

Pacific Marine Environmental Laboratory (PMEL)

Science Review

March 3-5, 2020

PMEL Response to Panel Review Recommendations

January 27, 2021

Submitted by:

Michelle McClure, Director

Introduction

A review of the NOAA Pacific Marine Environmental Laboratory (PMEL) at NOAA's Western Regional Center in Seattle, Washington was conducted by an independent science review panel on March 3 – 5, 2020. NOAA's Office of Oceanic and Atmospheric Research (OAR) requested the review as part of the required 5-year research laboratory review cycle.

The three-day review was organized around the four research themes in PMEL's 2013 strategic and research plan: Climate-Weather Research, Marine Ecosystems Research, Ocean and Coastal Processes Research, and Research Innovation and Development.

More information on the review can be found on the PMEL review website: <https://www.pmel.noaa.gov/2020-lab-review>.

In this report, each actionable recommendation provided by the Science Review Panel is italicized and followed by the PMEL response. Given the considerable overlap between a number of the panel's recommendations, we have grouped and combined some of our responses accordingly.

A table summarizing the actions with timelines for completion is included below. Detailed responses can be found in the Appendix following the table.

Financial Management Center (FMC) Science Review Action Sheet

Theme 1: Strategic Approach to Laboratory Research Themes and Resources

Recommendation	Action	Champion	Target Start & Completion Dates	Status/Notes
<p><i>1. Management should be grooming "heirs-apparent" to ensure continuity of leadership. This is particularly concerning because the same issue was raised by the previous PMEL Review Panel and little has been done to address it.</i></p> <p><i>2. The cooperative institute arrangement would be more advantageous to PMEL if it were used as a pathway to permanent PMEL employment for those people who demonstrate leadership qualities. Relying on a mechanism where a high percentage of the leadership team are essentially temporary employees is not in the laboratory's best interest.</i></p> <p><i>7. The time is now to groom the next generation of leaders. This is particularly important in order to afford continuity to the timeseries that have been a hallmark of the lab.</i></p>	<p>a) Identify needed expertise through strategic planning processes</p> <p>b) As resources allow, increase federal staff</p> <p>c) Build more explicit succession plan within strategic plan process.</p> <p>d) Promote leadership and development and other professional development activities</p>	<p>a) PMEL Leadership</p> <p>b) PMEL Leadership and supervisors as appropriate</p> <p>c) PMEL Leadership</p> <p>d) PMEL Leadership and supervisors</p>	<p>a-d) Start: April 2021</p> <p>Intended to be ongoing.</p>	<p>PMEL can take advantage of existing hiring and retention tools, e.g. adding career ladders to positions, promoting training and development opportunities, using Pathways, Direct Hire Authorities, etc. to achieve some of the succession planning goals.</p> <p>NOAA and DOC offer a variety of opportunities to teach, train, and advance federal employees to leadership opportunities. Over the past 5 years, several PMEL employees have participated in NOAA and DOC leadership programs (e.g., NRAP, LCDP, mentoring, details, etc.). PMEL will</p>

				<p>continue to promote these and other leadership opportunities.</p> <p>Cooperative Institutes are a valuable tool in exposing potential PMEL federal employees to the federal government and vice versa. Indeed, over the past 5 years, PMEL has hired at least five previous CI employees as permanent Federal employees through the competitive processes required by federal law. PMEL will continue to take advantage of the opportunities afforded by NOAA's CI Cooperative Agreement.</p> <p>In these efforts, as a federal organization, PMEL is constrained by merit system principles, and cannot target hires to specific people</p>
<p><i>4. PMEL must develop a strategy for identifying when a project area has reached its research plateau and should transition from research to operation, effectively shifting the budget burden for that topical area to</i></p>	<p>a) Convene a science leadership retreat to identify criteria for onboarding, continuing and phasing out research themes</p>	<p>a) PMEL Leadership b) PMEL Leadership</p>	<p>a) Retreat to be convened July 2021 b) July 2021 c) 2022</p>	<p>PMEL's 2021-2030 Strategic Plan, which will guide the leadership retreat and other processes, is anticipated to be finalized February 2021.</p>

<p><i>the operational side of NOAA (or to another client of the product).</i></p> <p><i>5. PMEL needs a strategy for onboarding new research themes, particularly since the continued investments in existing research lines provides limited new opportunities.</i></p> <p><i>6. PMEL is a leader with clear differentiation from the activities of other laboratories with which it collaborates. PMEL needs an onboarding strategy for science topics that clearly defines that vision at the outset and uses identification of its unique role as one of the criteria for investment decisions.</i></p> <p><i>10. Use the opportunity with a new director to make some changes to the research thrusts and move towards evolution rather than succession.</i></p> <p><i>14. It would be valuable for the Science and Engineering groups to identify a prioritized list of information needs that balances need versus development cost and time, as well as technology transition. Such a roadmap could assist in the creation of new technologies, the sunsetting of existing technologies (e.g., what's good enough), and the transition of technologies to operations versus research (and allow for budget definition between those two efforts).</i></p>	<p>b) Develop a process for reviewing PMEL science, technology and emerging topics on an annual basis</p> <p>c) Conduct first review of PMEL research themes</p> <p>d) PMEL will increase use of Transition Plans to document and guide plans for transitioning R&D into operations, applications, commercialization, and other uses.</p>	<p>c) PMEL Leadership</p> <p>d) PMEL Leadership in collaboration with PIs</p>	<p>d) Ongoing</p>	
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<p>9. <i>Regarding systems that originated at PMEL and then were transitioned to another entity to operate, the 2020 review team was encouraged to learn that the data return has improved, but we believe that sustained vigilance by scientists, skilled data analysts and engineers “looking over the shoulders” of the operational agency will be required to ensure high quality continuation of valuable long-term records.</i></p>	<p>a) Ensure that PIs work closely with transition partners and OAR leadership to highlight funding needs and ensure that end-user needs are met.</p> <p>b) PMEL will increase use of Transition Plans to document and implement transitioning R&D into operations, applications, commercialization, and other uses.</p>	<p>a) PMEL PIs</p> <p>b) PMEL Leadership in collaboration with PIs</p>	<p>a) ongoing</p> <p>b) ongoing</p>	
<p>15. <i>It would be useful to develop metrics for performance such as days at sea, systems at sea, system reliability, amount of data collected, geographical areas covered, etc., especially with regard to needed ship time versus ship time available (and the impact of lost or potentially lost ship time).</i></p>	<p>a) Develop lab-level, appropriate metrics for ship impact</p> <p>b) Work with OAR, and NOAA to develop appropriate metrics for ship impact</p> <p>c) At Leadership Retreat, consider developing one or more metrics for non-ship-related impacts to be used in AOP and related processes.</p>	<p>a) PMEL Associate Director for Ship Operations</p> <p>b) PMEL Associate Director for Ship Operations</p> <p>c) PMEL Leadership</p>	<p>a) Being May 2021</p> <p>b) Ongoing</p> <p>c) July 2021</p>	<p>Note that OAR’s Global ocean and Monitoring and Observing Program (GOMO) is beginning to work with OMAO on more appropriate ship-based metrics.</p>

Theme 2: Laboratory Culture

Recommendation	Action	Champion	Target Start & Completion Dates	Status/Notes
<p>3. Management should recognize and reward three aspects of the present culture: a) Client orientation, b) Collaborative attitude, and c) “License to fail”.</p>	<p>a) Review and synthesize 3 recent culture assessments for PMEL leadership</p> <p>b) Review this synthesis and develop actions in response to these three areas</p> <p>c) Implement and manage innovation mini-grants</p>	<p>a) PMEL Diversity and Inclusion (D&I) Team</p> <p>b) PMEL Leadership</p> <p>c) PMEL Leadership</p>	<p>a) Completed</p> <p>b) Begin by March 2021</p> <p>c) Implement by July 2021</p>	
<p>8. With PMEL’s ability to meet its objectives now critically dependent on CI contributions, more effort must be made to improve the working environment for these individuals.</p>	<p>a) Review synthesis of culture assessments; identify 1-3 key areas for dedicated effort</p> <p>b) Build a team to develop options for appropriate mentorship programs at PMEL</p> <p>c) Work with CI directors to coordinate efforts for career development and morale</p>	<p>a) PMEL Leadership</p> <p>b) PMEL Mentoring Team</p> <p>c) PMEL and CI Leadership</p> <p>d) PMEL Leadership</p> <p>e) PMEL Leadership</p>	<p>a) April 2021</p> <p>b) June 2021</p> <p>c) 2021</p> <p>d) 2021</p> <p>e) 2021 and ongoing</p>	

	<p>d) Build PMEL awards team to identify awards and other recognition for which CI, contractor and federal staff are eligible, and to identify PMEL staff deserving of such awards.</p> <p>e) Raise awareness among all PMEL staff about differences in rules and regulations that affect Federal and CI employees and the appropriate relationships with CI staff.</p>			
<p><i>17. PMEL needs to review the cost of supporting quality engineering in Seattle and work to ensure that competitive salaries and benefits are available. Engineering of all types, but especially electrical and software, are in high demand by industry. The high cost of housing and commuting is making it difficult for the engineers in the maritime domain to support a family. The new generation is also much more mobile and willing (and able) to change jobs in response to better opportunities, internal dissatisfaction and boredom. Hence, it becomes more difficult to find quality</i></p>	<p>a) Use CAPS effectively to incentivize and reward strong performance</p> <p>b) Emphasize and build capacity for non-monetary benefits and incentives (career development, purpose-driven research) in PMEL culture.</p> <p>c) Explore lab-wide options, such as</p>	<p>a) PMEL Supervisors</p> <p>b) PMEL Leadership</p> <p>c) PMEL Leadership</p>	<p>a) Ongoing</p> <p>b) Ongoing</p> <p>c) Ongoing</p>	<p>This issue extends to other arenas such as IT, and some technical jobs as well.</p> <p>Salaries in the federal government are determined at the national level. rates.</p>

<i>stable staff to work long hours on complex problems (especially at sea)</i>	increased support, that may reduce the administrative burden on scientific and engineering staff			
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Theme 3: Data Management

Recommendation	Action	Champion	Target Start & Completion Dates	Status/Notes
<p>11. <i>PMEL should continue to ensure that collected data are available to users in a timely fashion especially as systems are operated by contractors and/or transitioned to other organizations. Specifically, a careful review of the Saildrone contract with regard to data rights would be useful to ensure open access to the collected data.</i></p> <p>12. <i>In parallel with their efforts to optimize environmental sampling, sensor integration and data handling/synthesis using saildrones and other uncrewed measurement systems, PMEL investigators are encouraged to think hard about the issues of data availability from commercial and other non-traditional sources.</i></p>	<p>a) Develop a PMEL data strategy, consistent with the NOAA Data strategy</p> <p>b) Complete data delivery modernization for Saildrone</p> <p>c) Continue work toward establishing PMEL as a Data Assembly Center for data from uncrewed surface data</p>	<p>a) PMEL Science Data Integration Group (SDIG)</p> <p>b) PMEL Science Data Integration Group (SDIG)</p> <p>c) PMEL Science Data Integration Group (SDIG)</p>	<p>a) 2022</p> <p>b) 2021</p> <p>c) 2023</p>	

<p>13. <i>It was noted during the review that resource allocation for data management did not always meet the need. This is not unique to PMEL, but leadership might be reminded to not overlook this critical function.</i></p>	<p>a) Consider data management review of PMEL proposals that include data collection to ensure the lab is prepared to accept data and appropriate funding support is included</p> <p>b) Develop a template including data management costs into project budgets</p>	<p>a) PMEL Leadership</p> <p>b) PMEL Science Data Integration Group (SDIG)</p>	<p>a) July/August</p> <p>b) August 2021</p>	
<p>16. <i>The development of the Science Data Integration Group is a good start to better (i.e., more relevant, timely) and more efficient use of PMEL data. However, as the breadth of PMEL becomes more multi-disciplinary the range of data inputs and the utilization of data to support science and decision makers will make this group more critical. Security issues will impede the progress of this group. We recommend evaluating the needs of the group in order to accomplish future goals. The group may need to be larger, especially to support at-sea operations and interactions with users.</i></p>	<p>a) Consider data group needs in the strategic planning process and hiring prioritization</p> <p>b) Consider forming a “data team” to identify data needs/issues common to the lab and unique to individual research groups, and to design systematic approaches to meet the lab’s data needs.</p>	<p>a) PMEL leadership/ Science Data Integration Group (SDIG)</p> <p>b) PMEL leadership/ Science Data Integration Group (SDIG)</p>	<p>a) ongoing</p> <p>b) 2021</p>	

Theme 4: Logistics of Science Execution

Recommendation	Action	Champion	Target Start & Completion Dates	Status/Notes
<p>18. We concur with the previous 2014 Strategic Plan review, “Relatively low cost, low earth orbiting satellite communication technology (e.g., microsat) is rapidly advancing in other arenas, driven by the high cost of large communication satellites. Exploring communication alternatives to avoid reliance on a single network would be a wise investment.” Consider looking at the range of satellites (including CubeSats and MicroSats) for communication and sensors. This, like the new genomics and bioinformatics effort, could be a means of acquiring new engineering staff in a new capability area.</p>	<p>a) Evaluate Mini-sats with standard engineering 5-step principles.</p> <p>b) Coordinate across users within NOAA, as relevant.</p> <p>c) Incorporate the use of NOAA Observing Systems Council (NOSC) processes to inform satellite modifications to meet PMEL requirements.</p>	<p>a) PMEL Engineering Division</p> <p>b) PMEL Engineering Division</p> <p>c) PMEL Leadership and PMEL Engineering Division</p>	<p>a) Ongoing</p> <p>b) Ongoing</p> <p>c) Ongoing</p>	
<p>19. PMEL should explore the use of employee “interns” for summer work within the engineering group. Given the proximity to UW and other Universities, there may be good opportunities to have students participate in PMEL engineering. We suggest that a specific program be put in place to facilitate the use of students, especially for the Science Data Integration Group.</p>	<p>a) Continue emphasis on summer intern programs, including the William Lapenta internship, the use of NOAA Educational Partnership Program (EPP) at Cooperative Science Centers, as well as others.</p>	<p>a) PMEL Leadership</p> <p>b) PMEL Administrative Division</p> <p>c) PMEL Leadership</p>	<p>a) Ongoing</p> <p>b) Complete by May 2021</p> <p>c) Summer 2021</p>	<p>Note that PMEL hosted two engineering (high school age) interns from under- represented communities. We also seek to maintain continued engagement with the Youth Maritime Collaborative, and are building a relationship with the brand new</p>

	<p>b) Identify administrative requirements for establishing a PMEL-specific internship program</p> <p>c) evaluate budgetary constraints and implement a PMEL program if appropriate</p>			<p>Seattle Maritime High School.</p> <p>PMEL is making use of the NOAA Educational Partnership Program (EPP) Cooperative Science Centers to address this. We had our first EPP students this last summer (2020) and look forward to having more.</p>
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Appendix

Theme 1: Strategic Approach to Laboratory Research Themes and Resources

Recommendation Set 1: Leadership and succession planning.

Recommendation 1: Management should be grooming “heirs-apparent” to ensure continuity of leadership. This is particularly concerning because the same issue was raised by the previous PMEL Review Panel and little has been done to address it.

Recommendation 2: The cooperative institute arrangement would be more advantageous to PMEL if it were used as a pathway to permanent PMEL employment for those people who demonstrate leadership qualities. Relying on a mechanism where a high percentage of the leadership team are essentially temporary employees is not in the laboratory’s best interest.

Recommendation 7: The time is now to groom the next generation of leaders. This is particularly important in order to afford continuity to the time series that have been a hallmark of the lab.

Response to Recommendations 1, 2, 7: Agree. These recommendations highlight the need to build leadership capacity and a succession plan as many in our workforce reach retirement eligibility. Such efforts are intimately tied to our strategic planning processes (see below) and a key part of our response to this recommendation will be to identify programs in need of increased or different staffing and key areas of expertise that need to be enhanced. Our ultimate goal is to increase the number of federal employees as resources allow and within the constraints of federal hiring processes to meet the mission of PMEL. Such hires will also allow us to increase diversity within our ranks and sustain innovation and our ability to maintain long-term data sets. We also seek to maintain the strong partnership and benefits of close collaboration with universities that our CI relationships bring. Cooperative Institutes are a valuable tool in exposing potential PMEL federal employees to the federal government and vice versa. Indeed, over the past 5 years, PMEL has hired at least four former CI employees as permanent Federal employees through the competitive processes required by federal law. PMEL will continue to take advantage of the opportunities afforded by NOAA's CI Cooperative Agreement. NOAA and DOC offer a variety of opportunities to teach, train, and advance federal employees to leadership opportunities. Over the past 5 years, several PMEL employees have participated in NOAA and DOC leadership programs (e.g., NRAP, LCDP, mentoring, details, etc.). PMEL will continue to promote these and other leadership opportunities. In addition, one of our primary CIs (CICOES) has developed a professional development program for its employees, which is intended to contribute to the career development for these important partners.

Action Plan for Recommendations 1, 2, 7:

- Identify needed expertise through strategic planning processes.
 - Dates: Start April 2021, will be ongoing
 - Responsibility: PMEL Leadership
- As resources allow, increase federal hiring to increase the ratio of federal to non-federal PMEL staff.

- Dates: Start April 2021, will be ongoing
 - Responsibility: PMEL Leadership
- Build a more explicit succession plan within the strategic planning process.
 - Dates: Start April 2021, will be ongoing
 - Responsibility: PMEL Leadership
- Encourage participation in leadership and other professional development activities
 - Dates: Ongoing
 - Responsibility: Supervisory staff and research group leads

Recommendation Set 2: On-boarding, off-boarding, transitions and prioritizing research themes.

Recommendation 4: PMEL must develop a strategy for identifying when a project area has reached its research plateau and should transition from research to operation, effectively shifting the budget burden for that topical area to the operational side of NOAA (or to another client of the product).

Recommendation 5: PMEL needs a strategy for onboarding new research themes, particularly since the continued investments in existing research lines provides limited new opportunities.

Recommendation 6: PMEL is a leader with clear differentiation from the activities of other laboratories with which it collaborates. PMEL needs an onboarding strategy for science topics that clearly defines that vision at the outset and uses identification of its unique role as one of the criteria for investment decisions.

Recommendation 10: Use the opportunity with a new director to make some changes to the research thrusts and move towards evolution rather than succession.

Recommendation 14: It would be valuable for the Science and Engineering groups to identify a prioritized list of information needs that balances need versus development cost and time, as well as technology transition. Such a roadmap could assist in the creation of new technologies, the sunset-ing of existing technologies (e.g., what's good enough), and the transition of technologies to operations versus research (and allow for budget definition between those two efforts).

Response to Recommendations 4, 5, 6, 10, 14: Agree. The reviewers highlight the challenges of determining what broad areas of research the laboratory should undertake, when to decrease or eliminate effort in particular efforts, and how to transfer activities to other entities when appropriate. Thoughtful initiation and sunseting of research themes allows the most effective use of limited resources. In order to evaluate topical areas, PMEL leadership will develop a prioritization schema to evaluate the importance of existing and emerging research areas. The rubric may include NOAA, OAR and PMEL goals, societal importance, continuity and sustaining of long-term data sets, costs and obsolescence of technologies. After the rubric is developed, evaluation will occur on an approximately annual time scale. Because this is new to PMEL, we will also likely need to evaluate and improve the processes we develop for this purpose. This process should enable us to position ourselves for unanticipated opportunities, keep up with the fast moving technology development and societal needs.

Regarding transitions, PMEL will increase use of Transition Plans to document and implement transitions of R&D into operations, applications, commercialization, and other uses. Also, a new OAR HQ position will be leading a new Office of Research and Technology Applications (ORTA) that reports to the OAR Deputy Assistant Administrator (DAA) and may be a good contact point for PMEL to help fund, facilitate and manage transitions. Importantly, transitioning of projects or activities to other entities is a process that is highly dependent upon the ultimate user(s), the technology being transitioned, whether the organization to which a transition will occur has the budget to support the activity, and more (see also below).

Action Plan for Recommendations 4, 5, 6, 10, 14:

- Convene a science leadership retreat to identify criteria for onboarding, continuing and phasing out research themes
 - Date: July 2021
 - Responsibility: PMEL leadership
- Develop a process for reviewing PMEL science, technology and emerging topics on an annual basis.
 - Date: First iteration of the process to be developed by July 2021,
 - Responsibility: PMEL leadership
- Conduct first review of PMEL research themes
 - Date: 2021
 - Responsibility: PMEL leadership
- Increase use of Transition Plans to document plans for transitioning R&D into operations, applications, commercialization, and other uses.
 - Date: Ongoing
 - Responsibility: PMEL leadership and PIs.

Recommendation 9: Transitions

Recommendation 9: Regarding systems that originated at PMEL and then were transitioned to another entity to operate, the 2020 review team was encouraged to learn that the data return has improved, but we believe that sustained vigilance by scientists, skilled data analysts and engineers “looking over the shoulders” of the operational agency will be required to ensure high quality continuation of valuable long-term records.

Response to Recommendation 9: Largely agree. (Please note that this recommendation, when compared with recommendation 4 makes clear some of the challenges involved in transitioning research and development products.) Transitions are complex, mostly unfunded and require engagement with the end-user from the initiation of the project. In many cases, there will, in fact, be an ongoing need for continuous upgrading, improvement and development, using a Research AND Operations model rather than a Research TO Operations model. In addition, many transitions continue to have a scientific component to the transitioned operations. Overall, PMEL will increase use of Transition Plans to document plans for transitioning R&D into operations, applications, commercialization, and other uses.

Action Plan for Recommendation 9:

- Encourage and ensure that PIs work closely with transition partners and OAR leadership to highlight funding needs

- Date: Ongoing
- Responsibility: PIs and PMEL Engineering Development Division
- Increase use of Transition Plans to document plans for transitioning R&D into operations, applications, commercialization, and other uses.
 - Date: Ongoing
 - Responsibility: PMEL leadership and PIs.

Recommendation 15: Performance Metrics

Recommendation 15: It would be useful to develop metrics for performance such as days at sea, systems at sea, system reliability, amount of data collected, geographical areas covered, etc., especially with regard to needed ship time versus ship time available (and the impact of lost or potentially lost ship time).

Response to Recommendation 15: Agree. Adequately and usefully documenting the performance and success of field missions has been an ongoing challenge for all NOAA scientists. Currently, an OMAO officer on duty at GOMO is working with OMAO to develop easily available metrics that capture mission success better than days at sea. Similarly, performance metrics for other PMEL activities would be useful for overall lab management. Developing useful metrics, rather than ‘easy-to-count’ metrics, however, can be very challenging.

Action Plan for Recommendation 15:

- Develop lab-level, appropriate metrics for ship impact (begin May 2021)
 - Date: Begin May 2021
 - Responsibility: PMEL Associate Director for Vessel Operations
- Work with OAR and NOAA effort for ship impact metrics
 - Date: Initiated by HQ January 2021
 - Responsibility: PMEL Associate Director for Vessel Operations
- Consider developing one or more metrics for non-ship-related impacts to be used in AOP and related processes
 - Begin preparing May 2021; discuss at leadership retreat
 - Responsibility: Jamie Shambaugh

Theme 2: Laboratory Culture

Recommendation 3: Maintain positive cultural attributes

Recommendation 3: Management should recognize and reward three aspects of the present culture: a) Client orientation, b) Collaborative attitude, and c) “License to fail”.

Response to Recommendation 3: Agree. PMEL Leadership recognizes the importance of culture and that proactive management (setting clear goals, identifying problems, diagnosing problems to get to the root issues, designing a plan, monitor plan through completion) with clear and transparent communication is required to continuously monitor, evaluate and course correct to hone and improve PMEL’s competitive edge. Considerations to performance management and continuous engagement strategies will be included.

Action Plan for Recommendation 3:

- Review and synthesize 3 recent culture assessments for PMEL leadership

- Date: Complete
- Responsibility: PMEL Diversity and Inclusion Team
- Review this synthesis and develop actions responsive to the three areas
 - Date: Begin February/March 2021
 - Implement at least one action by August 2021
 - Responsibility: PMEL leadership (begin March 2021)
- Implement and manage innovation mini-grants
 - Date: Implement by July 2021
 - Responsibility: PMEL leadership, Eugene Burger, Chris Meinig, Dick Feely, Mike McPhaden

Recommendation 8: Improve working environment for CI employees

Recommendation 8: With PMEL's ability to meet its objectives now critically dependent on CI contributions, more effort must be made to improve the working environment for these individuals.

Response to Recommendation 8: Agree. The three existing cultural assessments available to PMEL (see R3) indicate that there are significant concerns among our non-federal staff about career paths and other aspects of our blended workforce. PMEL values our CI and contracted staff as full scientific partners, and believes it is important to increase our overall inclusivity and to strive for equity in all ways within our control. We acknowledge the need to raise awareness among all PMEL staff about differences in rules and regulations that affect Federal and CI employees and appropriate relationships between federal and non-federal employees.

Action Plan for Recommendation 8:

- Review synthesis of culture assessments; identify 1-3 key areas for dedicated effort
 - Date: April 2021
 - Responsibility: PMEL leadership
- Build a team to develop options for appropriate mentorship programs at PMEL
 - Date: June 2021
 - Responsibility: D&I team
- Work with CI directors to coordinate efforts for career development and morale
 - Date: ongoing
 - Responsibility: PMEL and CI leadership
- Build awards team to identify awards and other recognition for which CI, contractor and federal staff are eligible, and to identify PMEL staff deserving of such awards.
 - Date: completed
 - Responsibility: PMEL leadership/Awards Team
- Raise awareness among all PMEL staff about differences in rules and regulations that affect Federal and CI employees.
 - Date: 2021 and ongoing
 - Responsibility: PMEL leadership

Recommendation 17: Competitive salaries

Recommendation 17: PMEL needs to review the cost of supporting quality engineering in Seattle and work to ensure that competitive salaries and benefits are available. Engineering of all types, but especially electrical and software, are in high demand by industry. The high cost of housing and commuting is making it difficult for the engineers

in the maritime domain to support a family. The new generation is also much more mobile and willing (and able) to change jobs in response to better opportunities, internal dissatisfaction and boredom. Hence, it becomes more difficult to find quality stable staff to work long hours on complex problems (especially at sea).

Response to Recommendation 17: Agree in principle. This issue extends to a variety of our staff, including IT, data management, technical and other staff. Federal salaries, however, are set at the national level, and PMEL has no control over these levels. In the absence of controls on salary, we seek to maintain and foster a dynamic R&D environment with strong societal value (i.e. purpose) and to improve opportunities for professional development.

Action Plan for Recommendation 17:

- Use CAPS effectively to incentivize and reward strong performance in the federal workforce
 - Date: Ongoing
 - Responsibility: Federal Supervisors
- Emphasize and build capacity for career development and purpose-driven research in PMEL
 - Date: Ongoing
 - Responsibility: Supervisors, research group leads
- Explore lab-wide options, such as increased support, that may reduce the administrative burden on scientific and engineering staff
 - Date: First recommendations complete by September 2021
 - Responsibility: Jim Guyton, Ogie Olanday

Theme 3: Data Management

Recommendation Set 3: Commercial Data

Recommendation 11: PMEL should continue to ensure that collected data are available to users in a timely fashion especially as systems are operated by contractors and/or transitioned to other organizations. Specifically, a careful review of the Saildrone contract with regard to data rights would be useful to ensure open access to the collected data.

Recommendation 12: In parallel with their efforts to optimize environmental sampling, sensor integration and data handling/synthesis using saildrones and other uncrewed measurement systems, PMEL investigators are encouraged to think hard about the issues of data availability from commercial and other non-traditional sources.

Response to Recommendations 11, 12: Agree. Data licensing and the timely delivery of data were highlighted. PMEL has made pioneering efforts over the past decades to apply the FAIR principles (Findable, Accessible, Interoperable and Reusable) in data management to most data collected at PMEL, especially with a new generation of uncrewed robotic observing platforms. The concern raised on the licensing of in situ observation data buys from commercial data providers and timely public access to data are acknowledged. We also acknowledge the need to identify non-conventional sources for environmental data. Additional overhead associated with data acceptance, data integrity and quality control does place an additional burden on infrastructure that can, in some cases, offset the benefits to these data.

Action Plan for Recommendation 11, 12:

- Data licensing of the in situ observation data is on the NOAA Data Strategy Implementation Plan to be addressed at the NOAA level with active input and participation from PMEL.
 - Date: Complete FY 22.
 - Responsibility: Eugene Burger
- Complete data delivery modernization now in progress for more efficient cloud-to-cloud delivery of Saildrone data. SDIG/Saildrone
 - Date: Complete FY 21.
 - Responsibility: SDIG
- Implement a lab-wide data accessible quality control and metadata assembly functionality for PMEL to reduce data dissemination delays.
 - Date: Available end FY 23
 - Responsibility: SDIG
- To reduce latency and data handling and integration overhead, the harmonization of systems that receive data at PMEL and integration with data management workflows. PMEL will set a goal to on-board 40% data through these unified systems over the next 5 years. (Also relevant for R16).
 - Dates: End FY 25
 - Responsibility: SDIG

Recommendation Set 3: Resourcing for Data Management

Recommendation 13: It was noted during the review that resource allocation for data management did not always meet the need. This is not unique to PMEL, but leadership might be reminded to not overlook this critical function.

Recommendation 16: The development of the Science Data Integration Group is a good start to better (i.e., more relevant, timely) and more efficient use of PMEL data. However, as the breadth of PMEL becomes more multi-disciplinary the range of data inputs and the utilization of data to support science and decision makers will make this group more critical. Security issues will impede the progress of this group. We recommend evaluating the needs of the group in order to accomplish future goals. The group may need to be larger, especially to support at-sea operations and interactions with users.

Response to Recommendations 13, 16: Agree. Resources for, and the relevance of the Science Data Integration Group (SDIG), were highlighted. Most (90%) of the SDIG funding is proposal-derived from non-PMEL sources to support non-PMEL development efforts. While PMEL support amounts to only 10%, this is an increase over the historic funding of this group where 100% of SDIG funding was towards non-PMEL focused efforts. Noteworthy is the non-PMEL efforts that are leveraged in support of the PMEL data integration effort, thereby reducing the cost of data management capacity and capability development to PMEL. We recognize the capacity this group can offer PMEL, and will encourage this group's close collaborations with the other research groups to accomplish its objectives. An area this group needs to develop is ML/AI applications in data QC and analysis.

NOAA is entering a new realm of data management with requirements for NOAA enterprise business data. This will place additional constraints on PMEL and NOAA IT infrastructure and the need for recordkeeping.

Action Plan for Recommendations 13, 16:

- R13: Appropriate support for the Data Integration Group is essential to meet PMEL data management requirements. The following items will be considered to ensure calibrated support.
 - R13: Consideration of data management review of PMEL proposals that include data collection. This will ensure the lab is prepared to accept data, and the proposal includes full data lifecycle funding support.
 - R13 and R16: SDIG will develop a “template” for including data management costs into project budgets. This template could be a starting point towards ensuring that realistic data management AND data stewardship costs are included and could be tweaked and customized for each project/submission.
 - Date: FY 22
 - Responsibility: Eugene Burger, Michelle McClure, Science project leads
- R16: The role of a data steward in the PMEL Data Integration Group dedicated to PMEL data integration matters will allow for a timely response to PMEL data Integration support.
 - Date: FY 21
 - Responsibility: Eugene Burger/ Michelle McClure
- R16: PMEL will entertain the formation of a “data team” with its core members from the data group and additional members from each research group. This data team will identify data needs/issues common to the lab and those unique to individual research groups, and to design systematic approaches to meet the lab’s data needs.
 - Dates: FY 21
 - Responsibility: Eugene Burger/Chidong Zhang

Theme 4: Logistics of Science Execution

Recommendation 18: Microsatellites

Recommendation 18: We concur with the previous 2014 Strategic Plan review, “Relatively low cost, low earth orbiting satellite communication technology (e.g., microsats) is rapidly advancing in other arenas, driven by the high cost of large communication satellites. Exploring communication alternatives to avoid reliance on a single network would be a wise investment.” Consider looking at the range of satellites (including CubeSats and MicroSats) for communication and sensors. This, like the new genomics and bioinformatics effort, could be a means of acquiring new engineering staff in a new capability area.

Response to Recommendation 18: We agree that ongoing exploration of emerging technologies is important, and note that we have not ignored microsats since the last review. Miniature low earth orbiting satellites (Cubesats and smaller form factors) are a fast-moving and disrupting technology that present opportunities to PMEL’s core mission. While Iridium has served us well for global, realtime and bi-directional communications, we are somewhat vulnerable by relying on a single vendor. New advancements and reduction in broadband costs will be systematically evaluated for requirements in new observing systems. We will also consider incorporating the use of

NOAA Observing Systems Council (NOSC) processes to inform satellite modifications to meet PMEL requirements.

Action Plan for Recommendation 18:

- Evaluate Mini-sats with standard engineering 5-step principles.
 - Date: Ongoing
 - Responsibility: PMEL Engineering Division (EDD)
- As relevant coordinate across users within NOAA
 - Date: Ongoing
 - Responsibility: PMEL Engineering Division (EDD)
- Consider incorporating the use of NOAA Observing Systems Council (NOSC) processes to inform satellite modifications to meet PMEL requirements.
 - Date: Ongoing
 - Responsibility: PMEL Engineering Division (EDD)

Recommendation 19: Internships

Recommendation 19: PMEL should explore the use of employee “interns” for summer work within the engineering group. Given the proximity to UW and other Universities, there may be good opportunities to have students participate in PMEL engineering. We suggest that a specific program be put in place to facilitate the use of students, especially for the Science Data Integration Group.

Response to Recommendation 19: We agree, and in fact, have already brought on two college-bound high school graduates as summer engineering interns through the Youth Maritime Collaborative. PMEL is also making use of the NOAA Educational Partnership Program (EPP) Cooperative Science Centers to address this. We had our first EPP students this last summer (2020) and look forward to having more. PMEL has a long history of summer scientific interns, and the new Bill Lapenta Internship program offers additional data science and engineering internship opportunities. We will seek to increase opportunities for interns both to build the next generation of NOAA employees and to increase the pipelines of diverse candidates for NOAA positions.

Action Plan for Recommendation 19:

- Continue emphasis on summer intern programs, including the William Lapenta internship, NOAA Cooperative Science Centers and their EPP scholarships, as well as others.
 - Date: Ongoing
 - Responsibility: PMEL PIs
- Identify administrative requirements for establishing a PMEL-specific internship program
 - Date: May 2021
 - Responsibility: PMEL Administrative Officer
- Evaluate budgetary constraints and implement a PMEL program if appropriate
 - Date: Begin summer 2021, for first class in 2022
 - Responsibility: PMEL leadership