

CNMI PacIOOS Workshop – 2022

10/26/2022

CNMI - BECQ, 3rd Floor Learning Center (Suite 301)

8:30 am – 11:30 am

Workshop Summary and Results

Purpose and Design

The October 2022 CNMI Ocean Observing Workshop was a joint effort by PacIOOS and CNMI Liaisons (Pacific Coastal Research and Planning) to spur meaningful engagement with PacIOOS’ partners and MOA signatories in the CNMI. The workshop aimed to gather more in-depth feedback from the CNMI’s MOA partners regarding ocean observing priorities, familiarize additional organizations and agencies with PacIOOS programs and capacities, and begin brainstorming programs or partnerships to implement based on structured discussion.

After a series of presentations highlighting the PacIOOS mission, programs, and capacities, 33 participants representing a variety of CNMI government agencies, non-governmental organizations, and educational institutions (Appendix B) participated in facilitated conversations to identify jurisdictional priorities.

Collectively, the group distilled its various ocean observing interests down to a variety of discrete projects and capacities. The activities, outcomes, and next steps identified at the workshop are detailed in the following summary report.



Time	Topic, objectives, and activities
8:00 – 8:30 AM	Settle Down: <ul style="list-style-type: none"> • Sign-In, Greetings
8:30 – 9:00 AM	Welcome: <ul style="list-style-type: none"> • Participant and PacIOOS Introductions • Workshop Overview
9:00 – 9:20 AM	PacIOOS Programs and Capacities (Part 1): <ul style="list-style-type: none"> • Programs and Highlights Overview • Presentation by PacIOOS
9:20 – 9:30 AM	Break and Floating Discussion: <ul style="list-style-type: none"> • Opportunity for informal Q&A or open discussion with facilitators • Grab water/coffee/refreshments! • Time to take notes in worksheets!
9:30 – 10:15 am	PacIOOS Programs and Capacities (Part 2): <ul style="list-style-type: none"> • Presentations by PacIOOS and PCRP on: <ul style="list-style-type: none"> ◦ Marine Life Tagging/Telemetry ◦ Data Services + Tools
10:15 – 11:00 am	(brain)Storms in the Northern Marianas: <ul style="list-style-type: none"> • Breakout group discussion around four thematic areas and drivers of ocean observing efforts (Hazards, Water Quality, Ecosystems and Marine Life, and Marine Operations) <ul style="list-style-type: none"> ◦ Facilitated discussion and note-taking based on Participant Worksheet prompts
11:00 – 11:30 am	Wrap-Up, Next Steps, and Adjourn: <ul style="list-style-type: none"> • CNMI’s collective hopes and dreams for ocean observing in the Commonwealth are briefly summarized in a report-out • PCRP & PacIOOS discuss next steps for follow-up • Genuine show of gratitude

Pre-Workshop Survey and Participants

The CNMI Workshop announcement and invitations were accompanied by a registration form and brief pre-workshop survey, focusing on the information gaps and research interests of those who registered. Twenty-four individuals registered, answering the question: “If you could collect any information about the atmosphere, ocean, or animals in it, what would it be?”

A variety of interests were captured in the responses, including a number of observing activities or research/management priorities that align with the PacIOOS mission and programming. A generalized list of responses is provided in the table below. These responses provided workshop facilitators and presenters with an early indication of the interests that may be represented during the event. While some responses involved monitoring activities that may exceed the capacity of PacIOOS to assist with at a very high-resolution, local level, all fit well with at least one of the PacIOOS program themes of Water Quality, Coastal Hazards, Marine Operations, and Ecosystems and Living Marine Resources.

<u>CNMI Ocean Observing Workshop: Pre-Survey Response Summary</u>
Nearshore currents
Visualization of real-time or forecasted/modeled atmospheric and oceanic phenomenon in 3D
Tracking marine life (sharks, turtles, pelagic species migratory patterns)
Ocean acidification (not just pH), chlorophyll a, nitrate, nitrite, orthophosphate
Growth rates of priority reef and food fish species
Reef specific light stress
Equipping wave buoys with additional instrumentation (e.g., hydrophones)
“Coral Happiness” (Reef condition, health, and stressors)
Air and sea temperatures
Climate change impacts & air quality
Stormwater runoff impacts and threats
Water Quality and condition of the seagrass habitat and corals within the Saipan lagoon
Improving monitoring of shoreline erosion with satellite imagery
More data on how, where, and when erosion poses a threat, as well as longshore sediment movements
Sea Level Rise, Wind and Wave Patterns, Sea Temperature, and atmospheric CO2
Sea level changes and forecasting

Of the 24 individuals registered, 14 were able to attend in person, while an additional 19 participants, including a Natural Resource Management class from the Northern Marianas College, attended virtually. Participants hailed from the CNMI Bureau of Environmental and Coastal Quality (BECQ) and its Division of Coastal Resources Management (DCRM), the CNMI Office of Planning and Development, the CNMI Division of Fish and Wildlife, NOAA Fisheries, NOAA Office for Coastal Management, Johnston Applied Marine Sciences (JAMS), and Northern Marianas College (NMC).

Orientation and Content Presented

The workshop kicked off with a round of introductions, acknowledgement of MOA partners and PacIOOS Staff in Hawai'i, and brief responses regarding participants' driving interests and motivations to advance ocean observing capacity in the Northern Marianas. Attendees cited a balanced mix of management concerns, information gaps, and overarching research priorities. These included:

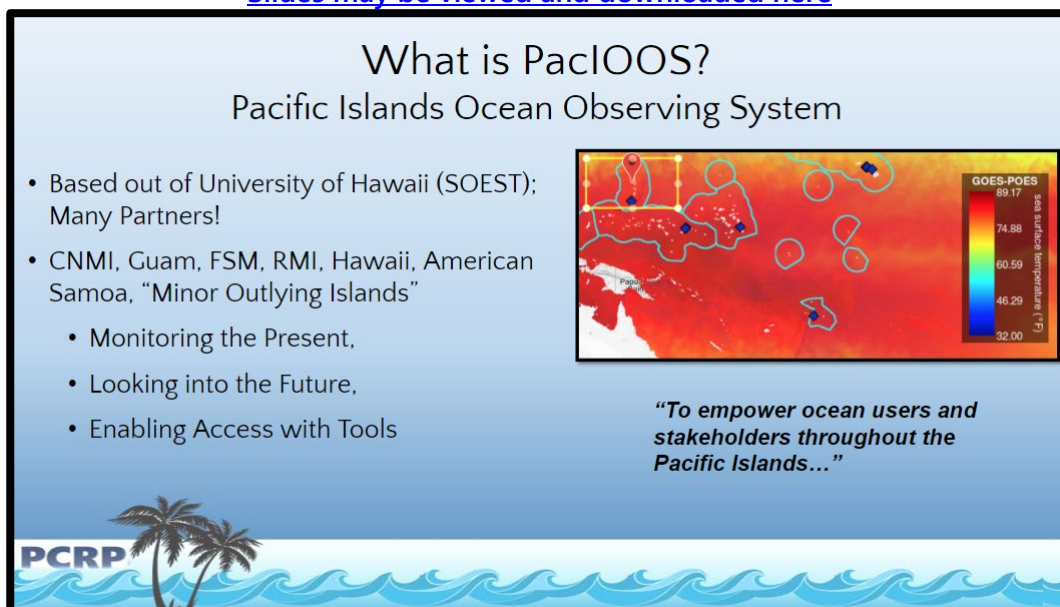
- Management and mitigation of coastal hazards.
- Filling information gaps in monitoring marine life (coral reef habitat and fish populations).
- Extending capacities, technology, and potential research ideas to educational institutions.
- Better informing permitting of projects in the nearshore and shoreline environments.
- Needs related to down-scaled datasets that could inform management at a locally-relevant scale (e.g., Saipan Lagoon).

A series of presentations were delivered with intermittent "Question & Answer" sessions. Presentations covered the workshop purpose and goals, PacIOOS programs and thematic areas, acoustic telemetry and marine life tracking, wave buoy projects, and data services and tools. The overall intent of these first workshop components were to orient (or refresh) CNMI stakeholders and partners with who PacIOOS is, what it does, and how it is relevant both regionally and in the Commonwealth.

Workshop Introduction and Overview

Robbie Greene from PCRP opened the workshop with an introductory presentation covering the meeting purpose and goals, a brief overview of PacIOOS, and its work in the CNMI over the last decade. PacIOOS Director Melissa Iwamoto also delivered opening remarks.

[Slides may be viewed and downloaded here](#)



What is PacIOOS?
Pacific Islands Ocean Observing System

- Based out of University of Hawaii (SOEST); Many Partners!
- CNMI, Guam, FSM, RMI, Hawaii, American Samoa, "Minor Outlying Islands"
 - Monitoring the Present,
 - Looking into the Future,
 - Enabling Access with Tools

"To empower ocean users and stakeholders throughout the Pacific Islands..."

PCRP

The slide features a map of the Pacific Islands region with a color scale for sea surface temperature. The scale ranges from 32.00 (blue) to 89.17 (red), with intermediate markers at 46.29, 60.59, and 74.88. The map shows various islands and oceanic features, with a color gradient indicating temperature variations across the region.

PacIOOS Overview and Programs

PacIOOS Director Melissa Iwamoto delivered a more in-depth overview of PacIOOS at a regional and jurisdictional scale. The program mission, four primary thematic areas, and implementation of projects and observing activities related to those themes were covered. Case studies and island-specific examples of ocean observing programs were provided to illustrate existing and potential capacities for the CNMI. The presentation was followed by a brief round of Q&A with PacIOOS staff.

[Slides may be viewed and downloaded here](#)



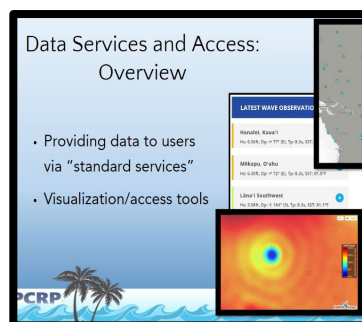
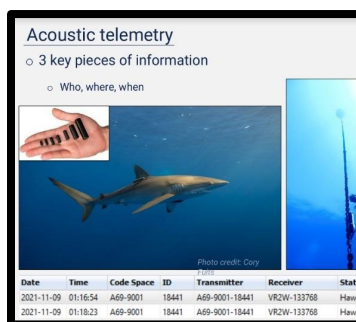
Specific Programs and Capacities: Acoustic Telemetry, Backyard Buoys, and Data/Tool Access

Three presentations followed the PacIOOS Overview session, focusing on the buildout of acoustic telemetry work in the Pacific Islands Region (Tom TinHan, PacIOOS – PIRAT Network Manager), the “Backyard Buoys” program and implementation considerations (Jesi Bautista, PacIOOS Communications Coordinator), and PacIOOS data services and tools for access, including Voyager (Robbie Greene, PCRP). The talks were followed with a second round of Q&A.

These presentations were intended to cultivate some initial ideas and brainstorming among workshop participants, and spur discussion around potential application to projects or management efforts in the CNMI. Presentation slides are linked below.

[Acoustic Telemetry Presentation](#)

[Data Services and Access Presentation](#)



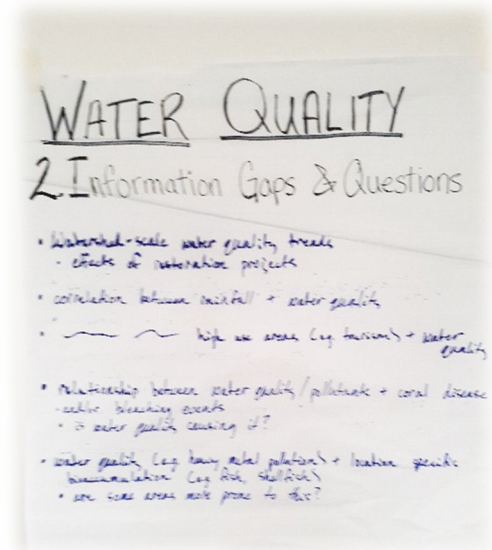
Activity: Thematic Breakout Groups and Worksheets

The second component of the CNMI workshop involved structured group discussions around:

1. The management concerns and research interests that drive ocean observing efforts or needs in CNMI.
2. The gaps in knowledge, technology, or expertise that should be filled to better achieve management or research goals.
3. The specific types of data, tools, or observing activities that could fill those gaps.

Four facilitated breakout groups, organized around PacIOOS program focal areas of Coastal Hazards, Marine Operations, Ecosystems and Living Marine Resources, and Water Quality, gathered at thematic stations to generate ideas and capture them on flip charts. In addition to responding to the three discussion prompts, participants were also encouraged to mark up maps of the CNMI with any specific projects or activities that would be targeted to priority sites or areas.

All meeting participants, both virtual and in-person, were provided with individual worksheets (see Appendix A), which mirrored the discussion questions and themes of the breakout group activities. Seven participants opted to fill out worksheets as either an alternative, or in addition to group feedback. The results of both the worksheets and breakout discussions are summarized in the following pages.



Let's put our heads together!

➔

Breakout Groups
Capture on flipchart:

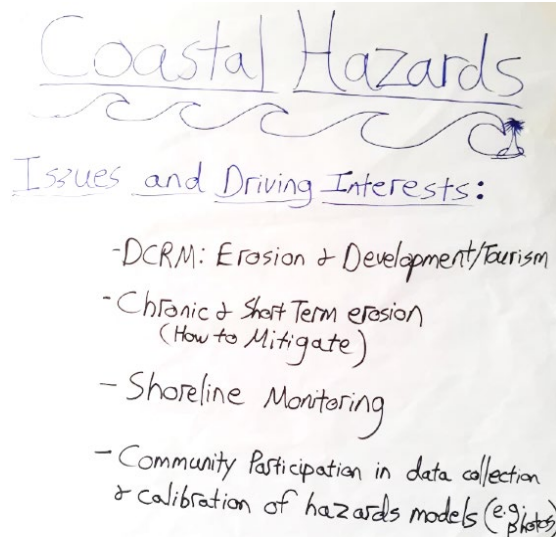
- Issues/Interests
- Gaps
- Filling those gaps!

Stop by our map station!

Coastal Hazards

Issues & Interests

- The CNMI Coastal Zone, and particularly the low-lying shorelines and western coastal plain of Saipan, are continuously impacted by erosion, typhoons, and volatile development/tourism.
- With recent impacts to some of CNMI's more vulnerable and unstable shoreline, multiple government agencies and partners are searching for answers to short-term and chronic shoreline erosion.
- DCRM is in the process of updating its "Coastal Hazards Area of Particular Concern" (coastal hazard regulations boundary). This involves delineating high-hazard areas for multiple threats (sea level rise, swash, FEMA FIRMs), and the agency is considering including wave run-up.
- Shoreline monitoring of beach morphology is an ongoing activity that has potential to be significantly improved, or coupled with new information that can explain apparent trends.
- There is a desire for more community participation in data collection and calibration of hazard models (e.g., photos of wave run-up or impacts during high sea level events).
- The protective capacity of reefs is a hot topic at the moment, particularly in the context of hazard and coastal flood mitigation. Advances in coral restoration efforts in CNMI should be informed by data regarding the coastal defense that reefs provide, and where it is needed most in CNMI.



Information Gaps & Unanswered Questions

- Wave run-up is one of the last remaining coastal flood and erosion hazards that does not have a substantial amount of data, modeling, or visualization in CNMI. This information is essential for effective coastal management and permitting, including the delineation of regulated hazard zones and informing DCRM's efforts of addressing vulnerable/changing shorelines.
- There are some unanswered questions and data gaps regarding the interaction of sea level extremes and wave run-up with coastal discharge

(e.g., backwater flooding; sediment transport and deposition). These dynamics are particularly important to understand in low-lying urban areas and stretches of lower watersheds with critical infrastructure.

- Hydrodynamics, particularly in the Saipan Lagoon, are currently modeled under four “snapshot” scenarios representing Saipan’s wave/wind climate, and involve large areas of interpolation for currents. There is a need/desire to achieve higher-resolution within the model, and ideally have some sort of forecasting ability.
- Shoreline morphology is currently monitored using a fairly simple method, but also has potential to leverage more “complex” equipment and methods (e.g., incorporating use of Total Station and survey methods). DCRM has an interest in evolving the monitoring to include additional methods for improving data, but these need to remain fairly simple.
- Both coastal erosion and human safety issues (e.g., swimmer safety) could be better managed by establishing safety “thresholds”, and understanding what wave heights and directions constitute a safety threat or are likely to incur extreme erosion.

Opportunities

- Backyard Buoys is of great interest, particularly to DCRM personnel involved in shoreline monitoring and permitting. There are some poorly understood coastal processes at a fine scale within the Saipan Lagoon and around the harbor/shipping channel that require more localized data (i.e., the existing hydrodynamic model of the Lagoon does not explain some of the shoreline and nearshore impacts being observed).
- This breakout group felt that a strategically-placed buoy and its data could:
 - Help refine regulations and policies for shoreline uses or development in certain areas.
 - Provide crucial information that, when coupled with existing shoreline monitoring and modeled nearshore currents and hydrodynamics, could more fully resolve ongoing and urgent questions about erosion patterns.
 - Inform policies or standards for the design of in-water structures or hazard/storm plans for in-water activities.
 - Help create a notification tool for coastal hazards (run-up and erosion) in targeted locations, whereby wave observations that reach specific thresholds trigger notices to coastal resource managers or hotels.
 - Provide data to help in the eventual development of wave run-up forecasting capabilities or tools.
- Wave run-up modeling and forecasts are a top priority, especially for Saipan’s western coastal plain. This modeling, along with a more nuanced understanding of erosion and shoreline processes in some locations, has

greater urgency than needs related to long-term climate impacts (e.g., sea level rise). Calibration with data collected by the community would also assist CNMI agency efforts in better engaging with citizen science.

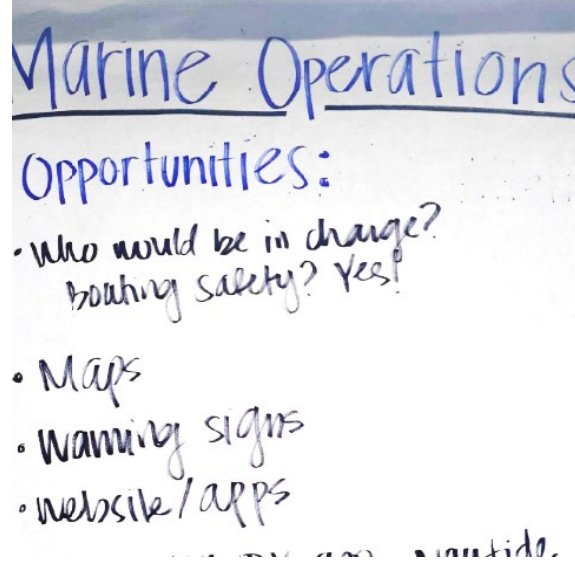
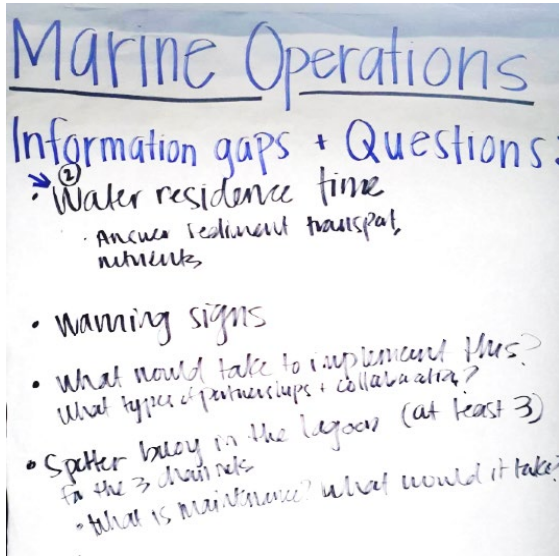
Marine Operations

Issues & Interests

- The Saipan Lagoon and Ship Channel are the most heavily used waterways and marine areas in CNMI, and can have strong fluctuations in currents.
- Search and rescue activities are strongly influenced by nearshore currents, and could potentially be informed by current observation or forecast products.
- Marine Sports Operators constitute one of the most important stakeholder groups for CNMI's tourism economy, and must assess conditions for safety of operations.
- DCRM manages a mooring buoy program that includes maintenance and decision-making on where/when to replace defunct or missing buoys.
- Most stakeholders either do not have access to or are not aware of existing hydrodynamic studies and maps of the Lagoon and Ship Channel, or that information does not exist in a user-friendly/non-technical format. Most in the CNMI continue to depend a lot on local knowledge of currents and popular apps that do not necessarily capture local nuance (e.g., Windy/Nautilus).

Information Gaps & Unanswered Questions

- High-resolution modeling of the Lagoon (beyond the existing hydrodynamic model) and Laulau Bay could be extremely helpful for safety purposes.
- With regard to Marine Sports Operators, the gap lies not so much with the data or observing capacity, but simply awareness of existing instrumentation and tools to assess waves, currents, etc.
- It would be helpful to know the "residence time" of waters in the Lagoon, particularly with respect to water impairment and human safety, nutrient/water quality management, and sediment transport.
- There is little information regarding wave action or localized hazards in some of the most dangerous locations along the west coast of Saipan (Ship Channel, "Lighthouse" Channel, Sugar Dock Channel).



Opportunities

- The group emphasized the potential utility of a high-resolution (hydrodynamic) model of the Lagoon and Laulau.
- Modeling output that includes accessible information regarding water residence time.
- Targeted outreach to Marine Sports Operators regarding use of PacIOOS products for evaluating safety of conditions (this applies to ocean conditions and status of water quality impairment at popular shoreline sites).
- Data or modeling results can inform the development of warning/safety signs for beaches, beyond the existing rip current signage at limited locations.
- Similar to Coastal Hazards opportunities, it would be useful to have some sort of notification tool or thresholds established for safe marine sports operations (e.g., swell direction and heights that make The Grotto unsafe for tour groups or diving/snorkeling).
- Data or modeling results need to be made accessible in the form of tools, ideally an app that CNMI stakeholders can easily access and use. This is particularly relevant for hydrodynamics (depth averaged currents and transport in the Lagoon).
- Spotter buoys could fill data gaps at critical points, in at least three channels in the Lagoon and Ship Channel.

Ecosystems and Living Marine Resources

Issues & Interests

- There are multiple disturbances to our reefs that could be better understood and managed with more monitoring and/or forecasts. This includes:
 - Acidification indicators and water quality measurements at the “site level”.
 - Consistent monitoring and observations within MPAs.
- Coral spawning events are incredibly important, and reef managers/restoration practitioners would benefit from enhanced observation.
- BECQ is interested in expanding its knowledge base and/or monitoring seagrass health and function.
- NMC is building capacity to address food security, specifically through expanding research into aquaculture and commercial fishing.
- Shark behavior is an important component for management of fisheries and marine ecosystems at large.

Information Gaps & Questions

- Lagoon hydrodynamics and nearshore currents in general have a key influence on acute disturbances to the reef (e.g., sediment plumes following a storm, thermal stress). There is very limited information in the form of real-time, high-resolution current data.
- Sea surface temperature is critical for disturbance response and monitoring, but is not monitored or observed at the site-level in many critical locations.
- With regard to food security, CNMI needs more data on fishing activity (especially commercial) to be able to evaluate potential impact on food fish stock, and assess feasibility of expanding commercial fishing effort.
- More consistent monitoring of seagrass habitat and its relationship to water quality.
- Coral spawning is not always systematically documented or mapped out, leaving some room for additional, key data to inform management and restoration efforts.
- Wave attenuation by coral reefs has only been modeled at a very coarse level (1-dimensional/transect-based wave run-up during a hypothetical storm with presence or absence of reef). It would be useful to have a better understanding of reef protective capacity, at a site level if possible.
- Shark (and large marine species) behavior has very little direct, consistent observation or data, and lacks sufficient information to help refine management.

Opportunities

- Given the scale of management and restoration efforts underway in CNMI, there is a need to expand the range of entities conducting research and stewardship activities beyond government agencies, and build a more robust local network. Community Research Implementation and Stewardship Plans (CRISPs) may help accomplish this.

- Many of the data or observing gaps identified could be partially addressed with real-time or near real-time data from the Lagoon. New sensors for water quality or acidification indicators at the site level is a high priority.
- Modeling or mapping of coral spawning activity, or even a forecasting tool to assist with collection in support of coral restoration methods.
- Participation in shark tagging would help resolve some questions around behavior, and subsequently inform management.

Water Quality

Issues & Interests

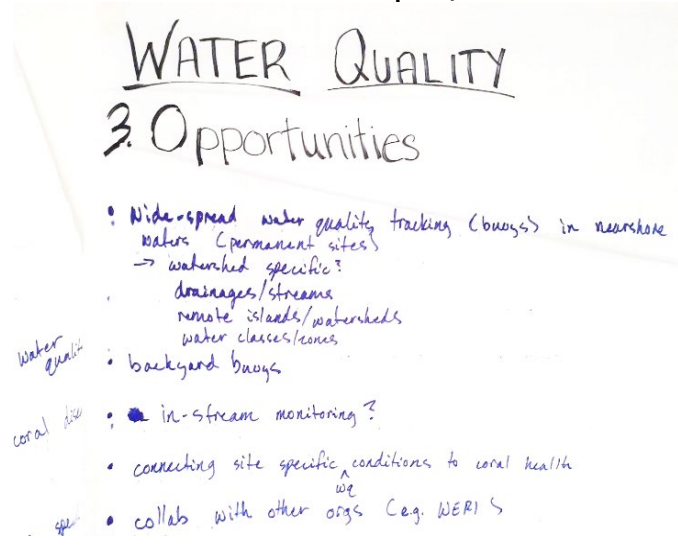
- Watershed management requires consistent, location specific data on water quality in both streams and shoreline/shoreline-adjacent sites.
- BECQ is interested in/developing water quality microbial standards and class requirements.
- DCRM Coral Nursery and relationship between water quality and health of coral fragments.
- Data from remote locations (e.g., Talakaya Watershed) are critical for some of the larger watershed restoration efforts, but difficult to obtain.
- Stream-specific monitoring (including estuarine and mangrove environments).
- There is a desire to better understand or model turbidity downstream/in the ocean, and look into interflow/mixing based on salinity fluctuations.
- Hazardous substance monitoring (e.g., heavy metals, PFAS, PCBS, bacteria) should be an element of water quality monitoring, and expanded beyond the current focus on groundwater/wells.

Information Gaps & Questions

- Watershed-scale water quality trends; effects of restoration projects (i.e., monitoring for efficacy).
- Correlation between rainfall and water quality and stormwater impacts in nearshore waters.
- More frequent monitoring of water quality in high-use tourist areas.
- Relationship between water quality/pollutants, coral disease, and/or bleaching events. In other words, to what extent are water quality indicators responsible for negative impacts to coral health vs. something like thermal stress.
- Information on temperature, dissolved O₂, CO₂, Nitrogen, and pH at long-term monitoring sites.
- Water quality (e.g., heavy metal pollution) and location specific bioaccumulation (e.g., fish, shellfish); Are some areas prone to this?

Opportunities

- Wide-spread water quality coverage via sensors in streams, lagoon, and reef sites.
- Avail of water quality sensor partnership for post-restoration project monitoring (e.g., quantifying effectiveness of large re-vegetation efforts).
- Site-specific sensing of dissolved oxygen and nitrogen, as well as access to that information online (e.g., easily retrievable data services and/or export).
- Collaborate with other organizations (e.g., WERI): Many gaps identified are very project specific or research specific. While PacIOOS may be able to assist with some sensors or the water quality partnership, some research questions could be answered by partnering with regional experts (e.g., WERI), and leveraging the new water quality data.



WATER QUALITY

3. Opportunities

- Wide-spread water quality tracking (buoys) in nearshore waters (permanent sites)
→ watershed specific?
drainages/streams
remote islands/watersheds
water classes/zones
- backyard buoys
- in-stream monitoring?
- connecting site specific conditions to coral health
- collabs with other orgs e.g. WERI S

Water quality

coral health

spe

Outcomes and Next Steps

Emphasis on filling gaps for Hazards, Water Quality, and Coastal Processes

- Among feedback, there was an overarching call for additional data, modeling, or tool development with regard to hydrodynamics, coastal hazards (especially wave run-up), and water quality indicators/reef stressors. Key next steps include:
 - Follow-up with relevant government agencies and organizations that consistently voiced a need related to these shared topics. Aim to refine the “need” and narrow down a project or program that falls within PacIOOS purview and capacities.

Localizing information to a “management scale”

- In many instances CNMI partners and stakeholders have identified a need to refine and improve upon information that is already available to a certain extent (e.g., hydrodynamic model of the Saipan Lagoon). Depending on the data or phenomenon of interest, this could involve:
 - Increasing resolution of products.
 - Expanding coverage of modeling or sensor networks.
 - Placing technical information into a tool or visualization product that is more accessible.

In some cases, PacIOOS may be able to assist in connecting CNMI partners with the right institutions or individuals to assist with downscaling. In other instances it may be that PacIOOS could actually provide the resources and expertise needed to expand observation coverage, or help host existing local data in a user-friendly format.

Increased awareness of existing data and tools may fill many gaps

- Some of the project ideas or needs identified during the workshop relate to data that already exists, and perhaps PacIOOS has rolled out in recent years but local partners are simply not aware of. Nearshore current modeling and forecasting is an excellent example, as this product could already be informing activities such as search and rescue operations.
 - An immediate next step should be taken when the summary report is distributed. The email should include links or information about PacIOOS services or tools that already address some of the needs identified in the workshop.

Interest in leveraging observations and forecasts to develop notification tools

- In addition to all of the needs or opportunities identified for additional modeling or forecasting, many participants also shared an interest in being able to use real-time data or near-term forecasts to trigger notifications, especially with respect to coastal hazards, marine operations, and potentially reef health.
 - A key next step is to reach out to key officials and resource managers from the Division of Coastal Resources Management, Division of Environmental Quality/DEQ, the Department of Public Safety - Boating Safety Division, and the CNMI Homeland Security and Emergency Management to discuss notable safety issues, existing signage or advisories regarding ocean/lagoon conditions, and the potential to

generate timely advisories or signage that is responsive to near-term forecasts or observations.

Concerns regarding agency/organization capacity for implementation

- There are consistent challenges to implementing some programs or activities due to resource limitations at various agencies or organizations. This leaves lingering questions regarding logistics and the feasibility of successfully implementing something like Backyard Buoys.
 - A key next step in the follow-up process after the workshop is for PacIOOS and Liaisons to work with CNMI partners that have identified a need and interest that seems viable, and to outline or clarify logistics of the relevant PacIOOS program or project. This should be done early in the follow-up process in order to assess any potential capacity issues that could stifle implementation.



Thank you to all workshop participants, and especially our MOA partners at DCRM for lending their Learning Center to us for the workshop!

Ready to follow-up with PacIOOS? Reach out to one of the smiling faces below (contact emails in lower right of graphic).

Thank You!

Tom TinHan
ACOUSTIC TELEMETRY NODE MANAGER

Becky Skeele
CNMI LIAISON

Jesi Quan Bautista
COMMUNICATIONS COORDINATOR

Melissa Iwamoto
DIRECTOR AND PRINCIPAL INVESTIGATOR

Jordan Watson
DEPUTY DIRECTOR

Robbie Greene
CNMI LIAISON

info@pacioos.org

PacIOOS Contact: jesiqb@hawaii.edu

PacIOOS Liaison Contact: Robbie.greene@pacificcrp.org

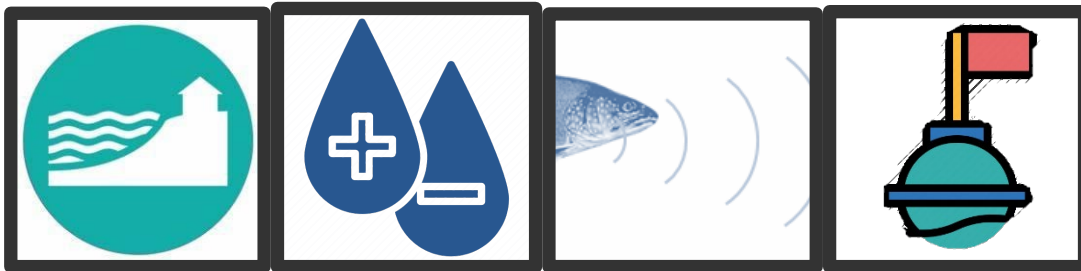
PCRP

Appendix A: Individual Worksheet Template

Participant Worksheet

Thank you for participating in the 2022 “PacIOOS in the CNMI” Workshop! As we move through today’s presentations and open discussion, please capture your thoughts and ideas using the pages in this worksheet.

The template is organized around four thematic areas: “Coastal Hazards”, “Water Quality”, “Marine and Living Resources”, and “Marine Operations”. You may choose to focus on just a thematic area that is most relevant to you, or address all four themes.



While we would appreciate inclusion of your name and contact information on this worksheet for purposes of follow-up, you may choose to omit that information. We do ask that you include at a minimum your affiliation (agency/organization).

Name: _____

Contact (email): _____

Affiliation: _____



Coastal Hazards

Coastal hazards come in many forms, including chronic & short-term shoreline erosion, flooding from wave run-up during storms or large swells, long-term sea level rise, or short-term sea level extremes.

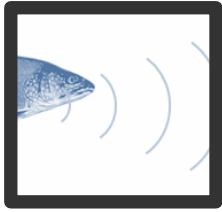
<p>What specific Coastal Hazards (e.g., inundation, erosion, typhoons) are you or your organization concerned with?</p> <p>Do you have any projects or programs (current or planned) that deal directly with Coastal Hazards? Please describe:</p>	
<p>What information, data, or tools do you use when dealing with coastal hazard issues?</p> <p>Have you used any PacIOOS tools or services related to coastal hazards before? Please describe/list:</p>	
<p><u>What's missing?</u></p> <p>What specific questions or problems related to the coastal hazards you work with remain unanswered, or require better information or tools?</p> <p>Please describe any specific information or capacity gaps:</p>	
<p>Filling the Gaps:</p> <p>Please describe the information/data or projects/programs that you or your organization would ideally have in order to answer those questions or fill the gaps listed above.</p> <p>In other words: What would best help you to address (or improve upon) your work with coastal hazards?</p> <p><i>Please include logistical considerations such as organization capacity and technical support!</i></p>	



Water Quality

Coastal and nearshore water quality is a major concern in CNMI, impacting coral reef ecosystems, fish/marine life habitat, human health, and our tourism economy. How turbid are our lagoon waters? What does pH and Dissolved Oxygen look like out on the reef? Is it safe for visitors to go swimming?

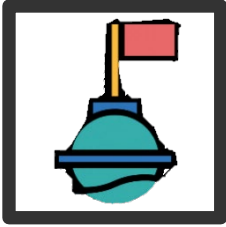
<p>What specific Water Quality issues or parameters are you or your organization concerned with?</p> <p>Do you have any projects or programs (current or planned) that deal directly with water quality? Please describe:</p>	
<p>What information, data services, or tools do you use when dealing with water quality issues?</p> <p>Have you used any PacIOOS tools or services related to water quality before? Please describe/list:</p>	
<p>What's missing? What specific questions or problems related to the water quality issues you work with remain unanswered, or require better information or tools?</p> <p>Please describe any specific information or capacity gaps:</p>	
<p>Filling the Gaps: Please describe the information/data or projects/programs that you or your organization would need in order to answer those questions or fill the gaps listed above.</p> <p>In other words: What would best help you to address (or improve upon) your work with water quality? <i><u>Please include logistical considerations such as organization capacity and technical support!</u></i></p>	



Ecosystems and Living Resources

From the fish we eat to the corals we grow, the management and decision making around living marine resources requires in-depth collection and understanding of biological, chemical, and physical data (and access to it!).

<p>What specific ecosystem and marine life issues are you or your organization concerned with?</p> <p>Do you have any projects or programs (current or planned) that deal directly with living marine resources? Please describe:</p>	
<p>What information, data services, or tools do you use when dealing with living marine resources?</p>	
<p>What's missing? What specific questions or problems related to the marine life or ecosystem components you work with remain unanswered, or require better information or tools?</p> <p>Please describe any specific information or capacity gaps:</p>	
<p>Filling the Gaps: Please describe the information/data or projects/programs that you or your organization would ideally have in order to answer those questions or fill the gaps listed above.</p> <p>In other words: What would best help you to address (or improve upon) your work with ecosystems and marine life? <i>Please include logistical considerations such as organization capacity and technical support!</i></p>	

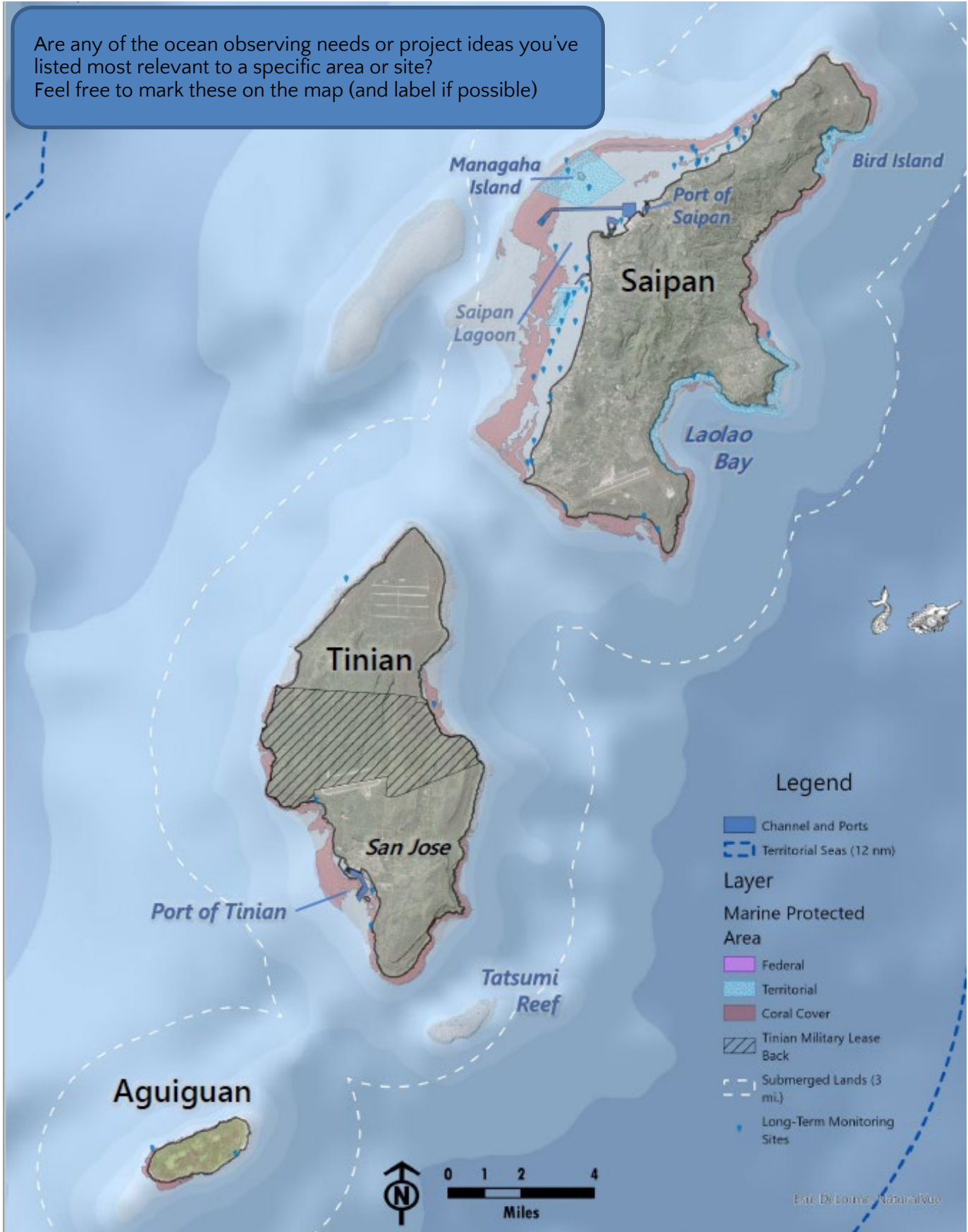


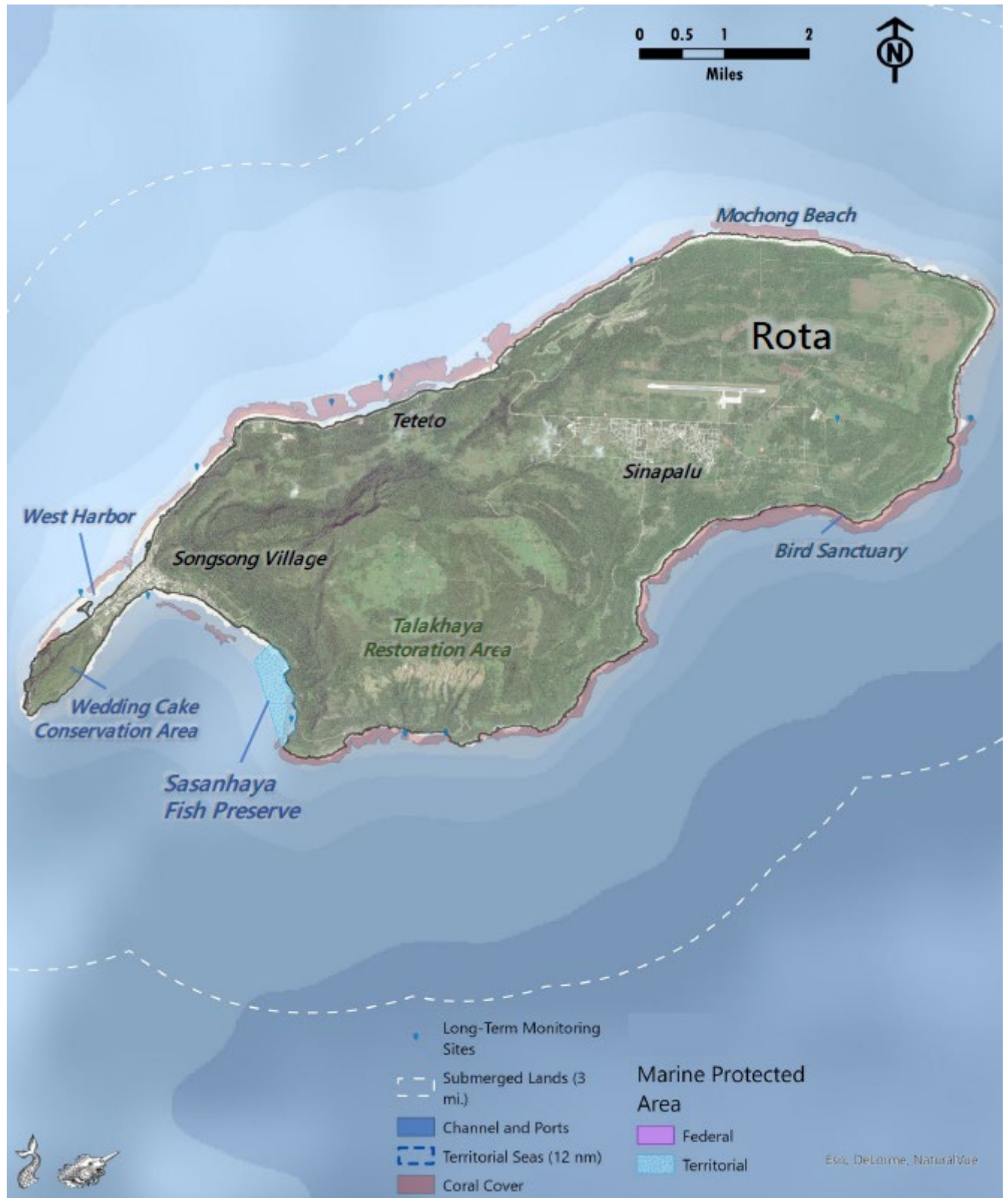
Marine Operations

Ocean conditions, both forecasted and in real-time, can make or break marine operations in CNMI. The safety of fishing derby participants, logistics for marine sports operators, and precision of search and rescue operations are all heavily influenced by the ocean currents, waves, and storms (among other phenomena).

<p>What specific marine operations are you or your organization engaged in?</p> <p>Do you have any projects or programs (current or planned) that deal directly with marine operations? Please describe:</p>	
<p>What information, data services, or tools do you use when dealing with living marine operations?</p>	
<p><u>What's missing?</u></p> <p>What specific questions or problems related to the marine operations you work with remain unanswered, or require better information or tools?</p> <p>Please describe any specific information or capacity gaps:</p>	
<p>Filling the Gaps:</p> <p>Please describe the information/data or projects/programs that you or your organization would ideally have in order to answer those questions or fill the gaps listed above.</p> <p>In other words: What would best help you to address (or improve upon) your work with marine operations?</p> <p><i><u>Please include logistical considerations such as organization capacity and technical support!</u></i></p>	

Are any of the ocean observing needs or project ideas you've listed most relevant to a specific area or site?
Feel free to mark these on the map (and label if possible)





Appendix B: Registration and Attendance

Workshop Participants		
Participants (In-Person)	Agency/Org	PacIOOS Affiliation
Galvin Deleon Guerrero	NMC	MOA Partner
Janice Castro	NOAA	
Justin Davis	OPD	
Nathan Van Ee	DFW	
Rich Salas	DCRM/BECQ	MOA Partner/CNMI GC Member
Mary Fem Urena	DCRM	
Arthur Charfauros	DCRM	
Rodney Camacho	DCRM	
Jon Iguel	DCRM	
Marlyn Naputi	DCRM	
Jordan Suel	DCRM	
Zak Williams	DCRM	
Kylie Hasegawa	DCRM	
Elly Perez	DCRM	
		Total: 14
Participants (Virtual)		
Steve McKagan	NOAA	
Frank Villagomez	DFW	
Lyza Johnston	JAMS	
Kelsey McClellan	NMC	
15 Students (13 Natural Resource Majors)	NMC	
		Total: 19
Facilitators		
Robbie Greene	PacIOOS/PCRP	CNMI Liaison
Becky Skeelee	PacIOOS/PCRP	CNMI Liaison
Jordan Watson	PacIOOS	Deputy Director
Jesi Quan Bautista	PacIOOS	Communications Coordinator
		Total: 4
Presenters		
Melissa Iwamoto	PacIOOS	Director
Tom TinHan	PacIOOS	PIRAT Network Manager
Robbie Greene	PacIOOS/PCRP	CNMI Liaison
		Total: 3