

**Performance Progress Report**  
**Developing the Pacific Islands Ocean Observing System (PacIOOS)**  
**Cooperative Agreement # NA16NOS0120024**  
**Performance Period: June 1, 2020 through November 30, 2020**

**Submitted December 2020 by:**  
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This report covers activities conducted during the ninth 6-month performance period of this 5-year cooperative agreement. PacIOOS’ operating budget for the fiscal year is \$4,260,602.67.

## **1.0 Progress and Accomplishments**

### **REGIONAL GOVERNANCE AND MANAGEMENT SYSTEM**

**Finalize Subaward for Wave Buoy Training; Original completion date:** November 2020. *Status: Complete. While the subaward is now in place, actual planning for the workshop has been delayed due to regional travel restrictions still in place due to COVID-19. The nature of this workshop requires in person training. If travel restrictions do not let up in the Spring of 2021, however, we will reassess options to achieve the objectives of this subaward.*

**Governing Council Elections; Original completion date:** August 2020. *Status: Complete. September 2020. Six organizational seats were up for election this year—four Hawai‘i seats and two Regional seats. Forever Oceans, Hawai‘i Pilots Association, and the Association of Pacific Island Legislatures are newly elected members to the council. Re-elected members include: Hawai‘i Coastal Zone Management Program, Mālama Maunaloa, and U.S. Army Corps of Engineers.*

**Convene Governing Council meeting; Original completion date:** November 2020. *Status: Complete. October 2020. Members of the PacIOOS Governing Council gathered virtually across six time zones for the annual meeting. Members from across the region represent various sectors and provide valuable feedback to help guide the future of the program. The focus of the one-day (split into two half days due to time zone differences) video conference was to provide program updates, and to discuss the proposed scope of our 5-year proposal and 10-year outlook.*

### **OUTREACH, STAKEHOLDER ENGAGEMENT, AND EDUCATION SUBSYSTEM**

**Pivot as necessary to achieve objectives of PacIOOS capacity building and stakeholder engagement meetings/workshops; Original completion date:** May 2021. *Status: Delayed. Due to the demands of our 5-year proposal development as well as the challenges the pandemic is facing our partners and stakeholders in the Pacific Islands, we have delayed action on this milestone until early 2021.*

**Continue to follow-up on DBCP PI-4 and OceanObs'19 synergies and collaboration;** **Original completion date:** Ongoing. *Status: Delayed. Some discussions have occurred, especially between the Global Drifter Program and PacIOOS for dissemination of small wave buoys in the islands, but realities of COVID-19 have delayed discussions with local partners.*

**Continue to seek additional funding to support ocean observing in the region and address stakeholder needs;** **Original completion date:** Ongoing. *Status: Ongoing. PacIOOS collaborated with partners and to successfully secure UNDP funding through a series of contracts for 2 new wave buoys each for Palau and the Marshall Islands.*

**Collaborate with NOAA OCM, other partners, and coastal management stakeholders to implement Data Ocean Sharing Initiative;** **Original completion date:** May 2021. *Status: In progress. The local project steering team agreed to hire a consultant to coordinate this project and move implementation along. PacIOOS hired EcoLogic, LLC, a local consulting entity that has experience in this topic area and this region, at the beginning of November. The lead from EcoLogic, Miranda Foley, has held one small kick-off meeting with PacIOOS and our partner on a related PI-CASC-funded project that was identified through synergies with the Ocean Data Sharing Initiative.*

**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 virtual meetings. In-person stakeholder meetings and community outreach and education efforts were suspended for this reporting period due to social distancing requirements related to COVID-19. Specific activities during this reporting period are listed below.*

#### **Outreach Efforts**

- *PacIOOS continues to publish and distribute monthly e-newsletters; more than 140 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 2357 recipients receive monthly updates. Highlighting PacIOOS data users and their specific use cases helps to illustrate the breadth of our stakeholders.*
- *Increased public awareness and interest for PacIOOS through media news releases and media coverage by collaborators and partners, including articles such as: Measuring marine toxins and pollutions in Marshall Islands; \$4.26 to support Pacific Islands Coastal, Ocean Observing; \$510 to research climate impacts of Hawai'i fisheries; UH researchers create free coral health monitoring tool; New UNEP funding to support climate resilience in Pacific Islands through early warning systems; and more.*
- *During this reporting period, the PacIOOS website was visited by over 59K users who had more than 196K sessions.*
- *Page views for the PacIOOS wave buoys alone totaled at over 355K. Data of CDIP website stats and NDBC website stats, data requests, and RSS requests are currently not available.*
- *PacIOOS' Facebook page has more than 1,520 likes; Twitter following increased to over 517 followers.*

### **Stakeholder Engagement**

- Throughout the summer of 2020, PacIOOS staff reached out individually to more than 500 partners across the Pacific Islands region, to solicit feedback for the 5-year proposal development. A total of 370 comments were received with input on coastal and ocean observing needs, priorities, and potential collaborations.
- Engaged via video conferences with stakeholders from various sectors to discuss collaborations, including agency partners (U.S. Army Corps of Engineers, Hawai‘i Office of Planning, Hawai‘i Department of Transportation, Hawai‘i Division of Aquatic Resources, ), non-profit organizations (South Kohala Coastal Partnership), and other programs and partners (Pacific Community, Hawai‘i Pilots Association, and Hawai‘i Sea Grant).

### **Collaborative Efforts, Events and Conferences**

- Served on the Steering Committee for the Hawai‘i and Commonwealth of the Northern Mariana Islands Coastal Resilience Assessments led by the National Fish and Wildlife Foundation
- Provided presentations at the (virtual) Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) conference, and the International Conference on Coastal Engineering; participated in the Pacific Islands Climate Adaptation Science Center (PI-CASC) Science Summit
- Online participation with NOAA Pacific Regional Outreach Group (PROG), State of Hawai‘i Ocean Resources Management Plan (ORMP) Working Group, and IOOS Outreach Committee.
- Mentoring of undergraduate college students and high school students by water quality team to support sensor and buoy program.
- Integration of PacIOOS data in UH Hilo Marine Science undergraduate projects.
- Participate with other IOOS Regional Association in IOOS’ economic evaluation survey.

## **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. Required maintenance for the two Hawai‘i Island HFR has been delayed to due COVID travel restrictions.

PacIOOS also participated in this year's virtual Radiowave Operators Working Group (ROWG), presenting an overview of the University of Hawai‘i in-house-built, open-source, and open-design HFR system that PacIOOS is using. <http://www.pacioos.hawaii.edu/currents-category/obs/>

**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. Four buoys broke free from their moorings during this reporting period: Kauai in July and November; Waimea in September; and Maui in October. Status updates for these buoys are provided below. In addition, Ipan was preemptively recovered due to concerns with major communication drops from the buoys. On August 9, the Mōkapu wave buoy celebrated its 20th anniversary! SOEST deployed the Mōkapu wave buoy as its first wave buoy in Hawaiian waters. Two decades later, this wave buoy site is still going strong and recording wave conditions every 30 minutes. <http://www.pacioos.hawaii.edu/waves-category/buoy/>

**Hire new wave buoy technician; Original completion date:** November 2020. **Status:** In progress. The position description has been drafted and submitted to RCUH for review, approval, and posting. We hope to post the position before the end of the calendar year. A notice of the upcoming posting was included in our November newsletter.

**Redeploy Ritidian wave buoy; Original completion date:** August 2020. **Status:** Complete. This buoy broke free at the end of last year during a storm with maximum waves heights of 34ft. Due to persistently rough ocean and weather conditions, followed by COVID-19 related travel restrictions, PacIOOS staff were unable to redeploy the wave buoy earlier this year. We were able to work with and train local partners to successfully deploy the buoy for us earlier than anticipated, in June 2020.

**Redeploy Hanalei and Waimea wave buoys; Original completion date:** November 2020. **Status:** Partially complete. Waimea was redeployed in September. Hanalei was redeployed in October 2020, only to break free soon thereafter. Shark activity is suspected. A new mooring design is in progress and will be deployed during the next reporting period.

**Swap Kalaeloa and Pearl Harbor wave buoys; Original completion date:** August 2020. **Status:** Complete. A new buoy was swapped at Kalaeloa in July 2020, and Pearl Harbor was swapped in August 2020. 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 Maui wave buoy; Original completion date:** November 2020. **Status:** Delayed. The buoy broke from its mooring before we were able to swap it out for new one. The buoy has been retrieved, and the team is working on travel logistics (inter-island) in order to deploy a fresh buoy on site.

**Maintain operations of nearshore water quality sensors, data online; Original completion date:** Ongoing. **Status:** Ongoing. PacIOOS currently has 5 near shore sensors operational in Hawai'i (4 on O'ahu, 1 on Maui), 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. Dynamic graphs and map viewers are on the PacIOOS website. <http://www.pacioos.hawaii.edu/water-category/sensor/>

The partners maintaining sensors in the Insular Pacific have been impacted to various degrees due to COVID. The team is working with partners to identify options to continue maintaining the sensors.

**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 two sensors deployed (Maalaea Harbor in Maui, and Babeldaob, Palau). The Palau project is with a local non-profit organization, Ebiil Society, who is monitoring water quality downstream of a terrestrial/forest restoration site. The Maalaea Harbor project is with the Maui Nui Marine Resource Management Council to monitor conditions in this highly used local harbor. All WQSPP data of completed projects are now available on the PacIOOS website under archival sites: <http://www.pacioos.hawaii.edu/water/sensor-archive/>

**Develop data interpretation product template for WQSPP projects; Original completion date:** November 2020. *Status:* In progress. A draft template for WQSPP projects has been developed and circulated within PacIOOS. The template will be finalized in early 2021, with additional input from local partners, including previous WQSPP partners.

**Transition to new cellular modem for Pelekane Bay Water Quality Buoy; Original completion date:** February 2021. *Status:* Complete. Dr. Steve Colbert along with his team of students at UH Hilo refurbished the water quality buoy with new solar panels, new data loggers and cellular modem, and an EXO sonde. The sonde collects data of water temperature, salinity, turbidity, chlorophyll, and oxygen in 15-min intervals. This coastal mooring helps to establish baseline data of coastal water conditions in Pelekane Bay, which often experiences high levels of turbidity.

**Maintain operations of Hawai'i Island water quality buoys, data online; Original completion date:** Ongoing. *Status:* Ongoing. Data are transmitted hourly and available on the PacIOOS website: <http://www.pacioos.hawaii.edu/water/wqbuoy-pelekane/>  
<http://www.pacioos.hawaii.edu/water/wqbuoy-hilo/>

**Manufacturer repair PacIOOS SeaGlider; Original completion date:** November 2020  
*Status:* Complete. The PacIOOS SeaGlider was sent to Kongsberg for servicing and repair in November 2018. We finally received the repaired glider back from what is now Hydroid, Inc. in October 2020.

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

- Continued partnership with numerous NOAA and American Samoa partners to maintain GPS readings of the new MAPCO2 buoy in Fagatele in the National Marine Sanctuary of American Samoa. The buoy has stopped collecting data and needs to be serviced. Travel restrictions due to COVID are delaying activities.
- Continued maintenance of the weather station at the entrance of Honolulu Harbor.  
<http://www.pacioos.hawaii.edu/weather/obs-honolulu/>

## DATA MANAGEMENT AND CYBERINFRASTRUCTURE (DMAC) SUBSYSTEM

**Upgrade server hardware for DMAC central infrastructure; Original completion date:** November 2020. *Status: Complete.* New hardware has been configured; in the next quarter it will be relocated to a new server room with the other PacIOOS computing facilities.

**Complete PacIOOS DMAC server migration; Original completion date:** November 2020. *Status: In progress.* **New target completion date:** March 2021. *DMAC staff continue to migrate PacIOOS servers from a single server to a stack of servers running Virtual Machines (VM). The plan is to take advantage of VM management and parse different services to different VM's, thus eliminating single points of failure. The team has successfully migrated the main services, i.e., the PacIOOS website, THREDDS, and ERDDAP. The final service to move is DataTurbine, which PacIOOS uses to manage real-time data from various in-situ platforms. This step has been delayed due to time availability of the contractor, but it is in progress.*

**Identify and ingest of new biological data sets with regional partners; Original completion date:** Ongoing. *Status: Ongoing.* PacIOOS will continue to work with the local Pacific Islands Fisheries Science Center (PIFSC) and the IOOS Program Office to identify and publish new data to OBIS.

**Hire data analyst to assist with DMAC operations; Original completion date:** November 2020. *Status: Delayed.* *Other commitments of the data management team, and challenges due to COVID-19 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:

- *In October, PacIOOS became the first IOOS Regional Association to be recertified by NOAA for another five years.*
- *During this performance period, over 177,203 unique visitors (via direct external access to our servers) accessed more than 29.13 million pages in our servers (TDS, ERDDAP) and transferred over 16.41TB of data.*
- *The water characteristic data from three short-term water quality sensors owned by the State of Hawai'i Department of Health Clean Water Branch and deployed by PacIOOS in Maunahua Bay, O'ahu, are now available on the PacIOOS website.*
- *PacIOOS implemented the most recent updates of NOAA's Coral Reef Watch products, Version 3.1. on PacIOOS Voyager, TDS, and ERDDAP. Specifically, changes in the underlying netCDF data files needed to be made to the NOAA/NESDIS operational products. The suite of operational global satellite coral bleaching heat stress monitoring products have a 5-km resolution and are produced daily in near real-time. It includes data sets of sea surface temperature (SST), SST anomaly, coral bleaching alert areas, coral bleaching hot spots, and degree heating weeks. In addition to the coral bleaching alert areas, the coral bleaching alert area 7-day maximum has been added.*

## MODELING, ANALYSIS, AND PRODUCT DEVELOPMENT SUBSYSTEM

**Maintain 6-day high-water level forecasts; tailored using ongoing feedback (e.g., multiple thresholds); forecasts available online; Original completion date:** Ongoing. *Status:* Ongoing. *Continued ongoing maintenance of data streams. Enhancements for the Pago Pago HSL forecast were made, with thresholds established based on ground-truthing during events, but the actual forecast is down due to the tide gauge data stream (non-PacIOOS asset) being down and travel restrictions inhibiting technicians being able to fix it.*

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

**Maintain wave run-up forecasts; tailored using 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. Enhancements for the Waikiki wave run-up forecast were made, with thresholds established based on local input. The next step is to continue vetting with key users before going live with the changes.*

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

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

**Convert West Maui model to forecast tool; Original completion date:** August 2020. *Status:* Complete. *The forecasts are currently being produced in their operational modes for all twelve regions that cover the West Maui coast from Honolulu Bay in the north to Papalaua Wayside Park in the south. These forecasts will go live after additional calibration and consistency checks specific to each region, and outreach with key stakeholders and users of the beta version of the webpages, planned for the first quarter 2021.*

**Support fieldwork for data to validate the West Maui model; Original completion date:** November 2020. *Status:* Complete. *The team now has in situ data coverage along the entire stretch of the West Maui region, with recent field sites focused on the parts of the region impacted by southern swells. The data will be quality controlled and converted from raw pressure data to sea level; then they will be used to check how the model is performing, especially for the southern domain.*

**Maintain harbor surge forecast; tailored using ongoing feedback/new inputs; forecast available online; Original completion date:** Ongoing. *Status:* Ongoing. *The Hale'iwa Harbor Surge forecast was down for part of this reporting period due to maintenance issue at NCEP when they transitioned the WaveWatch III model to its new instance. The harbor surge forecast relies exclusively on the directional spectra time series from virtual buoys and has no other backup, hence the delay in bringing the forecast back online. The issue has been resolved, and the forecast is again operational. Work is ongoing to refine the harbor surge forecast and obtain non-IOOS funding to expand locations. With our partners, we continue to make progress toward the development of a harbor surge forecast for Kahului Harbor in Maui, and we have developed a plan for deployment of pressure sensors and current meters to quantify the different wave-generated threats and their spatial variations within the harbor, and to relate these threats to incident swell characteristics (e.g., significant wave height, peak period, and direction). The deployment plan is still being refined for submission to USACE for permitting. The existence of*

COVID-19 has altered access to the harbor, requiring a re-evaluation of the deployment plan. We currently are only allowed to access the harbor on Sundays, which creates significant problems regarding travel from/to O‘ahu to/from Kahului, lodging, etc. Inter-island travel remains a challenge due to frequently-changing COVID-related requirements. A deployment date will be set after permitting, and will depend on the state of the pandemic regulations. <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.

**Observation forecast impacts for ROMS running operationally; Original completion date:** Ongoing. **Status:** Ongoing. We now have an experimental setup that quantifies how each observation improved (or degraded) the forecast for a particular metric. Currently, we are using the transport metric in Hawai‘i.

**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, allowing for a seamless integration of physical and biogeochemical parameters. The goal is to incorporate the ecosystem output into PacIOOS’ daily ocean modeling forecasts; however, the assimilation of biogeochemical data is a significant hurdle that we will need to work on in the coming years. We are collaborating with partners in CenCOOS on the work they are doing to incorporate biogeochemical data assimilation. We have received funding from NOAA MAPP to perform a suite of projections through the end of the century to examine the impacts of climate change on the fisheries around Hawai‘i. Initial model results for the time period 2010-2017 have shown that the availability of light is the most significant driver in the seasonal cycle of organisms around Hawai‘i. <http://www.pacioos.hawaii.edu/new-tools/new-comprehensive-ecosystem-model-hawaii/>

**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 (WaveWatch III and SWAN) models for Hawai‘i, Mariana Islands, and Samoan Islands; Original completion date:** Ongoing. **Status:** Ongoing. All models are operational. <http://www.pacioos.hawaii.edu/waves-category/model/>

## RESEARCH AND DEVELOPMENT SUBSYSTEM

### **Transmitting tags (including ocean profiling tags) deployed on pelagics (sharks)**

**throughout the year; Original completion date:** Ongoing. **Status:** *Ongoing. Deployment of satellite-linked ocean profiling tags has been severely impacted due to restrictions on small boat use in the islands due to COVID-19. New COVID protocols were approved by the UH in September 2020, and our team filed a specific ocean field work (tagging) protocol that was approved. A low level of field activity has now resumed, and we are hopeful of deploying tags during the last quarter of 2020. The team continues to develop data transfer protocols to allow transfer of ocean profiles to PacIOOS data portal.*

<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 (“Motes”) are deployed on O’ahu, and 2 are deployed on Maui, to collect and forward data from tagged sharks. During the reporting period the O’ahu receivers on Mt. Ka’ala and at Ka’ena Point were upgraded and reinstalled. Additional Motes funded through a subaward from NERACOOS (ONR funding) have been ordered and are in the vendor’s assembly ‘pipeline.’ These Motes will be received in January 2021, and deployed on the Kona coast of Hawaii Island, when COVID travel restrictions are lifted.*

### **Continue to assist the IOOS ATN DAC with data ingest of ocean profiles from telemetered**

**animals; Original completion date:** Ongoing. **Status:** *Ongoing. Historical shark tracks have been provided to the ATN DAC and used to refine and test transfer protocols for these kinds of data. These tracks were successfully ingested by the DAC and are available for viewing. Associated depth/temperature profiles have yet to be linked to these tracks but work on this aspect is ongoing.*

## **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. One organization, the Association of Pacific Island Legislatures (APIL), became a MOA partner with PacIOOS.

## **4.0 Budget Analysis**

Due to numerous restrictions and pivots due to COVID-19, we are slightly behind on spending. The University of Hawai‘i Office of Research Services submitted a semi-annual financial report for the period ending September 30, 2020, through Grants Online. That report showed total receipts of \$9,609,311.31. As of November 30, 2020, internal budget tracking shows expenditures of \$10,157,178.34 representing a drawdown of 66.56% of the Federal funding for this 5-year award.

## **Performance Progress Report Addendum (covering December 2019 – November 2020, 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](https://docs.google.com/a/noaa.gov/spreadsheets/d/1gjQiCa_cf1IGUNZPSoS4OG5CAKSXW_ejCFEVjLEOZHE/edit?usp=sharing)

### **PacIOOS Data Management, Products, and Services**

The PacIOOS DMAC subsystem enables the public to discover, access, and understand ocean and coastal information collected by PacIOOS and regional partners. The PacIOOS data management group (DMG) ensures the data collected by PacIOOS are stored and accessible to users via standard services. A brief description of how PacIOOS DMAC complies with the [IOOS core capabilities](#) and the NOAA data sharing requirements is below. Please see the PacIOOS Data Management System (DMS) Plan (2020) found on our [recertification webpage](#) 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 ascribe to the [GEOSS data sharing principles](#) are freely available through open services, without delay or restriction. Avenues for accessing the data are available through the [PacIOOS website](#). Geospatial data are served via GeoServer and OpenLayers. PacIOOS is committed to maintaining the FAIR data principles (Wilkinson et al., 2016). We do not restrict access to data. Metadata are provided for all data, and data are machine-readable.

#### **2. Data Management Planning and Coordination**

PacIOOS maintains a local data storage system and collaborates with NCEI for permanent archiving of appropriate data. The PacIOOS DMS Plan (PacIOOS, 2020) is regularly updated and is part of our successful recertification package through NOAA. In addition to being a regional data provider, PacIOOS also provides the infrastructure for data-assimilating models to receive data. PacIOOS continuously strives to make improvements to the system to ensure that regional DAC maintenance is stable, reliable, and efficient. PacIOOS supports data management coordination by participating in the operations, maintenance, and evolution of the national DMAC subsystem, including contributions via annual meetings, 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 consistently contributes to national data management committees and forums.

#### **3. Data Access**

All PacIOOS data are made available via standard 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). The Environmental Research Division's Data Access Program (ERDDAP)

is used for a variety of services, including display and subsetting. GeoServer is used to serve geospatial data.

#### **4. Metadata and Data Formats**

PacIOOS follows Federal Geographic Data Committee (FGDC) and/or ISO 19115 metadata standards. A python-based PacIOOS web catalog service (pyCSW) provides access to all metadata with query capabilities. All our metadata are published on a public web page and via the catalog service. 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. 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.

#### **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 IOOS catalog service.

#### **6. Provision of Data to the Global Telecommunication System (GTS) via NOAA National Data Buoy Center (NDBC)**

PacIOOS data that go through the functional DACs (e.g., data from the PacIOOS wave buoys) are sent by the DAC to the WMO GTS via NOAA NDBC when appropriate. WMO numbers for remaining PacIOOS observing platforms (near shore sensors (NSS) and water quality buoys (WQB)) were obtained for this procedure. The data from these platforms are sent to the GTS via ERDDAP and NDBC.

#### **7. Storage and Archiving**

Local storage for data streams is on a series of 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 (requiring double the storage capacity). PacIOOS is working with NCEI to ensure archiving of PacIOOS data. We set up a process to provide data to NCEI via a WAF. ERDDAP is used to aggregate the daily files into archive files. The system hardware has been recently upgraded, and once real-time data services are fully migrated, data from the remaining NSS will be sent for archive in a similar way. Storage and archiving of data that go to a functional DAC are handled by each respective functional DAC. We currently collect over 6 TB of data per year, most of this model output. With higher resolution models and additional model grids proposed, we anticipate an increase in volume of data. If we start to archive video from our beach camera, this could increase the volume of data by another 1-2 TB/year. At minimum, we anticipate collecting 7TB/year of data per year of this proposal, and potentially upwards of 15TB/year.

#### **8. Sustained 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, are 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 always 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. To date, PacIOOS has been relatively successful obtaining external funding by leveraging the IOOS investment in our data management infrastructure to better serve stakeholder and partner needs. [Section XI](#) of the DMS details our cost structure for hosting "external" data.

## **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.