Progress Report
Developing the Pacific Islands Ocean Observing System (PacIOOS)
Cooperative Agreement # NA11NOS0120039
Performance Period: June 1, 2014 through November 30, 2014

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1.0 Project Summary

The Pacific Islands Ocean Observing System (PacIOOS) is the Regional Association (RA) for Hawaii and the Insular Pacific region being developed as part of the national Integrated Ocean Observing System (IOOS). The primary goal of the work proposed under this award is to continue the development of an operational ocean monitoring and forecasting system that provides integrated, customized, and timely products that enable an ocean-literate and well-informed public and policy makers in the Pacific Islands. PacIOOS is being planned and implemented through the collective efforts of a consortium of users, signatories to the Memorandum of Agreement, and 18-member Governing Council. PacIOOS has focused initial development on water quality sensing, ocean-state and forecasting, the provision of marine ecosystem information, prediction of coastal hazards, and the development of integrated data visualization capabilities to inform marine spatial planning, operations, commerce, and recreation. Through the efforts proposed under this award, PacIOOS will enhance development of observing and product suites in each of the aforementioned focus areas and will continue to engage users, stakeholders, and system partners in the use, extension, education, and outreach of technical capacity, data visualization, and ocean information.

This report covers activities conducted during the seventh 6-month performance period of a 5-year award. Currently in Year 4 of the 5-year award, PacIOOS is operating with an annual budget of $2,272,846.

2.0 Progress and Accomplishments

2.1 User Needs, Stakeholder Input and Partnerships

- New Signatories to the MOA:
    - Kampachi Farms, LLC.
    - CNMI Bureau of Environmental and Coastal Quality
    - Palau Community College

- Participation in NOAA Pacific Island Regional Team (PIRT), NOAA Sentinel Site Program, NOAA Pacific Regional Outreach Group (PROG), NOAA Aquaculture Group, NOAA Habitat Blueprint Program, and State of Hawaii Ocean Resources Management Plan (ORMP) Working Group.

- In their new partnership, PacIOOS and Liquid Robotics are exploring the option of hosting and sharing wave glider data for both stakeholders on the Big Island, and ocean modelers at PacIOOS/UH.
- PacIOOS and the NOAA NWS continue to explore options to move PacIOOS forecasts into an experimental guidance product with hopes to transition them to operational capacity within AWIPS.
- Continue to work with the company, Strategies 360, in evaluating the effectiveness of the program organization and communication.
- PacIOOS developed many new partnerships with local organizations focused on measuring water quality parameters in and around coral reef ecosystems. PacIOOS measures and provides water quality data and hosts related citizen science data for the benefit of programs such as the Maui's Coral Reef Alliance and Friends of Kewalo.
- PacIOOS continues to contribute to the community coastal restoration project in Lanai, in partnership with Hawaii Fish Trust and Conservation International.
- Attend Pacific Islands Regional Planning Body (RPB) meetings and calls to promote PacIOOS data services role for the region.
- PacIOOS staff engaged a wide variety of federal partners conducing work in and around the region, including the NOAA NCCOS Biogeographic Assessment Team, the NOAA NCCOS Coastal Fisheries and Habitat Research (aquaculture), BOEM (offshore energy), NOAA CO-OPS (inundation and SLR), and NOAA NCDC Regional Climate Services (flooding and inundation), NOAA CSC (Flash Flood Tool, SLR Viewer), through various events, including conferences, workshops, and meetings. The relationships result in more effective product development and outreach to stakeholders.
- Heather Kerkering and Melissa Iwamoto met with current and potential partners on the Big Island of Hawaii to learn about local needs, highlight PacIOOS activities, and to form new and strengthen existing relationships. Meetings were held with the following organizations: The Nature Conservancy, NOAA Kona Integrated Ecosystem Assessment (IEA), the South Kohala Coastal Partnership, Cascadia Research Cooperative, NOAA Hawaiian Islands Humpback Whale National Marine Sanctuary, local fishers, and more.
- PacIOOS staff engaged with stakeholders in Saipan to assess needs and to identify a new location for the near shore water quality sensor.
- PacIOOS continues two collaborative projects with the Hawaiian Islands Humpback Whale National Marine Sanctuary. We are providing geospatial and data expertise, space, and assistance for the Niihau Management Project. Additionally, our modelers provided ocean circulation information for a West Maui discharge study. Most recently, we are working with the Sanctuaries (and Fisheries) to serve as potential data managers and provides for the Habitat Blueprint efforts off of the Kona coast (Big Island).
- Discussions with the USCG Sector HNL and D14 focus on improving understanding of and access to UH resources (HFR and ROMS) that feed into SAROPS with the goal of improving Search and Rescue efforts and outcomes.
- Discussions with PacIOOS and the US Navy (Pacific Command, PacFleet, and 3rd Fleet) focus on identifying areas for future collaboration and mutual benefit.
- Increasing numbers of researchers are looking to PacIOOS to serve their research data to the public in a user-friendly manner, especially on our PacIOOS Project Pages.

Examples include Hawaii Tiger Shark Tracking (HIMB) and Sea Level Rise Inundation Risk (UH Sea Grant NOAA Coastal Storms Program) http://pacioos.org/projects/
- Secured USCG permit for installation and operation of HFR on Pepeekeo, Hawaii.
- Worked with fellow IOOS RAs to contribute to and build the IOOS Pacific Ocean Acidification Portal for the purposes of better serving the aquaculture communities.

2.2 Governance and Administrative Structure
- Elections were completed in June 2014. New Governing Council representatives include Pacific Disaster Center, Malama Maunalua, Waikiki Aquarium, and Palau Community College.
- PacIOOS revised the Memorandum of Agreement (MOA) to include a Conflict of Interest statement. PacIOOS also released a new Accountability and Liability document. The MOA revision and the new document were both approved by the Governing Council and signatories, as required.
- PacIOOS hosted a Governing Council Meeting in October on Oahu to measure success based on the programs' strategic operational plan and to place and secure a process forward for applying to the 2015-2021 IOOS FFO, with expected release in spring 2015.
- Co-PI meetings are held frequently to engage and update all recipients of IOOS funding through the PacIOOS cooperative agreement.
- Continue to participate in national IOOS activities that provide direction on the development of PacIOOS.

2.3 Business/Operations Plan
- Operations and future plans continue to be informed by the PacIOOS 5-year Strategic Operational Plan.
- An addendum titled, 'Addendum – Engagement, Planning, Prioritization, and Evaluation' was added to the 5-year Strategic Operational Plan for programmatic purposes and to meet the certification criteria.
- Continue to seek strong partnerships on neighbor islands to assist with operations and maintenance of near shore water quality sensors and offshore wave buoys.
- Continued to work with COL and IOOS Association to participate in and promote IOOS initiatives in a national priority setting.
- Leveraged funding and partnership opportunities with NOAA CSC, NOAA Coastal Storms Program, City and County of Honolulu, State of Hawaii, EPSCoR, UH Sea Grant, and NOAA PMEL.
- PacIOOS is working closely with NOAA IOOS office to complete the RICE Certification Application.

2.4 Planning, Design, and Implementation
- New wave buoy deployed off the island of Tutuila in American Samoa; reporting real-time data through the PacIOOS webpage.
- Wave buoy redeployed in Majuro – Republic of the Marshall Islands after a year hiatus; also reporting in real-time.
- Successfully recovered, redeployed, or swapped wave buoys at Hanalei, Hilo, Kahului, Ipan, Tanapag, Kaneohe, and Lanai.

- Deployed near shore water quality sensors at Kalama Beach Park in Kihei, Maui and in Kahului, Maui in collaboration with local communities and partners.
- Enhanced the Ala Wai Turbidity Plume Model by incorporating model wave data for the near shore environment.
- Release of the new PacIOOS Waikiki Ocean Model – a high resolution ROMS ocean prediction model for the Waikiki area.
- Continued a temporary near shore water quality monitoring on Lanai in partnership with Conservation International and Hawaii Fish Trust.
- Released a Six-Day High Sea Level Forecast for Malakal, Palau. http://pacioos.org/data_product_SLpred/Maj_Exc.php
- Release of the new High Sea Level Wave Run Up Forecast for Majuro. http://oos.soest.hawaii.edu/pacioos/data_product/SLpred/Maj_Exc.php
- Continue compiling WW3 input files from original NOAA NCEP sources to bypass WW3 FTP site, which was experiencing frequent delays and a long outage.
- PacIOOS wave forecasts validated daily with measurements from NDBC buoys.
- Expanded WW3 wave model to the Northwestern Hawaiian Islands.
- Continued re-analysis of PacIOOS Wave Run-Up Forecasts along the North Shore of Oahu in order to improve forecast process for multiple locations along the coast.
- Global comparison of time spectra of satellite vector wind products, based on collocated observations from QuikSCAT and ASCAT. This study is important for numerous applications, including construction of seamless win climatology.
- One of two Hilo HFR installations completed. The USCG recently permitted the second system and installation has begun.
- Testing of prototype pop-up satellite tags capable of measuring oxygen concentrations throughout the water column.
- Continued tagging effort leveraged with State of Hawaii and PacIOOS funding. All implanted with acoustic transmitters; 10 equipped with fin-mounted 'SPOT' satellite transmitters. Data available on PacIOOS website.
- Continual service and maintenance of all water quality sensors (NSS) and buoys (WQB) throughout PacIOOS region.
- Trained new personnel on how to service, maintain, and download data from NSS in insular Pacific.

2.5 DMAC

The PacIOOS data management group (DMG) is tasked with ensuring the data collected by PacIOOS is stored and accessible to users via standard services. In addition, the DMG develops tools and products based on the collected data. Accomplishments by the DMG during this reporting period include the following:

- Released new Project Page: Sea Level Inundation Risk for Honolulu.
- Continued the development and update of the Hawaii Tiger Shark Tracking page in partnership with Hawaii Institute of Marine Biology (HIMB) researchers funded by the State of Hawaii to display near real-time tracks and locations of tiger sharks tagged off Maui. http://pacioos.org/projects/sharks/
- Release of a search toolbar in Voyager to make it easier to locate information of interest.

- Development and release of 'Super-Categories' in Voyager to ease navigation through the hundreds of existing overlays.
- Updated and improved coordinate formats in Voyager to satisfy user requests for degrees minutes. The new format is also now the default format.
- Collaborated with Liquid Robotics to provide real-time displays on a wave gliders deployed during Tropical Storm Iselle and Tropical Storm Ana. The display includes location as well as measurements made by the glider instruments.
- New data holdings added to the PacIOOS Voyager, our data visualization and download tool, include:
    - WW3 model output for the Northwestern Hawaiian Islands.
    - Real-time atmospheric and oceanic carbon dioxide data from 13 moored buoys across the insular Pacific. The three-hourly data are obtained from NOAA's Pacific Marine Environmental Laboratory (PMEL). These data are available in a new 'ocean acidification' category on Voyager.
    - Wave glider data from Liquid Robotics for Tropical Storms Iselle and Ana.
    - High resolution ROMS model for the Waikiki area: the PacIOOS Waikiki Ocean Model.
    - New wave buoy in American Samoa.
    - Computer model simulations of sea level rise for Hawaii (Hawaii Island, Kauai, Lanai, Maui, Molokai, and Oahu), Guam, and Saipan, showing the inland extent of coastal flooding due to SLR scenarios at 0 to 6ft above current day higher high water.
    - Wave Run-Up Forecast for Majuro Atoll in the Republic of the Marshall Islands.
- Development and release of a catalog web service to allow users to search the vast PacIOOS data holding in an automated fashion (near completion).
- Continue to enhance user interface and experiences on the web page.
- Continuously work with data and technical staff in each of the focus areas to improve user experiences and access to products and data.
- All of DMG continues to work toward meeting all of the IOOS goals and requirements.

2.6 Education, Outreach and Public Awareness

- During this reporting period, the PacIOOS website had 480,622 unique page views from 117,735 users. PacIOOS also gained our 1000th like on Facebook!
- PacIOOS continues to publish and distribute monthly e-newsletters to over 1200 contacts.
- In collaboration with COSEE Island Earth, PacIOOS kiosks have been developed and shipped to multiple locations. Kiosks are up and running at University of Guam, Maui Ocean Center, Dolphin Quest (Kohala Coast, Big Island), and Whalers Village (Lahaina, Maui). Others are in the process of being deployed at the following locations: UH Maui College, Windward Mall (Kaneohe, Oahu), Mokupapapa Discovery Center (Hilo).
- Collaboration with UH Maui College to develop classroom activities using data available on PacIOOS Voyager, focusing on data relevant to student experiences and real-world decision-making. UH Maui continues to run these activities in the Introduction to Oceanography lab. PacIOOS is also working with high schools on Oahu - Punahou, Iolani, and Kamehameha Schools to access and use real-time water quality data on Voyager.

- Presentations for numerous organizations, groups, and events including Hawaii Fishpond Caretakers, Kona Integrated Ecosystem Assessment, Waikiki Aquarium 10th Anniversary, Asia-Pacific Clean Energy Summit and Expo, and The Coastal Society Symposium.
- Exhibits at multiple local events, including the North Shore Ocean Festival, Friends of Kewalos Beach Clean-up Event, and Turtle Bay Biathlon.
- Continue to produce updated and relevant flyers and materials for workshops, conferences, partner meetings, and general outreach.
- Enhanced presence on social media outlets, including Facebook and Twitter.
- Collected and published success stories illustrating value of PacIOOS data, tools, and services.
- Increased public awareness and interest in PacIOOS with targeted, engaging press releases including:
    - 'Maui coasts suit tiger sharks, study finds': Honolulu Star Advertiser
    - 'Study Now Tracking 24 Tiger Sharks, Shows Habitat Insights on Maui, Oahu: Maui Now
    - 'Tracking tiger sharks: Key research findings released': Hawaii News Now
    - 'PacIOOS wave buoys serving communities across the Pacific': UH
    - 'PacIOOS wave buoy now serving Am. Samoa and the Pacific': Samoa News
    - 'Teams deploy wave buoy off Majuro': The Marshall Islands Journal
    - Ala Wai Plume Model: Ka Leo, Island Times, UH Manoa,
    - 'New model forecasts potential sea level flooding in Apra Harbor and Malakai': TIA BELAU
    - 'New tools forecast potential sea level flooding events': UH Manoa
    - 'UH Researchers Debut New Tool to Predict Seawater Flooding': Honolulu Civil Beat; Hawaii News Now; Phys.org; KITV News; UH Manoa.

2.7 National and International Collaborations

- PacIOOS continues to participate in all IOOS and IOOS Association conference calls and workshops.
- Melissa Iwamoto replaced Heather Kerkering as a member of the Finance Committee of the IOOS Association Board. Chris Ostrander also remains a member of the board.
- Chris Ostrander continues to serve on the IOOS Federal Advisory Committee.
- Chris Ostrander continues to serve on the Indo-Pacific Oceanography Reference Group (UNESCO-IOC).
- Jim Potemra participates in all monthly DMAC conference calls and annual meetings, as well as the marine portal forum.
- Melissa Iwamoto and Chris Ostrander represented PacIOOS as the IOOS Association Board meeting in November.
- Chris Ostrander and Jim Potemra both serve on the Pacific Islands Global Ocean Observing System (PI-GOOS) advisory board.

- PacIOOS collaborated with all of the RAs to present an Ignite-session panel at The Coastal Summit in Alexandria, VA in November.
- PacIOOS participated in a NOAA Panel: Ocean Data for PacIOOS Offshore Energy at the Asia-Pacific Clean Energy Summit and Expo in Honolulu.

3.0 SCOPE of WORK

3.1 User Needs, Stakeholder Input and Partnerships

- Continue to work with Pacific Regional partnerships and NOAA Pacific Regional Team.
- Continue to advocate for PacIOOS as a data provider for Pacific regional efforts.
- Develop tutorials focused on specific user groups and management questions.
- Engage PacIOOS MOA signatories and Governing Council members to help address stakeholder needs.
- Continue to increase engagement through Governing Council members and PacIOOS liaisons.
- Engage and survey stakeholders and partners to inform the 2016-2021 proposal. This will involve travel to Guam, Saipan, American Samoa, Majuro, and inter-island Hawaii.
- The feedback gathered from stakeholders will also help inform the creation and design of a new PacIOOS website.

3.2 Governance and Administrative

- Host Governing Council Executive Committee meeting in Majuro, March 2014.
- Continue to participate in national IOOS activities that provide direction on the development of PacIOOS.
- Continue to meet frequently with PacIOOS PIs and focus area groups.
- Conduct PacIOOS administration and staff evaluations.

3.3 Business/Operations Plan

- Conduct operations with the main goal of developing a successful and effective 5-Year, 2015-2021 proposal.
- Continue working with NOAA IOOS office to refine and finalize the PacIOOS RICE certification application.
- Complete an internal performance evaluation in relation to the PacIOOS 5-yr Strategic Operational Plan.
- Continue to identify and leverage funding and partnership opportunities with partners.
- Implement consultant suggestions for improved communications.

3.4 Implementation Activities

- Continued full-time operations, maintenance, deployment, swapping, and recovery of all 13 wave buoys throughout the Pacific, including redeploying Hanalei and Tanapag, Saipan buoys.
- Redeploy PacIOOS Kiholo Bay water quality buoy.
- Deploy new CNMI near shore water quality sensor in new location.
- Acquire necessary permits for deployment of PacIOOS assets.
- Develop new PacIOOS wave run-up forecast tool for Kwajalein.

- Continued analysis of data for improving the PacIOOS wave run-up forecast tool and adding new locations along the North Shore of Oahu.
- Analyze data collected in Haleiwa Harbor to improve the PacIOOS harbor surge forecast tool. Begin collecting data on currents in Barber's Pt. Harbor.
- Add NCEP storm surge forecast product to PacIOOS waves and waver-level forecast tools.
- Produce a technical report addendum for the Six-Day High Sea Level Forecast and a new technical report for the Wave Run-Up Forecast.
- Finalize installation of second Hilo HFR at Hamakua and provide coverage of Hilo Bay in coordination with the Keaukaha (Hilo) HFR.
- Installation of HFR at Kapolei, Oahu at Chevron Refinery.
- Upgrades to HFR installations on Oahu, including more antennae, wind turbines, and Faraday shielding.
- Address backlog of quality-controlled and reprocessed HFR data (*backlog due to new installations and replacements of WERA radars*).
- Continued testing of prototype pop-up satellite tags measuring oxygen (on top marine predators).
- Continued participation in IOOS OTN Initiative with acoustic receivers.
- Increased number of tagged animals, especially off Oahu, leveraged with State of Hawaii funding. Continue to provide near real-time shark tracks on PacIOOS website.
- Deploy new YSI water quality buoy in Pelekane Bay (Big Island), purchased with EPSCoR funding.
- Continue participating in the IOOS Pacific Ocean Acidification Portal development.

3.5 DMAC

- Continue to add additional tiger sharks to Hawaii Tiger Shark Tracking project page, as data become available.
- Work with the City and County of Honolulu (CCH) to finalize the Mamala Bay project page, leveraged with CCH funding.
- Continued expansion and addition of data into PacIOOS Voyager and Voyager mobile.
- Continue meeting IOOS DMAC protocols.
- Copy and locate PacIOOS data servers into a 24/7 secured, operational facility on the University of Hawaii at Manoa campus.

3.6 Education, Outreach and Public Awareness

- Examine options for refining website for a more user-friendly experience.
- Hire staff to update PacIOOS website for improved user experience and enable a content management system to make maintenance easier and more seamless for staff.
- Continue working with COSEE to code and deploy PacIOOS kiosk on Kauai.
- Work with partners at the University of Guam Sea Grant program to code and deploy a second kiosk on Guam and update existing PacIOOS kiosk.
- Continue to present and participate in local events (AGU Ocean Sciences Meeting, NOAA PRiMO, etc.).

- Continue to provide and create electronic and printed outreach materials (newsletters, flyers, fact sheets, etc.).
- Continue to publish and distribute press releases on compelling aspects of PacIOOS.
- Refine classroom activities using PacIOOS Voyager to raise awareness and enthusiasm for ocean data in secondary and undergraduate classrooms.
- Continue to identify and publish PacIOOS success stories.
- Continue to target outreach efforts to specific agencies/organizations to help address PacIOOS goals.
- Continue to engage stakeholders through social media (Facebook and Twitter).

3.7 National and International Collaborations

- IOOS Association meeting in Washington, D.C. in March 2015.
- Continued participation in IOOS Association, PI-GOOS, IOOS FAC.
- Explore potential partnership with IMOS; help build capacity to move toward an operational, integrated system.

4) Personnel and Organizational Structure

Significant changes in key scientific or management personnel occurred during this reporting period.

- Heather Kerkering resigned her post at PacIOOS Director, effective November 1, 2014.
- Melissa Iwamoto was promoted to Deputy Director, effective August 1, 2014.
- Chris Ostrander will maintain executive leadership of the program while also serving as Director, Chair of the Governing Council, and PI of the award.
- PacIOOS hired Fiona Langenberger as the new Communications and Program Coordinator, effective September 2014.

5) Budget Analysis

Spending is on track with projected program expenditures, with full draw down of funds anticipated by the conclusion of this 5-year funding agreement.

The University of Hawaii Office of Research Services submitted a semi-annual financial report for the period ending 9/30/2014, through Grants Online. That report showed total receipts of $7,304,991.00.

As of December 1, 2014, internal budget tracking shows receipts of $7,955,742.90, representing a draw down of 84% of this award, 70% of the way through the total performance period.

Semi-Annual Supplemental Information

1. Products and Services
   - Regional Products or Services
     - **PacIOOS Voyager** improvements include:
       - Ability to save and share measurement tools displayed in a generated map through a URL.
       - New custom map styles can be applied with Version 3 of the Google Maps API.
       - A new high resolution ROMS regional ocean model for the Samoa region. This grid extends west of Savai‘i in Western Samoa and east of the Manu‘a Islands in American Samoa.
       - Satellite tracks of several tagged whales from 2006-2011. Data is from Cascadia Research Collective.
       - New data visualization and animation capabilities for viewing trajectories of ocean glider measurements.
       - Near real-time measurements for rain gauges and stream gauges across Hawaii, managed by USGS National Water Information System (NWIS).
       - New search toolbar and capabilities.
       - Development and release of ‘Super Categories’ in Voyager to ease navigation through the hundreds of existing overlays.
       - WW3 model output for the Northwestern Hawaiian Islands, Guam, and CNMI.
       - Real-time atmospheric and oceanic carbon dioxide data from 13 moored buoys across the insular Pacific. The three-hourly data are obtained from NOAA’s Pacific Marine Environmental Laboratory (PMEL). These data are available in a new ‘ocean acidification’ category on Voyager.
       - Wave glider data from Liquid Robotics for Tropical Storms Iselle and Ana.
       - High resolution ROMS model for the Waikiki area: the PacIOOS Waikiki Ocean Model.
       - New wave buoys in Saipan, Kauai, and American Samoa, with data management occurring in partnership with Coastal Data Information Program.
       - Computer model simulations of sea level rise for Hawaii (Hawaii Island, Kauai, Lanai, Maui, Molokai, and Oahu), Guam, and Saipan, showing the inland extent of coastal flooding due to SLR scenarios at 0 to 6ft above current day higher high water.
       - Wave Run-Up Forecast for Majuro Atoll in the Republic of the Marshall Islands. High Sea Level forecasts for Malakal, Palau and Apra Harbor, Guam.
       - Two new water quality sensors in Maui – Kihei and Kahalui.

- PacIOOS "**Project Pages**" - serving as a repository of ocean and coastal program and project data collected by researchers, NGOs, community groups, and partners throughout the Pacific for a service fee. New "project pages" include:
    - Hawaii Tiger Shark Tracking (*ongoing*) developed in partnership with Hawaii Institute of Marine Biology (HIMB) researchers funded by the State of Hawaii to display near real-time tracks and locations of tiger sharks tagged off Maui. http://pacioos.org/projects/sharks/
    - Sea Level Inundation Risk for Honolulu. http://pacioos.org/projects/slr/
  - Released new Ala Wai Turbidity Plume Model, a tool developed by PacIOOS PIs (water quality and ROMS) that provides a forecast of brown water plumes after heavy rainfall in and near the Ala Wai.
  - Released new Six-Day High Sea Level Forecasts for Malakal, Palau and Apra Harbor, Guam.
  - Released new High Sea Level Wave Run-Up Forecast for Majuro.
  - Released new PacIOOS Waikiki Ocean Model, a higher resolution ROMS prediction model for the Waikiki area.
  - Expanded and made available WW3 for Northwestern Hawaiian Islands.
  - Value-added data and forecast plots for PacIOOS Aunu'u wave buoy in American Samoa.
- National Products or Services
  - Continue to make regional assets available to national data centers and repositories.

2. Data Management

PacIOOS is continuously working toward a standards-based foundation for DMAC capabilities. The PacIOOS data management group (DMG) is tasked with ensuring the data collected by PacIOOS are stored and accessible to users via standard services. The utilization of standard web services, in particular OPeNDAP, SOS, and OGC, ensure that PacIOOS has DMAC capabilities that are compatible with the larger IOOS effort. All PacIOOS data services are standards-based, all data are open (although some are redistributed), and the PacIOOS system is service-oriented and uses common vocabulary.

Updated progress:

- Work during this period has continued in many different areas, including new project pages, new data holdings and services. One focus has been on developing a catalog service for the web (CSW) for PacIOOS data. After experimenting with many different CSW packages, the PacIOOS data group developed our own solution based on python (PyCSW). This catalog service now allows users to search and discover PacIOOS data sets, as well as data services. The service also allows remote catalogs such as data.gov to automatically "harvest" the PacIOOS metadata. In this way PacIOOS can maintain a single instance of metadata and appear on many different catalogs. A second focus of the

report period was to develop more robust plans for real-time quality control of the PacIOOS data. This plan will help PacIOOS in the certification process.

- Open Data Sharing. The PacIOOS data management group provides a mechanism for partners and various individuals to expose their data in standard formats and services. Two examples over the reporting period include real-time data from a Liquid Robotics wave glider and estimates of coral reef health for the main Hawaiian Islands. The first dataset was provided by a PacIOOS industry partner who did not have the ability to serve the data in an open framework. The wave glider made different transects around Hawaii Island, and PacIOOS was able to serve and provide displays of the measurements taken. The second dataset was produced by a research scientist at the University of Hawaii. These are just two examples of PacIOOS data services assisting different groups to disseminate their data.
- Provision of data to WMO GTS. PacIOOS relies on NDBC to put data on the GTS. Whatever data NDBC receives from PacIOOS servers goes to the GTS. At this point, in this includes HFR and wave buoy data.
- Implementation of a service-oriented architecture. Architecture is the same as before, and is considered SOA. Due to instabilities in the host setting (power outages for example), PacIOOS has initiated a move to a more robust facility with 24/7 operations. This will hopefully be completed during the next reporting period.
- Use of common vocabularies and identifiers. All PacIOOS data are netCDF CF compliant. When there are no appropriate CF names, the PacIOOS DMG uses community standards.
- PacIOOS continues to use standard metadata conventions. The newly developed PacIOOS data search tool takes advantage of these metadata and provides both ISO and FGDC formats.
- Data storage and archiving continued throughout the reporting period. Additional data archived include high-resolution wave model output for the extended Hawaiian Islands and additional near-shore sensors in the insular pacific.

Examples of on-going program-level participation in data management planning and coordination include:

- Monthly IOOS DMAC conference calls.
- Member of IOOS Glider Plan Development Team.
- Participation in Hawaii regional Marine Debris response plan (providing data and services)
- Member of IOOS Biological Data Working Group.
- Numerous local meetings with regional stakeholders and data providers.

3. Observing Assets

- Ocean Acidification Platforms: Real-time atmospheric and oceanic carbon dioxide data from 13 moored buoys across the insular Pacific. The three-hourly data are obtained from NOAA's Pacific Marine Environmental Laboratory (PMEL). These data are available in a new 'ocean acidification' category on Voyager. The data are also made

available for participation in and population of the new IOOS Pacific Ocean Acidification Portal, http://www.ipacoa.org/.

- Please see included excel spreadsheet for detailed list of observing assets.