, skills, and interests in relation to emerging areas. It also requires the NGI to be proactive in promoting that awareness. The panel offers the following recommendation:

Recommendation 5: The NGI should be proactive in promoting awareness of the Institute's expertise and increase their influence on how the NOAA science mission is implemented.

Social Science

The panel finds that the social science investments made by the NGI are timely and relevant considering the hazards facing the Gulf of Mexico region. The panel received two social science presentations: Social Science Applications for Coastal Resiliency, and Tornado Warning and Risk Perception Research. The NGI manages four social science projects including one education and outreach project. Understanding of risk communication is an often-overlooked area of hazard science. The NGI recognizes the value of social science research and invested in numerous social science research projects to improve understanding and communication of risk by physical scientists, students, and teachers. The training program for physical scientists to learn how to use social science in their everyday work is innovative and can lead to better integration of social and physical science. Integrating social science more broadly within NGI projects is an opportunity for NGI to consider in the future. Likewise, there is an opportunity for natural resource economics to provide additional value to many of NGI's projects. Doing so would likely enhance the broader impacts made by the NGI.

Education and Outreach

K-12 and the General Public

Education and outreach are clearly areas of NGI emphasis, and the Institute has invested accordingly. NGI's education and outreach activities provide opportunities to resource managers, educators, citizens, and students through community engagement programs and outreach events. The NGI is also involved in science curriculum development at member institutions and for the Mississippi Department of Education. The NGI is a strong supporter of the education needs of individual teachers and students through training programs, summer camps, and field experiences. Furthermore, ***the panel commends NGI for playing a leadership role in serving the educational needs of underserved communities.*** There are opportunities for the NGI to enhance workforce development through additional internships and fellowships targeting underserved students.

The NGI creates many educational products such as lesson plans, traveling trunks, and educational displays. These products have been widely used by education stakeholders. While the NGI education and outreach program is very active, the panel offers the following recommendation:

Recommendation 6: The NGI should develop education and outreach metrics to track over time to determine the overall impact of the education and outreach program.

Stakeholder Engagement

The NGI does an excellent job of being entrepreneurial in seeking funds to pass through the program. This has led to growth of the diverse NGI portfolio of R&D projects. A more strategic approach in deciding which funding sources to accept could allow the NGI to achieve greater measurable impacts by focusing on a smaller number of topics. Reviewing the composition of the NGI Advisory Council and

reengaging with it could be a valuable platform to validate and brand the work NGI performs (see Science Management below). The panel offers the following recommendation:

Recommendation 7: The NGI should undertake focused engagement with potential end users of NGI products outside of NOAA, e.g., other agencies, private sector, municipalities, to identify priority stakeholder needs and justify additional investments necessary to fully address the stakeholder defined topics.

An NGI strength is its geographic reach and engagement within the Gulf of Mexico region. This strength could be enhanced by taking a more active convening role in bringing together scientists from member institutions to develop strategies to solve problems important to stakeholders. An example of this is the recent work related to the Bonnet Carre spillway openings (see below). Thoughtfully utilizing the scientific expertise within NOAA and NGI member institutions would provide the NGI with an opportunity to improve linkages between NGI science and decision-makers outside of NOAA.

Science Management Plan

New Opportunities

The Panel observed that NGI has been responsive to new opportunities to apply their work in many instances. Good examples are the UAS work with the National Weather Service's River Forecast Center, described above, and the appearance of *Karenia brevis* (Red Tide) along the Mississippi coastline in Dec 2015, much farther north than it normally occurs, which provided a timely opportunity for the application of the NGI satellite imaging group based at USM. Recently, NGI staff have responded to questions raised by more frequent and extended openings of the Bonnet Carre spillway and its ecosystem implications, e.g., potential for dolphin mortality and impacts to oyster beds, by convening regional research groups to discuss findings and research needs.

While these are worthy efforts, they largely demonstrate the application of work already ongoing, rather than a new initiative being developed within the NGI based on a perceived need. There is simply little flexibility for the NGI leadership team to do this within the current funding structure for the CI. Discretionary funding is limited, and some was directed to support a student, for a single semester, to work on the UAS flood mapping. A large portion of the Task 1 funds have been allocated to Education and Outreach, and as the panel observed above, this investment has paid off in an excellent program. The Panel's observations on the quality of science being conducted at the NGI and the relevance of their work to the Science and Technology Focus area provides a solid foundation for NOAA to look to NGI when opportunities arise (**see Recommendation 5**).

Furthermore, more deliberate engagement with stakeholders can help identify new opportunities for potential NGI research (**see Recommendation 7**). An additional resource for the NGI leadership team is the Executive Council and the Advisory Council. The Executive Council includes NOAA line office representatives and the vice-presidents for research (or equivalent) from the member universities. It is not clear that they are called upon to provide specific guidance or support strategic planning, and that may be appropriate because the NGI leadership is extremely capable. However, these advisors potentially provide real value to NGI by promoting new ideas arising from the CI and developing regional support in Washington DC for NGI to fulfill its potential. Similarly, the Advisory Council, which seems to meet rarely, provides NGI remarkable reach to scientific institutions across the Gulf. If NGI is to

effectively brand itself within NOAA and fulfill its vision of serving the entire Gulf, this group should be utilized on a regular basis so it can stay engaged with NGI work and better provide advice.

Workforce and Staffing

One of the NGI goals is to directly broaden the diversity of the future NOAA science workforce. The outreach program makes a significant effort to reach diverse communities, and the NGI team appears very committed to outreach efforts and promoting diversity. Some of the individual projects also mention diversity goals (e.g., 18-NG13-42 *Climate Variability in Ocean Surface Turbulent Fluxes*). Anecdotal successes in the outreach program and some projects were highlighted, but the message would be more powerful with quantifiable results (K-12 students touched by outreach, percent from underserved communities, K-12 students pursuing science education, student interns and NGI undergraduate/graduate students pursuing careers at NOAA, etc.).

Recommendation 8: Metrics should be developed to quantify diversity goals and outcomes that would provide NGI important information to demonstrate its impact on local communities and regional economies.

For NGI, with its diverse scientific themes, ensuring leaders have a broad range of expertise is an additional challenge. ***The Panel observed that the current leadership structure of NGI with a Director and three Associate Directors, with varied research backgrounds and interests, is well suited to guide the CI forward.*** An issue not directly addressed by the review guidance is continuity of leadership for CIs' that provide service to NOAA over decades. Leadership 'succession' is an issue for any scientific organization and that the leadership team are at different stages of their careers bodes well for continuity when, for example, individuals opt to take well-deserved retirement. While the Director of NGI is appointed by MSU, having such an experienced team in place will help ensure smooth leadership transitions in the future whenever they occur.

Appendix I – Review Panel Members

Denise Reed (Chair)

Professor Gratis, Pontchartrain Institute for Environmental Sciences, University of New Orleans

Denise J. Reed is a nationally and internationally recognized expert in coastal marsh sustainability and the role of human activities in modifying coastal systems with over 30 years of experience studying coastal issues in the United States and abroad. Dr. Reed has served as a Distinguished Research Professor in the University of New Orleans' Department of Earth and Environmental Sciences and spent five years as Chief Scientist at The Water Institute of the Gulf. She has served on numerous boards and panels addressing the effects of human alterations on coastal environments and the role of science in guiding restoration, including the NRC Committee on Sustainable Water and Environmental Management in the California Bay-Delta, and has been a member of the USACE Environmental Advisory Board and the NOAA Science Advisory Board. Dr. Reed received her B.S. degree in Geography from Sidney Sussex College, and her M.A. and Ph.D. degrees from University of Cambridge.

Ben Kirtman

Professor of Atmospheric Sciences, University of Miami, Rosenstiel School of Marine and Atmospheric Science

Director, Cooperative Institute for Marine and Atmospheric Studies

Director, Center for Computational Science Climate and Environmental Hazards Program

Ben Kirtman is a Professor of Atmospheric Sciences at the University of Miami's Rosenstiel School of Marine and Atmospheric Science. He uses atmosphere-ocean general circulation models to study the predictability and variability of the Earth's climate system. Kirtman teaches graduate courses on the general circulation of the atmosphere and El Niño/Southern Oscillation, and climate prediction and predictability. He also teaches dynamic meteorology and atmospheric thermodynamics to undergraduates. He mentors graduate students in the Meteorology and Physical Oceanography graduate program, as well as post-doctoral researchers.

Kirtman's research is a wide-ranging program designed to understand and quantify the limits of climate predictability from days to decades. His research also involves understanding how the climate will change in response to changes in anthropogenic (e.g., greenhouse gases) and natural (e.g., volcanoes) forcing. This research involves hypothesis testing numerical experiments, using sophisticated state-of-the-art climate models and experimental real-time prediction. His group uses and has access to a suite of climate models, climate data, and high performance computational platforms.

Kirtman received his B.S. in Applied Mathematics from the University of California-San Diego and his M.S. and Ph.D. from the University of Maryland-College Park. He was a Research Scientist at the Center for Ocean-Land-Atmosphere Studies and a tenured Associate Professor at George Mason University before joining the Rosenstiel School in 2007. Kirtman has published over 100 peer-reviewed papers focused on understanding the variability of the climate system on time scales from days to decades.

Jane Smith

Senior Research Scientist, U.S. Army Engineer Research and Development Center

Dr. Jane McKee Smith is the Army Senior Research Scientist for Hydrodynamic Phenomenon, stationed at the U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory in Vicksburg, Miss. Smith's research focus is on coastal hydrodynamics, including nearshore waves and currents, wave-current interaction, shallow-water wave processes, and storm surge. Her projects include theoretical and numerical studies as well laboratory and field experimentation.

Dr. Smith is the co-developer of the STWAVE numerical spectral wave model that is used throughout the world for coastal project planning and design. Smith was the wave modeling lead investigator for the Interagency Performance Evaluation Task Force evaluation of Hurricane Katrina. She also led development of a system to quickly forecast hurricane waves, storm surge, and inundation for the Hawaiian Islands.

Smith has over 200 professional publications. She is Chair of the Coastal Engineering Research Council of the American Society of Civil Engineers (ASCE) and served as President of the Governing Board of the Coasts, Oceans, Ports and Rivers Institute of ASCE (2013-14). She serves on the Editorial Boards of the Elsevier journal Coastal Engineering and the ASCE Journal of Waterway, Port, Coastal and Ocean Engineering. Smith is an Adjunct Professor at Mississippi State University, and she serves on Master's and Ph.D. Committees at the University of Florida, Louisiana State University, Mississippi State University, and Texas A&M University.

Smith's honors include National Academy of Engineering (2019), South Dakota State University (SDSU) Distinguished Engineer (2015), ASCE Distinguished Member (2014), SDSU Distinguished Alumni (2013), ASCE Government Civil Engineer of the Year (2010), and Waterways Experiment Station Woman of the Year (1987). Smith earned a Ph.D., from the University of Delaware in Civil Engineering with a focus on Coastal Engineering, and a M.S. from Mississippi State University and a B.S. from South Dakota State University, both in Civil Engineering. She is a Professional Engineer, a Coastal Engineering Diplomate (Academy of Coastal, Ocean, Port and Navigation Engineers), and a member of ASCE and the American Geophysical Union.

Richard Fulford

Ecosystem Ecologist, U.S. Environmental Protection Agency

Dr. Richard Fulford is an ecosystem ecologist from the US EPA Office of Research and Development's Gulf Ecosystem Measurement and Modeling Division. He received a Bachelor of Science in zoology from the University of Oklahoma, Master of Science in fisheries from Louisiana State University, and his Doctorate in zoology from North Carolina State University. He specializes in quantitative modeling of marine and estuarine ecosystems with the objective of understanding ecosystem resilience and sustainability. His work has included analysis of recruitment dynamics of yellow perch in Lake Michigan, food web analysis of oysters and eutrophication in Chesapeake Bay, and habitat modeling of forage fish in coastal Gulf of Mexico. He is currently leading a national-scale project to model human-

environmental interactions with an ecosystem services approach. Dr. Fulford's primary interest is how energy flows through ecosystems, either vertically through food webs, horizontally through behavioral interactions, or how this energy is used by people. Aquatic ecosystems provide a fruitful platform for this research as they are highly productive, highly connected, and are home to a large proportion of the human population.

LaDon Swann

Director, Mississippi-Alabama Sea Grant and Sea Grant Aquaculture Liaison

LaDon Swann is the director of the Mississippi-Alabama Sea Grant Consortium and serves as the national Sea Grant aquaculture liaison. He is responsible for implementing practical solutions to coastal issues through competitive research, graduate student training, extension, outreach and K-12 education in Alabama and Mississippi. In his national role as a Sea Grant aquaculture liaison, he works to strengthen the Sea Grant aquaculture portfolio. He has conducted research on shellfish aquaculture and habitat restoration, and he has many years of experience designing, delivering and evaluating adult education programs.

The Tennessee native worked 10 years with the Illinois-Indiana Sea Grant College Program at Purdue University, where he earned a Ph.D. in curriculum and instruction for adults. His bachelor's and master's degrees were obtained from Tennessee Technological University in wildlife and fisheries management and fisheries biology. He also served as a U.S. Peace Corps aquaculture volunteer in Togo, West Africa.

Appendix II – Review Panel Agenda

Note that all meetings were held virtually.

5/7/2020	Pre-meeting: CI review background	Robert Moorhead, NOAA personnel, Review Team
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Monday 5/11

8:00-9:00am	NGI: Overview and Summary	Robert Moorhead / Steve Ashby
9:00-9:30am	Review Process and Q/A	Gary Matlock (DAA for Science)
9:30-9:45am	Welcome	Julie Jordan, MSU VP
9:45-10:00am	Western Sound Science Collaborative	Steve Ashby
10:00am-noon	Break and lunch on your own	
noon-1pm	Review Team Executive Session	Review Team only
1pm-3:30pm	Science Talks (7)	15 min presentation; 5 min Q&A
1:00-1:20pm	Shipboard Meteorology	Shawn Smith
1:20-1:40pm	Hurricane Winds / Ocean Climate	Mark Bourassa
1:40-2:00pm	National Water Model Applications	Jamie Dyer
2pm-2:10pm	break	
2:10-2:30pm	Smalltooth Sawfish	Dean Grubbs
2:30-2:50pm	Metagenomics / Bioinformatics	Luke Thompson
2:50-3:10pm	Weather Warning Threats	Kathleen Sherman-Morris
3:10-3:30pm	Social Science Applications	Laura Myers
3:30-3:40pm	break	
3:40-4:00pm	Education and Outreach	Jonathan Harris
4pm-	Review Team Executive Session	Review Team only

Tuesday 5/12

8:30-9:00am	Q&A with NGI Leadership	Moorhead, Ashby, Cebrian, Linhoss
9:00-10:00am	Science Talks (3)	15 min presentation; 5 min Q&A
9:00-9:20am	Hypoxia	Steve Ashby
9:20-9:40am	South Florida WQ Data Analysis	Anna Linhoss
9:40-10:00am	Coastal Data Development (NCEI)	Just Cebrian
10:00-10:15am	break	
10:15-10:45am	Additional Q&A with NGI Leadership	Moorhead, Ashby, Cebrian, Linhoss
10:45-12:30pm	Review Team Executive Session	Review Team only
12:30-1:30pm	lunch on your own	
1:30pm	Debrief NGI Leadership	
TBD	Review Team Executive Session	Review Team only