

Performance Progress Report
Developing the Pacific Islands Ocean Observing System (PacIOOS)
Cooperative Agreement # NA16NOS0120024
Performance Period: June 1, 2019 through November 30, 2019

Submitted December 2019 by:
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This report covers activities conducted during the seventh 6-month performance period of this 5-year cooperative agreement. PacIOOS' estimated operating budget for the fiscal year is \$3,249,398.

1.0 Progress and Accomplishments

REGIONAL GOVERNANCE AND MANAGEMENT SYSTEM

Finalize Subaward for Regional Workshop; Original completion date: November 2019
Status: Complete. Initial planning phases have begun with PacIOOS, NOAA, and MERIP. PacIOOS has other capacity building workshops that will inform this workshop that will be held in Honolulu in Summer 2020.

Governing Council Elections; Original completion date: August 2019
Status: Complete. October 2019. Five organizational seats were up for election this year. The NOAA National Weather Service is newly elected to the council. Re-elected members include: Liquid Robotics, Inc., RMI EPA, Western Pacific Regional Fisheries Management Council, and Palau Office of Climate Change.

Convene Governing Council meeting; Original completion date: November 2019
Status: Complete. November 2019. Members of the PacIOOS Governing Council gathered on the University of Hawai‘i Mānoa campus for the annual meeting. Members from across the region represent various sectors and provide valuable feedback to help guide the future of the program. After learning about PacIOOS' programmatic updates on the first day, meeting participants engaged in site visits in Maunalua Bay to hear about ongoing water quality related initiatives and partnerships in the bay, spearheaded by numerous partners. On the second day of the meeting, discussions focused on performance measures, regional engagement and capacity building, regional resilience topics, and the upcoming 5-year proposal.

Internal PacIOOS Performance Metrics; Original completion date: August 2019
Status: Complete. October 2019. The purpose of PacIOOS' performance measures is to analyze annually the progress towards the Strategic Framework and long-term objectives. It is a snapshot of growth and operational reliability across core subsystems to further define success and improve the program. While all other performance measures met or exceeded the set goals, operational uptime performed below the target. Reasons for the change in uptime include aging assets and challenging weather conditions.

OUTREACH, STAKEHOLDER ENGAGEMENT, AND EDUCATION SUBSYSTEM

PacIOOS capacity building and stakeholder engagement meetings/workshops; Original completion date: May 2020

Status: In progress. Planning has begun for workshops throughout the PacIOOS region. The first workshops will be held in Pohnpei, FSM and Majuro, RMI in January 2020. Invitations have been sent, and initial response has been strong. The workshop in Majuro will include partners from the Hawai'i Institute of Marine Biology who will be working in the RMI on a marine pollution project funded through the Marshall Islands Marine Resource Agency (MIMRA). The workshop to be held in American Samoa will likely be delayed due to major medical challenges straining the community and its resources.

Collaborate, prepare, and host DBCP PI-4 capacity building workshop; Original completion date: September 2019

Status: Complete. PacIOOS participated in the planning committee for the 4th Pacific Islands Training Workshop on Ocean Observations and Data Applications in Honolulu, which included over 35 participants from over 14 countries. In addition to hosting of the workshop, PacIOOS staff provided 1.5 days of hands-on training on four spheres of capacity: needs assessment; pre-deployment; field work/operations; data telemetry, access, and utility. Other workshop topics included discussions on global ocean observing systems, data utilization, quality control, and best practices. The workshop was deemed a huge success, setting the standard for hands-on activities and interactive learning.

Collaborate, prepare for, and host/participate in OceanObs'19 and related events; Original completion date: September 2019

Status: Complete. Numerous PacIOOS management and staff participated in OceanObs'19 and related events throughout the entire week in September. PacIOOS management, co-investigators, and staff led or collaborated on four different community white papers for OceanObs'19, which have all been published. PacIOOS also provided a plenary presentation at OceanObs'19. PacIOOS was also on the planning committee for the Breaking Waves Breaking Barriers women in ocean science event. Numerous connections were forged during this important week in ocean observing.

Hosted IOOS 20th Anniversary Reception; Completion date: September 2019

Status: Complete. In collaboration with IOOS, IOOS Association, PacIOOS served as local host of IOOS 20th Anniversary Reception with 450 invited guests. PacIOOS staff coordinated on the ground logistics and served on planning committee for the event.

Hosted Annual IOOSA Fall meeting; Completion date: September 2019

Status: Complete. Hosted IOOS leadership, IOOS Association, regional directors, and staff on University of Hawai'i campus to follow up on OceanObs'19 action items, and for IOOS Association Business Meeting.

Collaborate with NOAA OCM, other partners, and coastal management stakeholders to implement Data Ocean Sharing Initiative; Original completion date: July 2020

Status: *In progress. PacIOOS coordinated an initial meeting with local OCM leadership and staff, and other NOAA and EPA partners. This group of regional partners agreed to serve as the core collaborators to ensure that the project delivers on the expectations of the funding. The group decided to limit the initial geographic scope to include Hawai‘i and the territories (Guam, CNMI, and American Samoa). We are now in process of compiling a list of target stakeholders (e.g., coastal resource managers, EPA directors, Department of Health staff, etc.) to learn more about and characterize specific management and policy decisions that could benefit from improved data sharing and/or new data sets. Finally, the collaboration and characterization will guide the implementation aspect of this project. Throughout the project, the specific actions will be determined in close collaboration with NOAA OCM and other relevant federal partners in the region, as well as in consultation with coastal management and related stakeholder community.*

Ongoing outreach and engagement with stakeholders and partners to ensure meeting ocean data needs; Original completion date: Ongoing

Status: *Ongoing. Outreach and stakeholder engagement with partners is ongoing via e-mail, phone calls, and meetings; stakeholder and community outreach and education efforts are conducted as appropriate. Specific activities during this reporting period are listed below.*

Outreach Efforts

- *PacIOOS continues to publish and distribute monthly e-newsletters; more than 190 new contacts were added to the newsletter mailing list, the majority of which signed up through the subscription form on the PacIOOS website. A total of 2153 recipients receive monthly updates.*
- *Increased public awareness of PacIOOS through media coverage, including articles such as New Monitoring Site for Ocean Acidification in American Samoa, Over 200 evacuate as ocean swells flood Majuro Atoll, Citizen Scientists Use Ko‘a Card for Coral, UH Hilo Student Projects Utilize PacIOOS Data, and more.*
- *During this reporting period, the PacIOOS website was visited by over 62K users and had more than 173K sessions.*
- *Combined page views of the PacIOOS wave buoy pages from CDIP and the PacIOOS website total over 374K. Data on NDBC website stats, data requests, and RSS requests are currently not available.*
- *PacIOOS’ Facebook page has more than 1,487 likes; Twitter following increased to over 487 followers.*
- *Developed new conference banner as well as a new booklet brochure for distribution to partners and stakeholders.*

Stakeholder Engagement

- *Met with stakeholders from various sectors to discuss collaborations, including agency partners (Department of Transportation, U.S. Army Corps of Engineers, U.S. Coast Guard, Office of Planning, Western Pacific Regional Fisheries Management Council), non-profit organizations (TNC, Hawai‘i Waterkeepers, Hawai‘i Beach Safety), and other programs and institutions (National Estuarine Research Reserve, Kaua‘i Community College, Hawai‘i Institute of Marine Biology).*
- *Hosted Hawai‘i legislative delegation (Lower/Higher Education Committee members and House leadership) to share about PacIOOS program.*

- *Participation in annual Hawai‘i Conservation Conference.*
- *Provided requested informational materials at Hawai‘i Fishers Forum.*
- *Participated in NOAA Pacific Regional Outreach Group (PROG), one NOAA American Samoa, and State of Hawai‘i Ocean Resources Management Plan (ORMP) Working Group.*
- *Met with congressional staffers in Honolulu (July 2019).*

Educational Efforts

- *Participated in and provided presentations at outreach and educational events, including SOEST Open House, GIS Day at the University of Hawai‘i, and modeling lecture to Guam college students.*
- *Continue collaboration with UH Maui College to use PacIOOS Voyager lesson plan as classroom activity for oceanography lab; focusing on data relevant to students and real-world decision-making.*
- *Water quality team continues to mentor undergraduate college students and high school students to support sensor program.*

OBSERVING SUBSYSTEM

Maintain and operate 7 HFR stations in Hawai‘i, real-time surface currents data available online; Original completion date: Ongoing

Status: *Ongoing. Focus continues to be on operations and maintenance of 7 HFR stations on O‘ahu and Hawai‘i Island. Significant effort has gone into maintaining access to the sites, particularly Ka‘ena, Kapolei, and Kaka‘ako during this reporting period. Issues are due to change in staffing, management, renewal of expiring permits, and in the case of Kaka‘ako, the transfer of the park where the HFR station is located from the State to a county agency. In addition, the team upgraded the power supplies to the Hilo HFR. The backup battery power is now more robust in case of a power outage. <http://www.pacioos.hawaii.edu/currents-category/obs/>*

Conduct site visits for the new HFR sites in the Mariana Islands; Original completion date: November 2019

Status: *Delayed. New target completion date: March 2020. Initial discussions with key partners on Guam, including with the multiple landowners, have begun. The team is currently strategizing with partners the optimal configuration of the system to be deployed, based on needs and feasibility of the sites, particularly with regard to access issues with the U.S. military.*

Maintain operations of waverider buoys in Hawai‘i, Mariana Islands, American Samoa, and the Marshall Islands, real-time wave data and associated products online; Original completion date: Ongoing

Status: *Ongoing. Three buoys broke free from their moorings during this reporting period: Maui in June, Hanalei in mid-October, and Ritidian at the end of November. Maui was redeployed in October. We are currently waiting for a favorable weather window to redeploy the Hanalei buoy, and a replacement buoy for the Ritidian site is currently en route to Guam. <http://www.pacioos.hawaii.edu/waves-category/buoy/>*

Hire new wave buoy technician; Original completion date: November 2019

Status: Complete. A new full-time, highly qualified technician has been hired for this position. Her official start date was December 2, 2019.

Redeploy Majuro wave buoy; Original completion date: August 2019

Status: Complete. July 2019.

Redeploy Maui wave buoy; Original completion date: November 2019

Status: Complete. October 2019. Partners at the University of Hawai'i Maui College helped with receiving, storing, forklifting, and staging the buoy prior to the deployment.

Swap American Samoa, Kāne'ōhe Bay, and Pearl Harbor wave buoys; Original completion date: August 2019

Status: Complete. June and August 2019. Regular maintenance ensures continued operation of the buoys to provide real-time information on wave height, direction, period, as well as sea surface temperature (and surface currents at Pearl Harbor buoy).

Swap Waimea wave buoy; Original completion date: November 2019

Status: Complete. September 2019.

Maintain operations of nearshore water quality sensors, data online; Original completion date: Ongoing

Status: Ongoing. PacIOOS currently has 4 near shore sensors operational in Hawai'i (4 on O'ahu), and 4 operational in the Insular Pacific (American Samoa, the Federated States of Micronesia, the Republic of the Marshall Islands, and Guam). Partners on the islands other than O'ahu are key to keeping these sensors operational, and data flowing. Despite new modems, we continue to experience issues with telemetry issues for the real-time sensors in Hawai'i. The team will continue exploring options to address these telemetry issues during the next reporting period.

The past year, we have experienced a rise in the need for service repairs of the sensors. This may be due to the age of the sensors, many of which are over 10 years old. On the upside, as we now have data to many of these sites for over 10 years, it is worthwhile to examine the data for environmental changes over time. According to the PacIOOS nearshore sensors off the south shore of O'ahu, temperatures in the coastal ocean between May and August 2019 were in the upper limit of recent historical values and even often exceeded them. Data from these in situ sites along the south shore corroborate the higher ocean temperature trends observed by NOAA satellites. See <https://myemail.constantcontact.com/Aloha-from-PacIOOS-.html?soid=1105866148764&aid=PvpBmX8trO0> for an example plot.

Dynamic graphs and map viewers on the PacIOOS website provide a quick way to check the latest observations. <http://www.pacioos.hawaii.edu/water-category/sensor/>

Continue Water Quality Sensor Partnership Program, data online; Original completion date: Ongoing

Status: Ongoing. The PacIOOS Water Quality Sensor Partnership Program (WQSPP) continues to be popular with partners and the PacIOOS Governing Council. The program currently has one sensor deployed (Maunalua Bay, O‘ahu), and two additional sensors scheduled to be deployed in December 2019 (Maalaea Harbor, Maui and Babeldaob, Palau).

The Maunalua Bay sensor is with the local non-profit organization, Mālama Maunalua, and is part of a larger, multi-partner effort to collect baseline data for the Bay. PacIOOS also has a separate contract with the Department of Health Clean Water Branch to purchase and operate 3 additional sensors throughout the bay to collect high-frequency baseline data for one year. This project is in progress. The Maalaea Harbor project is with the Maui Nui Marine Resource Management Council to monitor conditions in this highly used local harbor. The Palau project is with a local non-profit organization, Ebiil Society, who will monitor water quality downstream of a terrestrial/forest restoration site. All WQSPP data of completed projects are now available on the PacIOOS website under archival sites: <http://www.pacioos.hawaii.edu/water/sensor-archive/>

Implement Pohnpei water quality monitoring with local partners; Original Completion date: Ongoing

Status: Local partner Conservation Society of Pohnpei (CSP; a local NGO) deployed the rain gauges for the pilot project in June 2019. A river flow meter was ordered and received by PacIOOS staff in Pohnpei. River survey training and monitoring will commence in January 2020. Data will be collated with the sensor in the Nanpil River itself, rainfall data, and other coral and fish monitoring being conducted by CSP. Information derived will show how much sediment is reaching the lagoon and is expected to guide decision-making on development clearing in the Nanpil River basin. There have been some issues collecting data from these instruments, which are new to the local community partners. When the PacIOOS Operations Coordinator is on Pohnpei in January 2020, he will assist with this effort with additional capacity development and training.

Redeploy Hilo Bay water quality buoy; Original completion date: August 2019

Status: Complete. July 2019. This buoy was replaced after the previous buoy at this location was lost during Hurricane Lane in summer 2018. Fill the gaps and other PacIOOS funding supported the replacement purchase.

Maintain operations of Hawai‘i Island water quality buoys, data online; Original completion date: Ongoing

Status: Ongoing. Near the end of the reporting period, the data telemetry for both buoys started experiencing issues due to problems with Xylem’s Storm Central servers, which push data to PacIOOS. Data are logging internally on the buoys.

<http://www.pacioos.hawaii.edu/water/wqbuoy-pelekane/>

<http://www.pacioos.hawaii.edu/water/wqbuoy-hilo/>

Manufacturer repair PacIOOS SeaGlider; Original completion date: November 2019

Status: Delayed. The PacIOOS SeaGlider was sent to Kongsberg for servicing and repair in November 2018. We anticipated receiving the repaired glider during the spring of 2019, which

got pushed back to November 2019 due to staffing shortage at Kongsberg. The new estimated date of return of our SeaGlider from Kongsberg is February 2020.

Additional activities not mentioned above that highlight regional observing system successes and occurred during this reporting period include the following:

- *PacIOOS Operations Coordinator attended glider pilot and maintenance training at AOML in October. Connection was made through Ben LaCour at IOOS Program Office.*
- *Continued partnership with numerous NOAA and American Samoa partners to maintain the new MAPCO2 buoy in Fagatele Bay and conduct sampling protocol around the buoy, which is in the National Marine Sanctuary of American Samoa. All data can be viewed online on the PMEL and PacIOOS websites. <http://www.pacioos.hawaii.edu/latest-news/new-ocean-acidification-monitoring-station-american-samoa/>*
- *Continued troubleshooting data drops from the new weather station at the entrance of Honolulu. Utilized the warranty to replace the station from the manufacturer, which improved, but did not fully resolve the issue. Close communication with the main partner and user of the data, Hawai'i Pilots Association, indicates that the minor data drops are not adversely impacting them for now. <http://www.pacioos.hawaii.edu/weather/obs-honolulu/>*

DATA MANAGEMENT SUBSYSTEM

Purchase and install new disk enclosure for main PacIOOS RAID array; Original

completion date: November 2019

Status: Complete. September 2019.

Implement new cloud-based VMware option to prevent future downtimes; Original

completion date: November 2019

Status: Delayed. This solution ended up being prohibitively expensive. As a result, we are now looking into a private cloud solution, to possibly include a co-location agreement with another IOOS regional association.

Hire part-time biological data specialist for biology project; Original completion date:

November 2019

Status: Complete. Start date approved for December 16, 2019. Late August – early November, we also had a temporary hire working on this project. The new regular hire is the same person, and she will pick up where she left off in November with partners, especially with the NOAA PIFSC fish nSPC datasets for OBIS.

Hire data analyst to assist with QC and data ingest; Original completion date: November

2019

Status: Delayed. Other commitments of the data management team have pushed this hire back.

The other data management milestones that directly relate to specific observing, modeling, or other subsystem components are listed and described with those components.

Additional activities for the data management subsystem that are not mentioned within the other subsystems but that highlight regional observing system success and occurred during this reporting period include the following:

- *DMAC staff continue to migrate PacIOOS servers from a single server to a Virtual Machine (VM) stack of servers. The plan is to take advantage of VM management and parse different services to different VM's, thus eliminating single points of failure.*
- *During this performance period, over 126,176 unique visitors (via direct external access to our servers) accessed more than 9.7 million pages in our servers (TDS, ERDDAP, and LAS) and transferred over 4.58 TB of data.*

MODELING, ANALYSIS, AND PRODUCT DEVELOPMENT SUBSYSTEM

Maintain 6-day high-water level forecasts; threshold adjustments based on ongoing feedback; forecasts available online; Original completion date: Ongoing

Status: Ongoing. Continued ongoing maintenance of data streams. During this reporting period, the team organized event documentation (photos and videos by citizen scientists) from the environs around Pago Pago, Samoa, and the 6 Hawai'i stations, in order to define forecast thresholds at which different magnitudes of flooding will occur near each station.

<http://www.pacioos.hawaii.edu/shoreline-category/highsea/>

Maintain wave run-up forecasts; threshold adjustments based on ongoing feedback; forecasts available online; Original completion date: Ongoing

Status: Ongoing. Continued ongoing maintenance of data streams. PacIOOS continues to refine forecasts with user feedback and collaborating with partners to obtain on-the-ground validation during predicted events. The focus on this reporting period has been adjusting the Majuro wave run-up thresholds. The work being conducted for the PacIOOS Coastal Resilience Grant project for West Maui will also provide a significant addition and upgrade to our published PacIOOS run-up forecasts in the future.

<http://www.pacioos.hawaii.edu/shoreline-category/runup/>
<http://www.pacioos.hawaii.edu/pacioos-updates/data-collection-wave-dynamics-west-maui/>

Purchase and set up new server for the West Maui wave run-up forecast; Original completion date: November 2019

Status: Delayed. **New target completion date:** March 2020. The initial order was delayed due to a delay in the FY19 funding and descope approval. We appreciate the IOOS Program Office providing advanced approval of the purchase of this item while we awaited full approval of our FY19 descope. We placed the order for the new server in mid-November, but the supplier is experiencing delays.

Maintain harbor surge forecast; tailor based on feedback/new inputs; forecast available online; Original completion date: Ongoing

Status: Ongoing. Work ongoing to refine harbor surge forecast and obtain non-IOOS funding to expand locations. With our partners, we also made progress during this reporting period toward the development of a harbor surge forecast for Kahului Harbor in Maui. A literature search and historical data/model identification are complete. Much of the historical data has now been

acquired for re-analysis. Partners at the State of Hawai‘i Harbors Division and USACE were consulted regarding their field experiences and conclusions from prior studies. From the prior studies, practical knowledge, and data re-analysis, the significant spatial variations of the different threats (e.g., swell wave heaving; long-period surges) to navigation and ships at dock (e.g., differences between Piers 1 and 2) are becoming clearer. Additional interviews with the Harbors Division staff are planned and will further refine these impressions.
<http://www.pacioos.hawaii.edu/shoreline-category/harborsurge/>

Maintain ROMS circulation models for Hawai‘i, Mariana Islands, and Samoan Islands; Original completion date: Ongoing

Status: Ongoing. PacIOOS ROMS is available for various areas and grid sizes in Hawai‘i, the Mariana Islands, and Samoa.

Observation analysis impacts for ROMS running operationally; Original completion date: Ongoing

Status: Ongoing. We assess the impact of every observation used to perform the daily analysis: we examine transport, Eddy Kinetic Energy (EKE), and isopycnal depth in HI; transport and EKE in Guam.

Development of coupled Physical/biogeochemical model for Hawai‘i; Original completion date: Ongoing.

Status: Ongoing. Model development of a coupled ROMS/COBALT model is complete, and now a 10-year reanalysis is being validated. We are moving toward the PacIOOS goal of producing biogeochemical forecasts.

Model data and products (including Ala Wai Plume Forecast) online; Original completion date: Ongoing

Status: Ongoing. All forecasts and data output are available via the PacIOOS website.

<http://www.pacioos.hawaii.edu/currents-category/model/>,
<http://www.pacioos.hawaii.edu/water/model-plume-alawai/>

Maintain wave (WW3 and SWAN) models for Hawai‘i, Mariana Islands, and Samoan Islands; Original completion date: Ongoing

Status: Ongoing. PacIOOS developed a new high-resolution wave forecast for the Manu‘a Islands in American Samoa during this reporting period with funding from an Office of Insular Affairs grant.

RESEARCH AND DEVELOPMENT SUBSYSTEM

Transmitting tags (including ocean profiling tags) deployed on pelagics (sharks) throughout the year; Original completion date: Ongoing

Status: Ongoing. We are delaying the deployment of additional oceanographic profiling satellite tags on sharks until the ATN DAC is ready to ingest and serve the data collected from these tags. Tracks from previous tagging efforts can be viewed on PacIOOS' shark tracking pages and PacIOOS Voyager. <http://www.pacioos.hawaii.edu/projects/sharks/>

Maintain land-based receivers for shark tags throughout the year; Original completion date: Ongoing

Status: *Ongoing. Currently 3 land-based receivers are deployed on O‘ahu, and 2 are deployed on Maui.*

Continue to assist the IOOS ATN DAC with data ingest of ocean profiles from telemetered animals; Original completion data: Ongoing

Status: *Ongoing. We continue to work with and wait on the ATN DAC to ingest and serve our oceanographic profile data collected from satellite tags on sharks*

Additional activities for the research and development subsystem that are not mentioned within the other subsystems but that highlight regional observing system success and occurred during this reporting period include the following:

- *Co-Investigator Kim Holland attended a workshop in Hobart in November 2019, where the group developed a proposal for GOOS to have “Animal Borne Sensors” recognized as an official “network” in the GOOS structure (along with Argo, DBCP, SHIP-OPS, etc.). If approved, this will provide global JCOMMOPS support and streamlined access of the data from tagged animals to the GTS.*

2.0 Scope of Work

No changes to the project scope of work are anticipated.

3.0 Personnel and Organizational Structure

No major personnel changes during this reporting period. During the November 2019 Governing Council meeting, there was a significant discussion about the make-up of the Executive Committee (ExCom). Moving forward, the plan is to utilize the option of having an alternate member of the ExCom and for that person to attend the meetings.

4.0 Budget Analysis

Spending for this award is on track with projected program expenditures. The University of Hawai‘i Office of Research Services submitted a semi-annual financial report for the period ending September 30, 2019, through Grants Online. That report showed total receipts of \$7,133,946.69.

As of November 30, 2019, internal budget tracking shows expenditures of \$7,587,294.45 representing a draw down of 68.9% of the Federal funding for this 5-year award.

**Performance Progress Report Addendum
(covering December 2018 – November 2019, unless otherwise stated)**

Education and Outreach Inventory

The Education and Outreach Inventory has been updated with PacIOOS activities. Please see the Google Doc for responses.

https://docs.google.com/a/noaa.gov/spreadsheets/d/1gjQiCa_cf1IGUNZPSoS4OG5CAKSXW_ejCFEVjLEOZHE/edit?usp=sharing

Data Management, Products, and Services

The PacIOOS data management group (DMG) ensures the data collected by PacIOOS are stored and accessible to users via standard services. Progress and challenges toward addressing each data management requirement are described below. See PacIOOS Data Management System (DMS) Plan (2016) for details.

1. Open Data Sharing

PacIOOS adheres to the NOAA Data Sharing Procedural Directive. All real-time and near real-time data managed by PacIOOS are freely available through open services, without delay or restriction. Avenues for accessing the data are available through the PacIOOS website: <http://www.pacioos.hawaii.edu/data-access/servers/>. Geospatial data are served via GeoServer and OpenLayers. PacIOOS does not restrict access to any data it collects or serves. Metadata are provided for all data, and data are machine-readable.

2. Data management planning and coordination

PacIOOS ensures local data storage and is working with NCEI for permanent archiving of data. PacIOOS routinely updates our data management plan, which was also part of our successful certification package. The PacIOOS DMG enables activities within PacIOOS modeling groups. PacIOOS continuously strives to make improvements to the system to ensure that regional DAC maintenance is stable, reliable, and efficient. Funding is always a challenge when planning for long-term operations and maintenance, including of a DMAC system. Additional funding sources outside of IOOS are continuously being pursued in order to ensure continuity and stability of the DAC.

PacIOOS supports data management coordination by participating in the operations, maintenance, and evolution of the national DMAC subsystem, including attending annual meetings and joining webinars and conference calls throughout the year. PacIOOS actively participates in cross-regional data management policy and implementation plan development, when invited to do so. PacIOOS is willing to participate in national data management committees and forums.

3. Provision of data to the Global Telecommunication System (GTS)

PacIOOS data that go through the functional DACs (e.g., data from the PacIOOS wave buoys) are sent by the DAC to the GTS when appropriate. WMO numbers were obtained this reporting period for the remaining observing platforms (near shore sensors (NSS) and

water quality buoys (WQB)). A sample data set from a Water Quality Buoy was selected as a test case, and data from this buoy now go to the GTS via ERDDAP and NDBC. Given the success of this test, data from the other NSS and WQB will be processed in a similar way.

4. Data access services

All PacIOOS data are made available via data access services, and all are registered in the IOOS Catalog. Direct, binary access is provided through standard open-source protocols. Our main service is OPeNDAP (Open-source Project for a Network Data Access Protocol), and the system is built around the Thematic Real-time Environmental Distributed Data Services (THREDDS) DODS Server (TDS). In accordance with IOOS requirements, PacIOOS has also employed Sensor Observation Services (SOS) for providing data from point measurements via the latest version of THREDDS ncSOS service. PacIOOS maintains several web-based data browsing and display tools for gridded, point, and geospatial data. One, a Live Access Server (LAS) was retired this year and replaced by ERDDAP. The Environmental Research Division's Data Access Program (ERDDAP) is used for a variety of services, including display and browse, and a Web Map Server (WMS) based on GeoServer, is used to serve geospatial data.

5. Catalog registration

All PacIOOS data have complete and accurate metadata. These metadata are provided in a web accessible folder (WAF) that is read by various catalog services, including the IOOS catalog service.

6. Common data formats

PacIOOS offers data in IOOS-approved common data formats, including but not limited to, NetCDF, flat IEEE binary, ASCII, CSV, HDF, GRIB, and GIS formats. Our format is consistent with the NCEI netCDF templates.

7. Metadata standards

PacIOOS data sets conform to the Federal Geographic Data Committee (FGDC) and/or ISO 19115. A python-based PacIOOS web catalog service (pyCSW) provides access to all metadata with query capabilities. All our metadata are in a WAF and catalog service.

8. Storage and archiving

Local storage for data streams is on a Redundant Array of Independent Disks (RAID) system, which is a single unit with multiple hard drives with data stored redundantly across the disks, so in the event of a hardware failure on a single disk data are preserved on another. In addition, all PacIOOS data are replicated across mirrored RAID systems. PacIOOS is currently working with NCEI to ensure archiving of PacIOOS data. We have set up a process to provide data to NCEI via a WAF. ERDDAP is used to aggregate the daily files into archive files. An initial test has been successful, and we are now waiting for all metadata vocabularies (particularly for QC flags) and for WMO numbers (see 3 above) before proceeding with the other WQB and NSS data. Storage and archiving of data that go through a functional DAC from PacIOOS are handled by each respective functional DAC.

9. Ontologies, vocabularies, common identifiers

The PacIOOS DM sub-system employs a service-oriented architecture (SOA), built on controlled ontologies, vocabularies and identifiers, that enables six essential functions: 1) data storage, 2) metadata management, 3) data discovery tools, 4) data transport servers, 5) on-line browse capabilities, and 6) data quality assurance/quality control (QA/QC). The vocabularies used for geophysical data adhere to the netCDF Climate and Forecast (CF) conventions. Biological data use the IOOS Biology Standard that is based on Darwin Core.

10. Consideration for Long-term Operations

PacIOOS aims to maintain and enhance a system that will persist long-term. Changes to the IOOS DMAC policies and procedures, such as QARTOD updates, will be incorporated as necessary. While PacIOOS has implemented, and will continue to implement automation in the system (through programming, etc.) as much as possible, there will also be a need for experienced, knowledgeable personnel. Federal requirements, software, stakeholder needs, etc. are always changing, and automation cannot always appropriately accommodate such evolutions. Funding, therefore, is always a key consideration when planning for short- or long-term activities. Therefore, PacIOOS' strategic goals moving forward include the need to diversify and expand funding and leveraged resources to create a resilient and robust financial foundation. Additional funding sources outside of IOOS are continuously being pursued in order to ensure continuity and stability of the DAC. This is an ongoing challenge.

Observing Assets

1. RA Observing Asset Inventory

Please see the attached Observing Asset Inventory spreadsheet for PacIOOS.

2. HFR Operations and Maintenance progress

Please see the attached spreadsheet for an annual update on HFR expenditures. Also, please see the attached annual update on HFR assets and staffing.

3. Annual Glider Days Inventory

Please see the attached Annual Glider Days Inventory spreadsheet.