University of Hawai'i
Sea Grant College Program

Research Priorities in the Insular Pacific:

Transforming Research into Regional Management

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Pohnpei, Federated States of Micronesia *Photo: Dolan Eversole*

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Photo: Matthew Iacchei

EXECUTIVE SUMMARY

Introduction

Recent advancements in U.S. ocean management have occurred in response to the difficulty faced by government jurisdictions to adequately respond to increasingly severe drivers of environmental stress. These include a new National Ocean Policy that has been articulated in the White House Executive Order, "Stewardship of the Ocean, Our Coasts and the Great Lakes" (Obama, 2010) and an Ocean Research Priorities Plan and Implementation Strategy (JSOST, 2007) that was developed by the National Science and Technology Council. Both plans set forth priorities for ocean and coastal research and management policy.

In response to these federal mandates and the emerging emphasis on ecosystem-based management, the National Oceanic and Atmospheric Administration (NOAA) has initiated a program to identify the ocean research and information needs in each of the nation's major coastal ecoregion to support the new national policy objectives. The Insular Pacific is one such region formally identified by NOAA and includes the state of Hawai'i, the territories of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI), as well as the freely-associated states of the Republic of Palau, the Federated States of Micronesia (FSM), and the Republic of the Marshall Islands (RMI). The NOAA National Sea Grant Office has charged the University of Hawai'i Sea Grant College Program (UH Sea Grant) to develop and implement a plan to identify the ocean research priorities for the Insular Pacific Region. The research priorities and associated recommendations identified in plan implementation form the basis of this report.

Purpose, Goals, and Objectives of the Insular Pacific Research Needs Assessment Report

The purpose of this report is to provide NOAA with research and information priorities relative to ocean and coastal management needs in the Insular Pacific Region. The primary goals of the report are to:

a) *Create a foundation to support contemporary plans and approaches to integrated coastal management in the Insular Pacific Region.*
b) *Help develop a platform for a U.S. Pacific Island Regional Ocean Partnership.*
c) *Develop strategic concepts and recommended actions useful for creating implementation frameworks for addressing identified priorities.*
d) *Identify and prioritize managerial relevant research priorities as identified by stakeholders and government jurisdictions in the Insular Pacific Region.*

Geopolitical Context

The immense size, insular character, jurisdictional diversity (state, territories, nations), and cultural complexity make the Insular Pacific Region unique among NOAA's regional designations. Each island state and nation has a unique history, culture, governance, and environmental setting. However, there is also a high degree of commonality that makes a regional approach

Pago Pago Harbor, American Samoa *Photo: Jeffrey Kuwabara*

to assessment valuable. These include tropical insular environments and fluid, growing populations, ocean dependent economies, climate change impacts and resource limitations, importance to national security, and a common urgency for effective ocean and coastal management.

Methodology

Management-related research as defined in this assessment also includes development and important innovations that make research more effective and available for management and policy. Initial steps in the assessment process involved forming a team of knowledgeable people from each jurisdiction. Using policy documents and other sources, the team then developed an initial set of five thematic areas for stakeholder engagement through interviews, workshops, and questionnaires. Over 600 individuals from government, academia, non-governmental organizations (NGOs), stakeholder groups, and key industries from every jurisdiction participated over the duration of the study. Over 100 individual priorities were identified, of which 48 were determined to be common to all jurisdictions. These then constitute the Insular Pacific regional research priorities. All of these could be assigned to one of 20 priorities in the Ocean Research Priorities Plan and Implementation Strategy thus providing a direct link to current national policy objectives.

Given the urgency of action, resource limitations, the need for prioritization, and jurisdictional differences in mission, we identified the 10 highest priority needs in each jurisdiction except for Hawai'i. While management decisions concerning prioritization of research effort depend on strategic and mission mandates, it is critical that allocation of resources be strategically focused on the most important research needs however determined. The highest ranked priorities identified in this report constitute a point of focus for federal and jurisdictional management, planning, and resource allocation.

Thematic Areas and National Priorities

The 48 regional priorities referred to above are listed in the body of this report. Each priority falls under one of five major thematic areas. These are listed below, along with the distribution of the 48 priorities according to theme.

- **Theme 1: Connecting Land and Ocean.** In island communities, land use is directly tied to a diverse array of societal benefits from and impacts to land and sea (9 priorities).
- **Theme 2: Preserving Ocean Heritage.** Healthy ocean and coastal environments and ecosystems are the foundation of economic prosperity and quality of life for island communities (12 priorities).
- **Theme 3: Understanding Climate Change Impacts and Adaptation.** Islands are particularly dependent upon ocean climate patterns. Changes in these patterns can have major consequences for island communities and associated ecosystems (7 priorities).
- **Theme 4: Promoting Collaborative Governance and Stewardship.** Increased human impacts on coastal and ocean environments require new holistic, integrated approaches to management and governance that involve collaborative management and policy alignment among sector specific jurisdictions of government (8 priorities).
- **Theme 5: Supporting and Enhancing Ocean Observations and Data Management.** Critical research and evaluation for coastal management by necessity is dependent on well-developed systems of observation, sampling, monitoring, periodic assessments, and timely and accurate transfer of information (12 priorities).

Significant Conclusions

This work represents a strong foundation for ocean and coastal integrated management in the Insular Pacific for the coming decade. Broad stakeholder agreement, a high degree of jurisdictional overlap, and conformance with national themes provide strong evidence of the validity of the priorities identified in the report. These priorities also provide a basis for implementation strategies and development of decision support tools for management and policy decisions. A number of important conclusions relative to governance and planning can be drawn from the data and stakeholder input. The more important include:

- The high and growing degree of urbanization for a regional population of approximately 1.8 million who live in an area of 19,167 km^2 (7400 m^2) in the region.

Photo: Dolan Eversole

Island of O'ahu, Hawai'i

- The paucity of comprehensive planning and implementation frameworks for coastal management.
- The limited capacity for research, monitoring, planning, and assessment especially in the territories and freely-associated nations.
- The significant diversity in cultures, institutions of governance, policies, and patterns of enforcement.
- The urgency for addressing resource limitations plus socioeconomic and environmental problems.
- Limited resources and capacity for sustainable financing for coordinated priority setting and interjurisdictional alignment for spatial planning, research, monitoring, and assessment.
- The acute vulnerability of the region to climate change impacts and the relatively low adaptive capacity.

Recommendations for Implementation

Addressing the environmental challenges resulting from rapidly changing conditions requires management approaches that evolve at a much faster rate than contemporary governmental institutions with overlapping jurisdictions, and compartmentalized structures and mandates. *The major priorities identified in this report provide an excellent starting point for making significant improvements in resource management region-wide.*

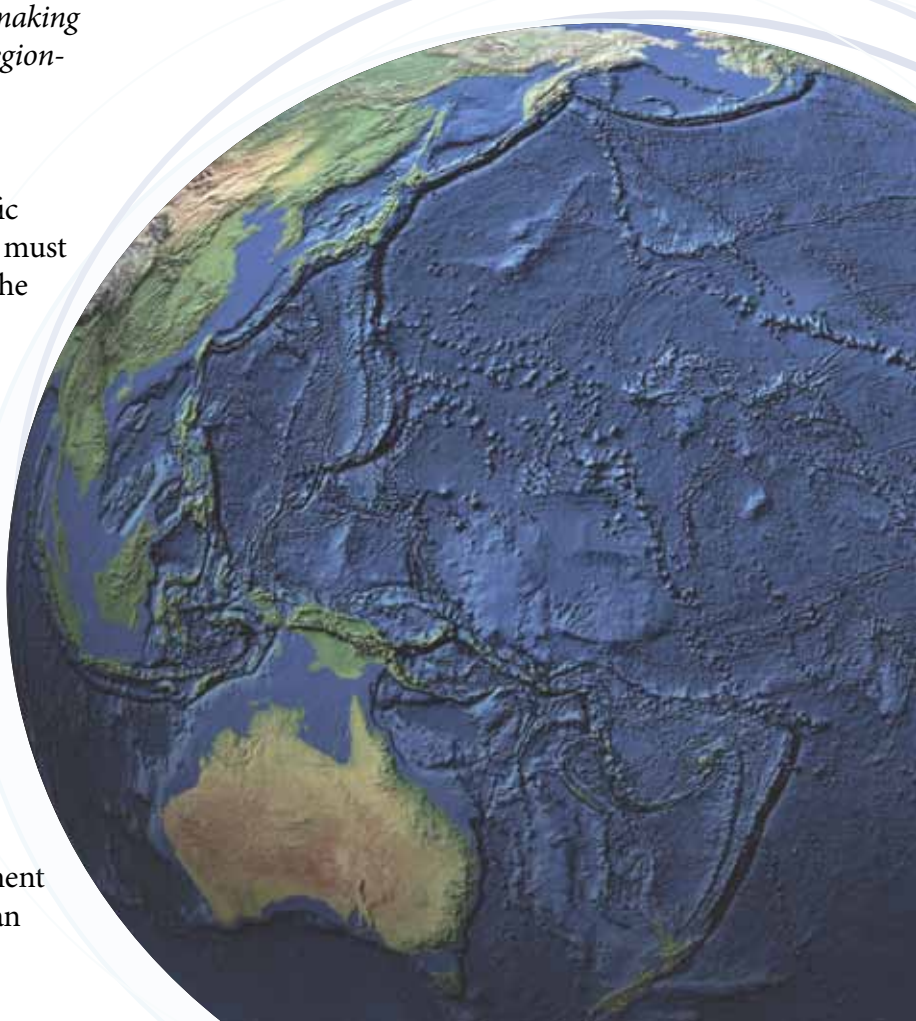
While we now have a firm basis for understanding current problems and priorities in the Insular Pacific Region, frameworks for successful implementation must also be based on a consideration of future trends. The following issues are relevant to formulating such implementation frameworks:

- Increases in regional population, urbanization, and intensity of human activity are inevitable over the next decade and must be addressed.
- Reconciling socioeconomic considerations with the environment will remain the primary management challenge.
- Insular economies and cumulative human impacts are location specific. Therefore, precise place-based knowledge at relevant spatial scales is critical to managing human activities in time and space. Once management decisions are made regarding built-out urban and coastal contexts, they often cannot be easily or quickly reversed. Thus, special attention to new development and careful planning is paramount.

Recommended Actions

Finally, we make the following eight recommendations relative to management and implementation of the research priorities identified in this report:

1) Consider the establishment of a U.S. Pacific Islands Regional Ocean Partnership (PROP) program that builds on and enhances existing partnerships.
2) Promote and support effective mechanisms that enhance coordination and communication among agencies, institutions, and jurisdictions region-wide.
3) Facilitate informed decision-making through enhanced support of information transfer and stakeholder engagement.
4) Recognize and engage the unique attributes and cultures of each jurisdiction.
5) Develop and implement regional spatial planning frameworks.



6) Implement strategies to maintain and enhance critical financial resources for ocean stewardship.
7) Link NOAA, other federal agencies, and non-federal organizations' objectives and resource allocations in coastal stewardship for the Insular Pacific Region directly to regional research priorities.
8) Work with regional partners and existing initiatives to link global priorities and resources to research and outreach needs. Review and assess progress on management goals and the relevance of research priorities to those goals every five to six years.

Photo: Jeffrey Kuwabara

BACKGROUND

In 2004 the U.S. Commission on Ocean Policy (USCOP) published a seminal report, *An Ocean Blueprint for the 21st Century* (USCOP, 2004). The USCOP report calls for major reforms in U.S. ocean policy and the science infrastructure to support ocean research. In response, the Joint Subcommittee on Ocean Science and Technology (JSOST) of the National Science and Technology Council released a national research plan based on input from multiple federal agencies and individuals. Referred to as the *Ocean Research Priority Plan* (ORPP), the plan outlines major national societal themes and research priorities (JSOST, 2007). Both documents set forth much of the current basis for priority setting in ocean and coastal research and management policy.

There are a number of concepts in the USCOP report and in a review of the ORPP by the National Research Council (2007) that are relative to ocean research priorities and provide a national strategic framework for this effort, namely:

- The importance of oceans to society.
- The need for ecosystem-based approaches to management in the policy domain.
- The need for understanding and forecasting processes important in supporting ecosystem-based management especially of coastal and nearshore environments.
- The need for identifying specific ocean and coastal challenges to society and setting research priorities to address these challenges.
- The need for social sciences and economics in ocean stewardship.
- The importance of public awareness, education, and knowledge transfer to decision-makers for conflict resolution and support for the human and economic resources necessary to support capacity for ocean stewardship.
- That ecosystem characteristics, government jurisdictions, and specific coastal challenges differ regionally and thus require place-based, spatially-specific knowledge for informed decision-making in the policy domain. H.R. 21 (2007) actually codifies regional area designations for the coastal U.S. and territories. The Western Pacific Ocean Region as defined here is a formally designated region in H.R. 21.

Finally, in July 2010, the White House Council on Environmental Quality issued a report entitled *Final Recommendations of the Interagency Ocean Policy Task Force*. The report summarizes the Presidential Memorandum that articulates both a new National Ocean Policy (Obama, 2010) and nine priority objectives of the Interagency Ocean Policy Task Force. These priorities involve ocean and coastal management and research that are consistent with the National Research Council framework outlined above. The plans and policies described above constitute the national drivers for this report. A chronology of major events influencing the development of this current Insular Pacific ocean research prioritization is presented in Figure 1.

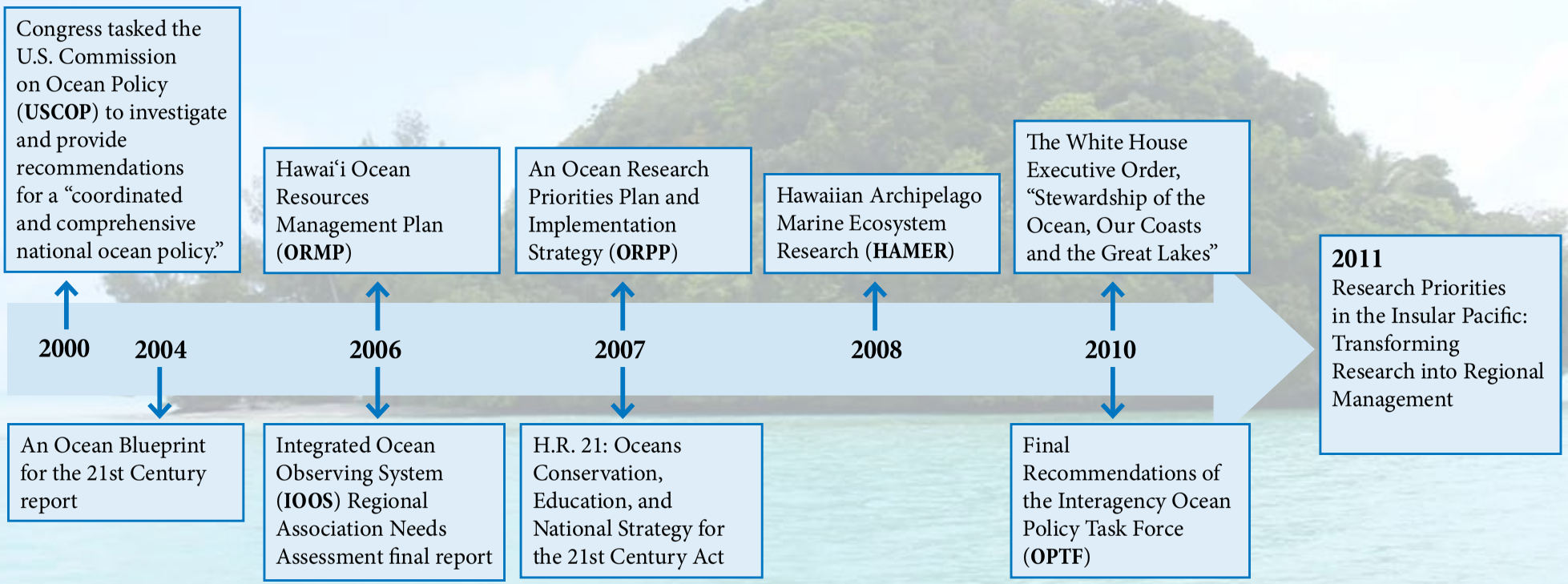


Figure 1. A chronology of major events influencing the development of this current Insular Pacific ocean research prioritization.

Republic of Palau

Photo: Simon Ellis

INTRODUCTION

To address the national mandates for regional place-based management mentioned previously, NOAA provided funds to its NOAA National Sea Grant College Program to develop assessments of regional research needs and priorities for U.S. coastal and Great Lakes states and jurisdictions. Nine such regions were identified by NOAA based on ecosystem characteristics and jurisdictional boundaries. In collaboration with stakeholders, UH Sea Grant was charged with developing a research plan for NOAA's Insular Pacific Region comprising the State of Hawai'i, territories of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands, and the freely-associated Pacific Island nations (Federated States of Micronesia, Republic of the Marshall Islands, Republic of Palau). The Insular Pacific Region has now become codified in the lexicon of regional designations by national policy and federal agency mandates.

It is vitally important that the highest priority research needs be identified given both the critical dependence of the insular jurisdictions comprising the Insular Pacific Region on the ocean and the current resource limitations on research region-wide. To do that well requires broad input from stakeholders, universities, governments, and community leaders. Currently, because of compartmentalization, government often does not respond in an adequate, coordinated, and timely manner to human drivers of environmental stress. In response, the State of Hawai'i Coastal Zone Management Program updated the *Ocean Resources Management Plan* (ORMP) in 2006 for the subregion of Hawai'i based on priorities identified through public consultation and the efforts of many individuals, agencies, and organizations throughout the state (ORMP, 2006). The 2006 ORMP was developed with the help of 30 federal, state, and local agencies and programs, three major university programs, and 20 non-governmental organizations (NGOs), private sector, and advisory groups. The goal of the ORMP is to provide a contemporary plan and approach to integrated coastal management in Hawai'i to better align the numerous management agency jurisdictions and broaden support from the various cultural and socioeconomic sectors in the state, while being appropriate for extension to the Insular Pacific Region as a whole.

Thus, the ORMP provides a solid foundation for the development of a regional research needs assessment to support the implementation of management goals, aligns with the objectives of the National Ocean Plan, and forms the basis for extension of the governance concepts, research priorities and capacity building needs region-wide. The ORMP is well grounded in broad community participation and the major thematic areas are generally applicable broadly in the Insular Pacific Region. The current ORMP Working Group, an interagency group that has been meeting monthly since 2007 to foster collaboration and implementation across sectors, could form the basis for a Hawai'i Subregional Ocean Partnership and provide the foundation and model for later development of a U.S. Pacific Islands Regional Ocean Partnership (PROP). The guiding perspectives for ocean resource management in Hawai'i as identified in the ORMP were therefore used as the basis for the development of the theme areas from which research priorities throughout the Insular Pacific were identified in this report. *The primary objective of this study is to identify and prioritize managerial relevant research priorities and to understand the relative importance of various regional research and information needs for implementation.*

Photo: Jeffrey Kuwabara

GEOPOLITICAL CONTEXT

The immense size of the Insular Pacific Region and its geopolitical complexity (a state, two territories, one commonwealth, and three sovereign nations) make the region unique and different from the mostly contiguous jurisdictional makeup of U.S. mainland regional designations. Each island jurisdiction has a unique history, environment, institutions of governance, and cultural mores. For instance, in Hawai'i it is often remarked that the environment is the economy. Hawai'i is also a place where an indigenous, highly practical and successful ecosystem-based resource (political and social) management system (ahupua'a) was practiced for centuries. The six other Pacific island regional jurisdictions mentioned in this report also have highly diverse and strong traditional resource management practices that are being revived and honored.

Despite this uniqueness, there is a high degree of environmental commonality that makes a regional approach to marine and coastal management, regional partnerships, and related research particularly attractive. Those attributes include:

- Interrelated and mobile populations that are entirely located in tropical insular coastal environments.
- Economies that are ocean and coastal dependent.
- Rapid changes in population, culture, and economics are occurring.
- Insularity that places severe limits on resource sustainability.
- A pace of change that has created urgency for effective resource management.
- Current capacity and resources for managing critical research are insufficient, particularly in the territories and freely-associated jurisdictions.
- The importance of the region for national security.
- The severity of impacts from climate change and natural hazards coupled with low adaptability.
- Management approaches that have not been sufficient to balance current ecological, economic, and social needs of Insular Pacific stakeholders.
- The international nature of the region with one state, two territories, one commonwealth, and three sovereign nations that share populations, economies, and cultures.

American Samoa *Photo: Jeffrey Kuwabara*

METHODS

Approach and Data Collection: Research as used here includes not only careful study but also the important elements that make research more effective and new knowledge more available for management purposes. These include data management, monitoring, predictive modeling, evidence-based practices, knowledge transfer, outreach and similar transitional and application innovations to support the policy, and management decision-making process.

As a first step, UH Sea Grant established a regional planning team that included knowledgeable individuals from each jurisdiction in the Insular Pacific Region. Secondly, the team conducted an analysis of relevant published national and regionally-focused plans such as the ORMP and other federal and regional planning documents (*IOOS Regional Association Needs Assessment Final Report, 2006; H.R. 21, 2007; HAMER, 2008; Gulf of Mexico Research Plan (GMRP), 2009; South Atlantic Regional Research Plan, 2010, Coral Reef Ecosystem Research Plan for Fiscal Years 2007 to 2011, 2007*). From this analysis, the team developed an initial set of thematic areas. Three themes were derived directly from the ORMP and two additional themes were added based on discussions with stakeholders in the region. A list of potential research priorities were then developed for each theme area. The list of themes and possible research priorities was then used by the team as a starting point for stakeholder engagement through workshops, interviews, and questionnaires.

The team then identified key stakeholders from each jurisdiction in the region. These stakeholders were then engaged through a series of workshops, interviews, facilitated discussions, and, in the case of Hawai'i, through a follow-up web-based survey. From the engagement process, the team identified an initial list of priority research needs and knowledge gaps for each jurisdiction. Participants included representatives of jurisdictional governments and federal agencies, the private sector, municipal officials, researchers, NGOs, and community leaders. Over 600 individuals representing major federal, state, and local government agencies, universities and colleges, NGOs, and stakeholder organizations participated in the numerous workshops, interviews, and discussions over a three-year period (see listing in the acknowledgements section).

Data Analysis: Data on research priorities from the various workshops and facilitated discussions were compiled for each jurisdiction in the region. Except for the state of Hawai'i, the jurisdictional research priorities identified were reviewed by the team leaders and a smaller cadre of participants from each jurisdiction for completeness. These lists represent the equally-weighted research priorities for each jurisdiction reported. It is from these lists that the 48 regional research priorities were derived as described below.

Team leaders in each jurisdiction, except for the state of Hawai'i, were also asked to identify 10 research priorities of particular relevance to their jurisdiction. The jurisdictionally-specific needs that were identified were not required to be common across all jurisdictions in the region (i.e., were not required to be one of the 48 region-wide research priorities). The groups of 10 research priorities are listed under the jurisdictional overview section.

Photo: Chris Ostrander

The equally-weighted research priorities from each jurisdictional list were then assigned to one of the five research themes that were determined from an analysis of existing plans and assessments. Research priorities listed under each theme area were then compared across all jurisdictions in the region. Those priorities common to all jurisdictions were identified. These were reviewed once more by the jurisdictional representatives for completeness and consistency. The 48 research priorities common to all jurisdictions emerging from that process were then classified as region-wide priorities. These are shown in the results section.

The region-wide research priorities for the Insular Pacific were also linked individually to the national research priorities defined in the ORPP report in order to provide a national perspective for the regional assessment. Each regional research priority was linked to one of the 20 ORPP research priorities that most closely describe that regional priority.

As mentioned previously, the State of Hawai'i Coastal Zone Management Program updated the ORMP in 2006. The challenges associated with implementing that plan combined with the scarcity of resources, and severity of environmental issues identified, highlight the importance of critical research and information needs to address these problems. Consequently, it was deemed important to add additional prioritization steps in 2010 to the assessment process for Hawai'i. These are described as follows:

To refine the analysis for Hawai'i, we conducted a web-based survey using the 82 research priorities developed from workshops, documents, and interviews statewide. Approximately 380 key stakeholders, including the ORMP Working Group, were asked to complete the questionnaire. Respondents were asked to score each research priority on a scale from 1 to 5 (not a priority to a very high priority) in terms of importance for immediate investment of resources. There were 219 completed responses. Each of the 82 identified research priorities was ranked according to its average weighted ranking by respondents. Those research priorities that scored in the top 11 in the survey results are listed separately under the jurisdictional overview section. Further details of the methodology and analysis for the Hawai'i survey can be found in Appendix A. Step-by-step progression of data collection and analysis for the Insular Pacific Region is presented in Figure 2.

The Northwestern Hawaiian Islands (NWHI) represent an important but largely uninhabited jurisdiction under both state and federal protection mandates. Participants in workshops and interviews in Hawai'i were also asked to identify research priorities for this special marine conservation area. These were included in the web-based survey.

Tumon Bay, Guam *Photo: Dolan Eversole*

Step 1

- Workshops, interviews, and facilitated discussions resulted in a list of research priorities in each jurisdiction.

Step 2

- Team leads and working groups reviewed research priorities for completeness.

Step 3

- These equally-weighted research priorities were assigned to one of the five research themes that were determined from the analysis of existing plans and assessments.

Step 4

- Research priorities listed under each theme were compared across all jurisdictions in the region.

Step 5

- Common priorities across all jurisdictions were identified.

Step 6

- Reviewed once more by the jurisdictional representatives for completeness and consistency.

Step 7

- The 48 research priorities common to all jurisdictions were identified as region-wide priorities.
- Team leads and working groups also identified the 10 highest priorities of particular importance to their jurisdiction, except for the State of Hawai'i for which an online survey was used to identify the 11 highest priorities.

Step 8

- In order to provide a national perspective for the regional assessment, 48 research priorities were linked individually to the 20 national research priorities as defined in the ORPP Report.

Figure 2. Step-by-step data collection and analysis for the Insular Pacific Region.

Photo: Simon Ellis

Republic of Palau

RESULTS

Definition of Regional Research Priorities: Almost 100 research priorities across all jurisdictions in the region were identified exclusive of the unpopulated NWHI. The highest research priorities from the NWHI that were identified from the Hawai'i survey are listed separately in Appendix B. The 48 research priorities common to all jurisdictions derived from the cross comparisons are defined here as the "Research Priorities for the Insular Pacific Region." These research priorities were assigned to the appropriate societal theme as identified in the workshops and interview sessions. *We consider all of these common research priorities to be important to coastal and ocean resource management throughout the Insular Pacific Region.* In this assessment the research priorities are equally weighted in terms of importance and collectively represent the current research needs framework for the region as a whole. The five themes and the associated research priorities for each theme area are listed in the following section.

Research Themes and Priorities for the Insular Pacific Region: The five themes and their associated research priorities are shown in Tables 1-5. For the purpose of making the connections between this regional prioritization and the national ORPP explicit, we have indicated, to the right of each insular research priority, the number of the ORPP priorities to which that insular research priority can best be linked.

Table 1. Theme 1: Connecting Land and Ocean (9 Priorities). In island communities, land use is directly tied to a diverse array of societal benefits from and impacts to land and sea.

Insular Pacific Research Priority	Linked ORPP Priority No.
Develop predictive tools for and map potential impact zones of chronic and episodic natural hazards.	6
Analyze and model soil erosion patterns to streams/coastal ocean as a function of land use, development patterns, and current management protocols.	14
Analyze and model pollutant and nutrient loads to streams and the coastal ocean as a function of land use and development patterns.	14
Analyze and predict impacts of land use and development practices to spatially specific degradation of environment including marine ecosystems and coral reefs.	14
Estimate the societal value and associated costs of restoring and protecting streams, wetlands, and estuaries.	15
Analyze current and future land use and development patterns on hydrology, water resources, and related infrastructure (solid waste, sewers, septic systems, wastewater treatment).	15
Analyze shoreline erosion trends, restoration options for shoreline areas and scenic vistas, and criteria for public and coastal dependent uses for shoreline management planning.	15
Determine sources and impacts of illegal storm and wastewater discharges.	15
Identify health hazards from impaired water quality (freshwater and seawater) from land use and development and map high risk areas.	17

Table 2. Theme 2: Preserving Ocean Heritage (12 Priorities). Healthy ocean and coastal environments and ecosystems are the foundation of economic prosperity and quality of life for island communities.

Insular Pacific Research Priority	Linked ORPP Priority No.
Determine the socioeconomic and environmental impacts of non-extractive recreational activities (diving, snorkeling, boating).	2
Develop tools to detect and control the introduction and spread of invasive species including socioeconomic impacts of established invaders and risks of future introductions.	3
Develop status and trends analyses for threatened and endangered species and assessments of current management policy.	3
Develop criteria for establishment, site selection, evaluation and assessment of marine protected areas.	4
Develop evidence supported criteria for ecosystem based approaches to nearshore fisheries management.	4
Develop innovations and best practices for improving enforcement and compliance with rules and regulations for ocean protection and management.	4
Conduct cost benefit analyses, site selection and zoning criteria for marine alternative energy sources.	4
Promote research, development, site selection, and leasing criteria for sustainable aquaculture in coastal and ocean waters.	4
Understand ocean currents and nearshore water movement especially in the areas of environmental concern and significant human usage and impact.	8
Develop criteria for locating wastewater discharge zones for commercial and recreational vessels.	10
Assess the impacts of human activity and natural stressors (e.g., coral bleaching and ocean acidification) on specific coral reefs and associated ecosystems and develop mitigation strategies.	14
Develop criteria for determining the comprehensive state of marine environments including easily measured variables and indicator and keystone species.	16

Photo: Paul Brown

Pago Pago, American Samoa

Table 3. Theme 3: Understanding Climate Change Impacts and Adaptation (7 Priorities). Islands are particularly dependent upon ocean climate patterns. Changes in these patterns can have major consequences for island communities and associated ecosystems.

Insular Pacific Research Priority	Linked ORPP Priority No.
Estimate impacts of climate change on coral reef structure and coastal ecosystem health.	12
Better understand and predict current climate patterns and likely future changes in such patterns.	13
Understand and map major impacts (e.g., sea-level rise, salt water intrusion, and weather conditions) on shorelines, and associated infrastructure.	13
Understand and model socioeconomic impacts (e.g., public health, agriculture, energy, transportation, tourism, etc.) from climate change.	13
Develop adaptation and mitigation protocols and integrated management strategies in response to climate change.	13
Understand and model climate change impacts on sustainability thresholds for human populations (water, waste, energy, transportation, economies, living space).	13
Develop methods to capture indigenous knowledge for climate change adaptation.	13

Fagasa, American Samoa *Photo: Ephraim Temple*

Table 4. Theme 4: Promoting Collaborative Governance and Stewardship (8 Priorities). Increased human impacts on coastal and ocean environments require new holistic, integrated approaches to management and governance that involve collaborative management and policy alignment among sector-specific jurisdictions of government.

Insular Pacific Research Priority	Linked ORPP Priority No.
Document traditional indigenous management and sustainable use practices.	3
Develop new strategies for more timely knowledge transfer and exchange among institutions of governance to better align objectives and resolve conflicts.	16
Develop outreach and education tools to build knowledge and capability for public understanding of the importance of natural and cultural resources and management of these resources.	16
Develop innovations and identify best practices to improve enforcement capacity and public understanding of regulations.	16
Explore new avenues and partnerships for building research capacity and human resources to support management and policy.	16
Develop methods to engage stakeholders in policy setting and conflict resolution through public meetings and opinion surveys, assessment reports, and other avenues for engagement.	16
Understand the environmental and socioeconomic impacts of cultural, social, and demographic changes.	16
Develop standardized approaches and spatial planning tools for coastal management, planning, and decision-making across jurisdictions of governance.	16

Table 5. Theme 5: Supporting and Enhancing Ocean Observations and Data Management (12 Priorities). Critical research and evaluation for coastal management by necessity is dependent on well-developed systems of observation, sampling, monitoring, periodic assessments, and timely and accurate transfer of information.

Insular Pacific Research Priority	Linked ORPP Priority No.
Develop more comprehensive and accurate methods for monitoring pelagic fish populations, catches, and landings.	1
Identify and implement monitoring and observation strategies for status and trends analysis of water quality, especially high risk areas.	1
Identify and map sites and corridors of biological importance (e.g., coral reefs, whale, fish, turtle migration and spawning sites, bird flyways, etc.).	2
Establish a process for more timely, accurate, and synoptic assessments of effectiveness of policy decisions (e.g., laws, regulations, protected areas, land and ocean zoning).	4
Define and ensure adequate physical and meteorological data for safe harbor operations and to optimize vessel routing.	10
Identify gaps and prioritize needs in observation and monitoring capability for commonly-used models for management (e.g., circulation, contaminants, pollutants, nutrients, etc.).	14
Resolve issues about appropriate spatial and time scales and variables to be measured and monitored adequately for coastal management needs and define spatially the most critical areas for systematic observations.	14
Identify and map existing uses of coastal waters including transportation corridors, protected areas, fishing grounds, recreation areas, aquaculture leases, military reserves, etc.	15

Table 5. *(continued)*

Insular Pacific Research Priority	Linked ORPP Priority No.
Develop criteria for mapping and monitoring as a basis for site selection of restricted use areas.	15
Identify and map jurisdictional authorities for shorelines and coastal waters.	16
Promote the development and application of new technology, instrumentation, and best practices for systems of observation, monitoring, spatial analysis, and information transfer.	16
Establish university-state-federal partnership frameworks for coastal and marine spatial planning (CMSP) and associated standardized data management and information transfer for coordinated planning and policy decision-making across jurisdictions of government.	16

Linkages to ORPP National Priorities and Societal Themes: Each of the 48 region-wide research priorities for the Insular Pacific is linked to one of the 20 equally-ranked research priorities in the ORPP report that best describes that priority. The results of this linkage analysis are presented in Table 6.

Table 6: Linkage of Insular Pacific Regional Research Priorities to ORPP Theme Areas. The U.S. Ocean Research Priority Plan research priorities under each theme are arranged in order by the number of linkages (highest to lowest) to research priorities in the Insular Pacific Region. The total number of linkages for each theme also appears in parentheses.

ORPP Theme 1: Stewardship of Natural and Cultural Resources

ORPP Priority No.	Total Number of Insular Pacific Regional Research Priorities (n=13)
4. Apply advanced understanding and technologies to enhance the benefits of various natural resources from oceans and coasts.	6
2. Understand interspecies and habitat/species relationships to support forecasting resource stability/sustainability.	4
3. Understand human use patterns that may influence resource stability and sustainability.	2
1. Understand the status and trends of resource abundance and distribution through more accurate, timely, and synoptic assessments.	1

ORPP Theme 2: Increase Resilience to Natural Hazards

ORPP Priority No.	Total Number of Insular Pacific Regional Research Priorities (n=1)
6. Understand the response of coastal and marine systems to natural hazards and apply that understanding to assessments of future vulnerability to natural hazards.	1

ORPP Theme 3: Enabling Marine Operations

ORPP Priority No.	Total Number of Insular Pacific Regional Research Priorities (n=3)
10. Apply understanding of environmental impacts and marine operations to enhance the marine transportation system.	2
8. Understand the interactions between marine operations and the environment.	1

ORPP Theme 4: The Ocean's Role in Climate

ORPP Priority No.	Total Number of Insular Pacific Regional Research Priorities (n=7)
13. Apply understanding of the ocean to help project future climate changes and their impacts.	6
12. Understand the impact of climate variability and change on the biogeochemistry of the ocean and implications for its ecosystems.	1

ORPP Theme 5: Improving Ecosystem Health

ORPP Priority No.	Total Number of Insular Pacific Regional Research Priorities (n=23)
16. Apply understanding of marine ecosystems to develop appropriate indicators and metrics for sustainable use and effective management.	11
14. Understand and predict the impact of natural and anthropogenic processes on ecosystems.	6
15. Apply understanding of natural and anthropogenic processes to develop socioeconomic assessments and models to evaluate the impact of multiple human uses on ecosystems.	6

ORPP Theme 6: Enhancing Human Health

ORPP Priority No.	Total Number of Insular Pacific Regional Research Priorities (n=1)
17. Understand sources and processes contributing to ocean-related risks to human health.	1

The linkage analysis in Table 6 reveals a number of patterns of import in the assessment data relevant to national ocean research priorities. These can be summarized as follows:

- All of the research priorities in the Insular Pacific Region could be linked directly to a national ORPP societal theme and associated research priorities.
- The distribution of linkages among ORPP societal themes is highly skewed, yet low linkage themes such as resilience to natural hazards and human health (themes 2 and 6, respectively) are highly important regional priorities.
- About 75 percent of all research priorities in the Insular Pacific Region are linked to just two ORPP societal themes, namely stewardship of natural and cultural resources and improving ecosystem health (themes 1 and 5, respectively).
- Climate change issues represent about 15 percent of linkages yet adaptation to climate change is among the region's most important priorities.

The highly skewed distribution reflects both the urgency of issues in the two highly linked ORPP theme areas and the management-related complexity of the more general nature of ORPP issues listed under each theme. This complexity results in a high number of individual research priorities articulated by stakeholders encompassed in these two ORPP theme areas. A similar highly skewed pattern was also observed among GMRP (2009) where almost 70 percent of top research priorities identified were linked to the same two ORPP theme areas as identified here. *The U.S. Ocean Research Priority Plan themes and priorities that are associated with insular issues of evident and immediate urgency for coastal management are clearly reflected in these results.*

Photo: Chris Ostrander

Republic of the Marshall Islands

JURISDICTIONAL OVERVIEW

Purpose and Objectives: The purpose of this section is to provide a list of the 10 highest priorities for each jurisdiction in the Insular Pacific Region and include in that list any jurisdiction-specific priorities so ranked (i.e., not included in the 48 region-wide priorities). The objective is to provide a point of focus for future investment of scarce resources and for decision-making in policy and management processes.

Descriptions of the methodology appear in the methods section of the report for all jurisdictions. For Hawai'i, we present more detailed descriptions of the methods and results in Appendix A, including ranked priorities based on the survey data.

1. Territory of American Samoa

Background: American Samoa, which became a U.S. territory in 1900, is the only U.S. territory located south of the equator. With a land area of 199 km^2, American Samoa consists of five high volcanic islands and two coral atolls. There are limited coastal plains and natural freshwater sources. The principal villages of Utulei and Pago Pago are within one of the finest natural harbors in the Pacific region. This harbor has historical and contemporary military and commercial importance. There is a growing population of 70,260 of which 92 percent live in developed areas. Urbanization (growing at 2.4 percent per year) and its impacts on land and marine environments is a major issue for coastal management in the territory.

Much of the economy is dependent on agricultural products, the fishing industry, and a large U.S. government presence. Both nearshore and pelagic fisheries in the 390,000 km^2 exclusive economic zone (EEZ) are critical management concerns. Landings by foreign fishing fleets, especially tuna for canning, are important to the economy. The tropical climate and location make American Samoa prone to severe hurricanes and the rare tsunami. Over 90 percent of the land is communally owned, adding complexity to land-use decision-making. The American Samoa Community College is a well-regarded institution with ties to the University of Hawai'i. Both have been involved in a number of joint research and education projects on environmental issues.

Highest Research Priorities:

- Understand the impacts and limit introduction of alien species.
- Develop ecosystem-based management approaches to both pelagic and nearshore fisheries including improved monitoring protocols.
- Develop sustainable commercial aquaculture including outreach and extension programs.
- Improve practices related to sand and coral mining to insure least damaging methods.
- Better understand sedimentation and erosion related to coastal and terrestrial land use practices.
- Improve monitoring of coastal and marine water quality and impacts on human health.
- Develop best management practices for construction to minimize environmental impacts and improve resistance of infrastructure to weathering and natural hazards.
- Develop better marine and coastal spatial planning and zoning to guide urban, rural, and coastal development.
- Better understand fish toxicity in coastal waters.
- Better understand the impact of ballast and ship wastewater on human health and alien species introductions.

2. Commonwealth of the Northern Mariana Islands

Background: The Commonwealth of the Northern Mariana Islands (CNMI), which became a U.S. commonwealth in 1986, is comprised of a group of 15 geologically young islands with a total land mass of 463 km^2 north of Guam. The population of approximately 80,000 is heavily concentrated (99 percent) in the southern islands with 91 percent residing in Saipan. There are about 600 km^2 of both fringing and barrier coral reefs. The southern islands have relatively more coral development than the volcanic northern islands. These coral reefs harbor 256 species of corals as well as 1,106 species of fish with 10 endemics. With an EEZ of 758,000 km^2 both subsistence and commercial fishing are important to the economy including significant commercial fleet landings in Saipan. Grazing, agriculture, tourism, and urbanization have significantly affected the landscape.

Invasive plants and animals are of major concern in the CNMI, as are feral ungulates (goats, cattle, and pigs). The Commonwealth of the Northern Mariana Islands is home to 15 listed endangered or threatened species. There are also a number of issues associated with human impacts. These include watershed and coastal erosion, water pollution, seawater intrusion of potable water sources, marine water quality, and management of wastewater. The Commonwealth of the Northern Mariana Islands will also be impacted by military activities as the area is used for training exercises such as firing ranges.

Highest Research Priorities:

- Military build-up and the anticipated impacts on resources and ecosystems.
- Understanding the impacts of coastal development including shoreline changes, public access, erosion, and water quality.
- Hazards awareness and preparedness including the impacts of climate change.
- Increasing boater safety and prevention of groundings to protect both lives and coral reefs.
- Better understanding of watersheds, water supply, and wastewater treatment including impacts of pollution, sedimentation, erosion, and drought.
- Improved monitoring systems, assessments and mitigation strategies for ocean and coastal resource management.
- Increasing local capacity to understand and address marine resource management issues.
- Improved data management and accessibility including use of spatial planning for decision-makers and stakeholders.
- Pelagic and reef fish management and enforcement including marine protected areas (MPAs), community-based fisheries, catch, and population monitoring.
- Improved methods for control of invasive plant species.

Photo: Simon Ellis

3. Federated States of Micronesia

Background: The Federated States of Micronesia (FSM) is an independent nation freely-associated with the United States. The FSM signed a Compact of Free Association with the United States of America in 1986. Government services dominate the economy at 43 percent of Gross Domestic Product with expenditures totaling $129 million in 2002 of which the U.S. provides approximately $80 million. In 2006, foreign commercial fishing fleets paid over $13 million for the right to operate in FSM territorial waters.

The FSM is made up of the Central and Western Caroline archipelago that includes four states: Kosrae, Pohnpei, Chuuk, and Yap. Each state, except Kosrae, consists of multiple islands that are linguistically and culturally diverse. Each of the states differs considerably from each other in nearly all aspects. This nation of small islands (700 km^2 total land area) extends over an ocean area (EEZ) of approximately 2.9 million km^2. There are 30 high islands, one raised coral island, and 33 atolls bringing the total number of islands to over 600. The preliminary results of the 2010 census reveals that the percentage of the population by each state stands at approximately 35 percent for Pohnpei, 11 percent for Yap, 7 percent for Kosrae and 47 percent for Chuuk. Although population declined by -0.42 percent per year for the last decade, the population is very young, with 37.7 percent of the population under 15 years of age.

The FSM economy is largely dependent on natural resources. Due to a combination of factors including population growth, globalization, and internally-driven development, natural resources are facing increasing exploitation. Challenges and trends faced by FSM residents include overharvesting of nearshore resources such as reef fish and encroachment on native forests and watersheds by agriculture, urbanization, and other activities. Research and natural resource management needs and priorities in the FSM are complex and encompass many fields of science. Management of natural resources is complicated by the existence of both national and state governments and the continuation of certain aspects of customary management. In addition to its marine environments, the FSM is also home to unique terrestrial forest and grassland ecosystems as well as to important brackish and freshwater habitats such as mangroves, freshwater streams, and lakes.

Highest Research Priorities:

- Coastal erosion and sea-level rise.
- Water pollution for both the environment and human health.
- Erosion, sedimentation, and other impacts arising from economic development and urbanization.
- Destructive methods, poor practices, and over-harvesting affecting both marine and terrestrial environments.
- Dredging and mining, particularly in the most inhabited islands.
- Landfills and waste management.
- Sustainable forms of economic development such as ecotourism, natural products, aquaculture, and sustainable agriculture.
- Conservation and management of species and habitats, including control of invasive species.
- Promoting technical and scientific capacity in the FSM and cooperation with other countries, organizations, and institutions.
- Developing a national mechanism for exchanging and integrating information on biological diversity and ecosystem condition.

4. Territory of Guam

Background: The U.S. Territory of Guam is the largest, southernmost island in the Mariana Islands Archipelago with a land mass of 541 km^2 and a coastline of 125.5 km^2. With a population of over 170,000, Guam is the most densely populated island in the western Pacific. For the last half century, Guam has been an island of rapid coastal and inland development. Population influx continues to accelerate, as the island is one of the principal U.S. gateways to the Pacific Islands and Asia, and vice versa. One of the most strategically important military installations for the U.S., the current projected build-up of an additional 5,000 personnel has raised concern regarding the management, protection, use, and resiliency of coastal resources.

Guam's EEZ (218,000 km^2) includes diverse coastal and marine habitats such as seagrass beds, mud flats, beaches, a variety of coral reefs, and the largest mangrove stands in the Mariana Islands. The socioeconomic importance of these coastal resources is critical as beaches and reefs are among the primary attractions for tourism, and fishing is very important to local people both culturally and as a resource. Rapid and extensive development present a wide range of impacts including diminution of natural habitat, coastal erosion, persistent organic pollution, coral reef sedimentation, and effects on water resources and indigenous species. Guam is particularly vulnerable to natural hazards such as strong winds, typhoons, and earthquakes. Global climate change impacts, particularly sea-level rise and storm frequency/intensity, are also of concern. The University of Guam represents a valuable asset for resource management in the region with significant research, education, and outreach capabilities.

Highest Research Priorities:

- Insure a sustainable, safe seafood supply including pelagic and reef fish management and enforcement, MPAs, contamination prevention, and stakeholder outreach.
- Better understanding and monitoring of local ocean conditions (currents, waves), marine ecosystems, and pollution and sedimentation patterns.
- Hazard mitigation including typhoon-related impact predictions, dangers to navigation, and climate change impacts.
- Documenting the military buildup in Guam and understanding the impacts on coastal ecosystems and resources.
- Increase overall capacity to deal with coastal issues.
- Better understand and manage land use, erosion, sedimentation, nonpoint source pollution, and impacts to ecosystems.
- Understand impacts of development and tourism on shorelines and coastal ecosystems.
- Improve data accessibility and public understanding of coastal resource issues.
- Understand water supply and sources including issues related to pollution, sedimentation, erosion, and drought.
- Improve management of waste and wastewater treatment.

Photo: Simon Ellis

5. Republic of the Marshall Islands

Background: The Republic of the Marshall Islands (RMI) is an independent nation freely-associated with the United States with a population of 56,000. The RMI signed a Compact of Free Association with the United States of America in 1986. It is one of only four nations in the world that consists entirely of coral atolls and islands (29 atolls and 5 islands). With 13,456 km^2 of coral reef ecosystems, the RMI possesses about 35 percent of the 36,812 km^2 of such ecosystems. While the RMI reefs and resources (with the exception of Majuro and Kwajalein) have remained fairly pristine until recent years due to their isolation and the nation's underdevelopment, increasing threats and pressures are now catalyzing awareness of the need to understand, protect, and sustainably manage these resources. The RMI is also of interest due to its special historical relationship with the U.S.; the northern islands of Bikini and Enewetak were the sites of 57 nuclear tests between 1946 and 1958. The impacts of the nuclear testing continue to play out today, with displaced populations suffering from poverty, disease (including some possibly related to nuclear fallout), and other effects of displacement.

Most of the population of the RMI (approximately 70 percent) is concentrated on two islands, Majuro and Ebeye. The latter is the site of the U.S. intercontinental ballistic testing and research at the U.S. Army Kwajalein Atoll facility, and hosts one of the most densely populated and poorest communities in the Pacific. Due to their high population densities, poverty, and related issues, special research and challenges face these islands. The other, less developed outer islands face challenges compounded by their isolation, lack of transportation and communication, and generally low capacity among the population. Natural resources management involves both government agencies and the continued existence of traditional land and sea tenure, which places much of the decision-making power with the traditional chiefs "Iroij."

One characteristic of the RMI is the rapidly growing institutional and individual capacity for research and management. This has led to a number of new local research and management initiatives accelerating over the last five years, as well as collaborations between local scientists and managers, and overseas colleagues. Infrastructure, instrumentation, and other resources have also increased significantly. The RMI may be poised to become a major site of coral reef and atoll research in the Pacific within a few years.

Highest Research Priorities:

- Improving all aspects of fisheries management including monitoring illegal, unreported, unregulated (IUU) fishing practices.
- Criteria for creating marine management areas.
- Monitoring and developing protocols for managing coastal erosion.
- Forecasting impacts from sea-level rise and other climate change impacts such as drought, salinization, and storm intensity.
- Improving disaster preparedness and recovery programs.
- Solving waste and water quality issues.
- Improved understanding of lagoon and oceanic water quality and impacts on health and aquaculture.
- Basic data and indicators needed for environmental assessments and marine habitat monitoring.
- Developing education and outreach programs for awareness of ocean issues.
- Combating poverty and over-extraction of resources through sustainable economic development.

6. Republic of Palau

Background: The Republic of Palau is the westernmost island group in Micronesia. This is an independent nation, which became freely-associated with the United States in 1994. Palau consists of 550 islands, of which 12 are inhabited, has a total landmass of 458 km^2. Including the more remote southwest islands located 600 km from the main islands Palau's EEZ encompasses over 629,000 km^2. Palau is located close to Southeast Asia and shares some of its flora and fauna. Geologically Palau is diverse with islands falling into four main groups: reef and atoll, high limestone, low platform, and volcanic. Most of the population of 19,907 in Palau lives on the main island of Koror (11,000).

Palau has both national and state systems of governance with 16 individual state entities, some with only 100 residents. Collaboration of research and development presents unique challenges for Palau, a place renowned in Micronesia for its fierce individual independence. This is compounded by the fact that the states have control over the use of their marine resources including fishing, aquaculture, and conservation areas. The nation as a whole has a high number of endemic species, especially corals, and is designated a biodiversity hotspot by Conservation International. Palau has an international reputation as an environmental leader and is responsible for initiating the Micronesia Challenge, an initiative whereby all states in the U.S.-associated western Pacific islands set a goal of putting 30 percent of their terrestrial and 20 percent of their marine areas under effective management.

Highest Research Priorities:

- Understand linkages between and among marine and terrestrial ecosystems.
- Distribution and impacts of introduced and invasive species.
- Status of species important in nearshore and offshore fisheries.
- Improve methods to measure quantity and description of fish and non-fish bycatch in the offshore fishery.
- Identify gaps in fisheries data for tuna, highly migratory fish, reef fish, and invertebrates (land crabs, lobster, and mollusks).
- Provide accurate, long-term information related to climate change: sea level and temperature changes.
- Understand and better manage cumulative socioeconomic and environmental impacts of development projects including dredging and sand mining.
- Understand processes and impacts of sediment loading and hydrology of rivers.
- Determine quantity and extent of pesticide, fertilizer, detergent, bleach, and other chemical contamination in rivers.
- Document short- and long-term land use changes (assessment and mapping), including population and demographic trends.

Photo: Simon Ellis

7. State of Hawai'i

Background: Hawai'i is the largest island jurisdiction in the Insular Pacific Region with a population of over 1.4 million inhabiting eight major islands. The Hawaiian archipelago stretches for over 2,400 km from the island of Hawai'i northwest to Kure Atoll (the world's highest latitude atoll). It is one of the most isolated island systems with high degrees of endemism in associated fauna and flora. The large marine ecosystem for the archipelago as defined by NOAA is immense and encompasses about one million km^2.

The eight main islands are human-dominated, high volcanic islands while the Northwestern Hawaiian Islands are primarily uninhabited atolls. The island of O'ahu is the epicenter of population with over 900,000 permanent residents. The state capitol and largest city, Honolulu, on O'ahu is a major political and commercial center built around a tourist industry approaching seven million visitors annually. Hawai'i was granted U.S. statehood in 1959 making it the only such jurisdiction in the Insular Pacific Region. As the largest population, economic, and political center it also houses the region's major university (University of Hawai'i) and the great majority of science and research capacity.

The state faces significant challenges in managing and maintaining its considerable coastal and ocean resources so vital to its economic well-being, cultural heritage, and quality of life. Adequately addressing these formidable challenges will require critical science-based information and data to support policy and management decision-making.

As indicated previously, a list of ocean management priorities was developed for the State of Hawai'i through a stakeholder engagement process that updated the ORMP in 2006. The significant challenges in implementing those priorities, the size of Hawai'i in area and population, knowledge gaps, scarcity of resources, and growing severity of the environmental issues identified highlight the critical importance of articulating and prioritizing the research and information needs for the state. The priority ranking process serves to focus the numerous management objectives advanced by the ORMP and other agencies of ocean jurisdiction. A list of the 10 highest-ranked research priorities for the state of Hawai'i appears below. Note that because of equal relative ranking in the 10th position both priorities are listed. The research priorities are listed by relative rank based on an average weighted score from the survey results where the highest score is set at 1.0. The rank score for each research priority appears in parentheses in the list below.

Highest Research Priorities:

- Improve methods to minimize long-term impacts to coral reefs from shoreline projects (e.g., stream channels, dredging, beach replenishment, and harbor development). (1.00)
- Develop science-based criteria and best management practices for ecosystem-based approaches for nearshore fisheries management in Hawai'i. (0.93)
- Understand the impacts of climate change on island carrying capacity (e.g., potable water, waste disposal, energy use and production, transportation, economics, and living space). (0.88)
- Assess the impacts of shoreline projects (e.g., stream channels, dredging, beach replenishment, and harbor development) on coral reef productivity. (0.85)
- Understand and map major impacts (e.g., sea-level rise, saltwater intrusion, and weather conditions) of climate change on shorelines and infrastructure. (0.81)
- Relate various impacts of land use and development practices to localized degradation of environmental quality including marine ecosystems. (0.79)
- Understand the dynamics of, and model pollutant and nutrient loads from, point or nonpoint sources to receiving waters as a function of land use and development patterns. (0.74)
- Develop protocols and tools to monitor and control the introduction and spread of marine alien and invasive species into the Hawaiian Archipelago. (0.73)

- Identify innovations and best practices to improve enforcement capacity and voluntary compliance with existing rules and regulations for ocean resource protection. (0.68)
- Model and map soil erosion patterns and sediment loads to receiving waters as a function of land use and development patterns. (0.66)
- Develop outreach and education tools to build knowledge and capability for public understanding of the importance of natural and cultural resources including their management. (0.66)

Highest Research Priorities for the Northwestern Hawaiian Islands

- Identify and implement effective restoration, recovery, and remediation strategies to address human impacts, including marine debris, ship groundings, and hazardous waste in the NWHI.
- Assess the effectiveness of MPAs in conserving ecologically-important species and their habitats in the NWHI.
- Map, characterize, and assess coral reefs and their associated habitats in the NWHI.

Photo: Dolan Eversole

SUMMARY AND CONCLUSIONS

Regional Plan Development: This work completes the necessary first step in developing a comprehensive approach to coastal resource management in the Insular Pacific and associated jurisdictions for the next decade and beyond. Broad stakeholder engagement, the high degree of inter-jurisdictional overlap in priorities, and conformance with national themes provide strong support for the validity and urgency of the research needs identified. *The research priorities, in turn, provide a firm foundation for strategic planning for implementing actions to address knowledge gaps and develop appropriate management and policy approaches to issues identified*. A number of important conclusions stemming from both the assessment process and results are evident. These include:

- The overarching importance of climate change and impacts from natural hazards.
- The criticality of improved understanding of land and ocean connections to insular economies and quality of life.
- The increasing per capita impacts on environment and socioeconomic factors with population growth due to limited land, natural resources and economies.
- The immense size of the EEZ and its importance to island economies.
- The high degree of dependence on ocean transportation systems and associated infrastructure.
- The high and growing degree of urbanization for a regional population of about 1.8 million spread across 19,167 km^2 of land mass in the region.
- The importance of the Insular Pacific Region to national security.
- The possibility of exceeding natural and economic sustainability thresholds in the next decade in the absence of corrective action.
- The consistency of Insular Pacific research priorities with national and other U.S. regional priorities.

Governance and Planning: A number of issues related to regional planning and governance also emerged from the assessment process and include the following:

- The absence of a region-wide comprehensive planning and implementation framework for coastal management. Several initiatives and agencies such as the Pacific Islands Ocean Observing System (PacIOOS), Hawai'i ORMP, NOAA Coral Reef Task Force, NOAA National Weather Service, NOAA Fisheries, Micronesia Challenge, Pacific Climate Information System (PaCIS), NOAA Coastal Storms Program (CSP), Pacific Risk Management Ohana (PRiMO), and NOAA Sea Grant programs have regional elements to contribute to development of a formal regional alliance.
- The limited capacity for research, monitoring, planning, and assessment, especially in territories and freely-associated states.
- The significant diversity in cultures, institutions of governance, policies, and patterns of enforcement.
- The urgency for addressing resource limitations and environmental problems.
- Insufficient mechanisms for outreach activities and public and stakeholder engagement.
- Fragmented, compartmentalized federal and local jurisdictional governance and authority.
- Limited resources for coordinated priority setting and inter-jurisdictional alignment for spatial planning, research, monitoring, and assessment.
- Insufficient information transfer and data management capabilities.

Because of the problems of chronically insufficient resources and capacity and urgency of issues and jurisdictional differences in critical priorities, we added a second step in the assessment process in order to articulate a small subset of only the highest priorities in each jurisdiction of the region. These are summarized in the jurisdictional overview section on page 19. The results provide a strong foundation for more targeted prioritization of scarce resources and human capital for both the Insular Pacific Region and the individual jurisdictions therein.

Island of Kaua'i, Hawai'i *Photo: Andrew Bohlander*

TOWARD IMPLEMENTATION

Overview: As this assessment makes clear, Insular Pacific jurisdictions are faced with escalating challenges in protecting the ocean and coastal resources that are so critical to economic vitality and quality of life. It is also clear that current jurisdictions of government are having difficulty in responding adequately to human drivers of environmental stress. The reality is that current systems of government change slowly in relation to changing economic and environmental conditions.

Addressing the environmental challenges from rapidly changing conditions requires management approaches that evolve at a much faster rate than contemporary institutions of government with compartmentalized structures and overlapping jurisdictions. A similar problem exists with resource allocation where multiple agencies and institutions have separate and uncoordinated agendas and spending priorities. With the major priorities identified in this report, we now have an excellent starting point for making significant improvements in resource management region-wide.

The USCOP and emerging ocean policy call for more integrated, regional management approaches and provide insight into the development of implementation strategies to address management challenges. Such insights form the basis for many of the ideas put forward in the following sections. The purpose is to provide guidance in developing strategic frameworks for articulating effective actions to address the priorities identified above.

Understanding Reality and Thinking Strategically: Thinking strategically is an approach to problem solving, not the formal process of strategic planning. It may be viewed as the practice of thinking realistically about current and likely future trends, and then devising practical strategies for achieving goals. That means utilizing a broad array of approaches, engaging many constituencies, blending scientific understanding with the realities, and limited resources of current institutions in order to enhance management performance. While we now have a firm understanding of current problems and priorities in the Insular Pacific Region, good implementation frameworks must also be based on a consideration of future trends.

We, therefore, provide the following nine considerations as guidance for formulating implementation frameworks for the Insular Pacific:

- Increases in regional population, urbanization, immigration, and intensity of human activity are inevitable over the next decade and must be addressed.
- There is a significant time lag between onset of ecological degradation and management responses; it takes time to pass a law, build infrastructure, improve technology, and change behavior.
- The current multi-jurisdictional, compartmentalized, and hierarchical management and legal structures are unlikely to radically change in the coming decade. Improvements in management performance must come from innovations that enhance integration, coordination, and efficiency under current institutions of governance.
- Reconciling socioeconomic considerations with the environment will remain the primary management challenge.
- We are entering an age of unprecedented advances in communication, data management, monitoring, computational power, spatial resolution, and pattern recognition. These innovations need to be rapidly assimilated into implementation frameworks.
- Insular economies and cumulative human impacts are location specific. Therefore, precise place-based knowledge at relevant spatial scales is critical to managing human activities in time and space.
- Current limitations on resources for research and management are likely to continue well into the coming decade.
- Management decisions once made in built-out urban and coastal contexts cannot be easily or quickly reversed. New development demands intense management focus.
- Economic variables need to be included in considerations of insular carrying capacity and sustainability.

Strategic thinking must also lead to effective action that is based on smart planning, reliable information, defining objectives, taking responsibility, and evaluating performance. The following is a list of 10 guidelines for action in developing effective regional alliances and implementation frameworks:

- Determine the primary impediments to effective environmental management (however defined) and focus on practical, workable solutions.
- Build on strong leadership, collaboration, partnerships, coordination, learning networks and action.
- Enhance and promote effective mechanisms for a culture of communication at all levels of decision-making.
- Focus on strategies that reduce management response time.
- Promote anticipatory decision-making, which is, use of predictive models and current trends analysis as decision-support tools.
- Insure that both environmental and socioeconomic information are incorporated into databases and analytical methods used in decision-making.
- Insure a strong foundation of science and practice through periodic information exchange between researchers and practitioners.
- Concentrate on timely collection, integration, and transmission of information and research to decision-makers.
- Increase the degree of alignment of strategic goals and resource-allocation policies among local, state, federal, and international agencies, as well as private and public institutions in the Insular Pacific Region.
- Place high priority on data management and outreach gathering, translating, and transferring needed information to critical constituencies in easily accessible formats and through engagement at forums or other outreach activities.
- Understanding and integrating indigenous knowledge, particularly when indigenous groups and leaders have land/sea tenure and/or legal responsibility for management.

Photo: Murray Ford

RECOMMENDED ACTIONS

1) **Consider the establishment of a U.S. Pacific Islands Regional Ocean Partnership (PROP) Program that builds on and enhances existing partnerships.**
There is currently no single regional coordinating body for integrated ocean management that exists in the Insular Pacific Region. A number of such regional alliances have been established among multi-state regions in the continental U.S. Many contemporary federal initiatives call for regional approaches. The ORMP working group, for example, provides a foundation for a Hawaiʻi subregional partnership and possible regional model. There are also several consortia and groups in the U.S.-affiliated Pacific Islands and territories that such a partnership program could build on, thereby strengthening existing alliances.

2) **Promote and support effective mechanisms that enhance coordination and communication among agencies, institutions, and jurisdictions region-wide.**
Many government agencies, private industries, NGOs, and universities and colleges have mission objectives in the region. Most have strategic plans, individual program agendas, research assets, investment priorities, and constituencies. Innovations that promote partnerships and communication among these entities collectively are critical to progress. Partnerships increase alignment around common objectives, maximize use of expertise and scarce resources while enhancing synergy and communication. For example, every major line office in NOAA has a major (often multiple) independent program presence on the island of Oʻahu.

3) **Facilitate informed decision-making through enhanced support of information transfer and stakeholder engagement.**
Establishing regional guidelines for planning, priority-setting, monitoring, data management, analysis, and dissemination of information can provide a framework for more informed decision-making across jurisdictions in the Insular Pacific Region. Related elements include mechanisms that promote research, outreach, education, and engagement of stakeholders. Use of common protocols such as evidence-based and best management practices, often developed elsewhere, can increase management effectiveness and reduce lag time in response to priority research needs.

4) **Recognize and engage the unique attributes and cultures of each jurisdiction.**
Local knowledge, cultural values, ecosystems, economies, and priorities vary among jurisdictions in the Insular Pacific Region. Understanding and engaging these values and local conditions need be incorporated in decision-making and policy. Regional planning bodies must have the flexibility to recognize different subregional needs and adjust research protocols to best reflect unique jurisdiction specific priorities.

5) **Develop and implement regional spatial planning frameworks.**
Economic, environmental, and social characteristics vary spatially and at different scales throughout the vast Insular Pacific Region. Information about each major element must be incorporated and integrated in planning and policy-making on a place-based basis. The emerging field of coastal and marine spatial planning (CMSP) provides exciting new opportunities for mapping multidimensional information at spatial scales critical for decision-making. Serious consideration should be given by the University of Hawaiʻi, UH Sea Grant, and key state, territorial, federal agencies, and existing partnerships (i.e., the ORMP policy and working groups) in promoting the establishment of a university-based federal-state partnership or center in Hawaiʻi for spatial applications. Primary functions of the center would include research, applications, data management, information transfer, and use of spatially-explicit decision-support tools.

6) **Implement strategies to maintain and enhance critical financial resources for ocean stewardship.**
Resources and management decisions are dependent on the public economy and political will. In a time of scarce resources, maintaining funding for critical programs is essential. Regional plans must include strategies that maintain and enhance funding for critical research and assessment. Creative ways to consolidate or reallocate existing resources and leverage additional resources from private and public agency sources is paramount. Finally, local and jurisdictional leadership need to communicate to the region's elected officials, especially in the U.S. Congress, on progress and the importance of maintaining and enhancing federal support for coastal and ocean programs so important to constituent well-being.

7) **Link NOAA, other federal agencies, and non-federal organizations' objectives in coastal stewardship directly to regional research priorities.**
To adequately address the critical needs identified will require prolonged strategic focus and commitment of financial and human resources by all federal and state agencies as well as important NGOs and international groups. All programs with coastal stewardship missions need to coordinate and implement actions that link regionally-relevant research, outreach, and strategic planning objectives directly with the research priorities identified here.

8) **Work with regional partners and existing initiatives to link global priorities and resources to research and outreach needs.**
In concert with the coastal stewardship mission, NOAA, other agencies, and organizations need to lead coordinated efforts to assess progress in addressing the high priorities identified here, as well as review and update regional management goals and research needs assessments once every five to six years.

REFERENCES

Derrickson, S. A. K., M. P. Robotham, S. G. Olive, and C. I. Evenson. April, 2002. Watershed Management and Policy in Hawai'i: Coming Full Circle. Journal of the American Water Resources Association, Vol. 38 (2): 563-576.

Georgia Coastal Research Council, University of Georgia, Athens. April, 2010. South Atlantic Regional Research Plan.

Hawai'i State Department of Transportation-Harbors Division. September, 1997. Economic Impact Assessment of Hawai'i's Harbors.

Hawai'i State Office of Planning, Coastal Zone Management Program (Hawai'i CZM Program). April, 2009. Hawai'i Community Stewardship Directory.

Hawai'i CZM Program. December, 2006. Hawai'i Ocean Resources Management Plan (ORMP).

Hawai'i CZM Program. Hawai'i Ocean Resources Management Plan Working Group (ORMP). Accessed on August 12, 2010. http://hawaii.gov/dbedt/czm/ormp/working_group.php.

Hawai'i CZM Program. January, 2006. Hawai'i Ocean Resources Management Plan 2005 Status Report to the Twenty-Third Legislature, Regular Session of 2006.

Hawai'i CZM Program. December, 2006. Hawai'i Ocean Resources Management Plan 2006 Status Report to the Twenty-Third Legislature, Regular Session of 2007.

Hawai'i CZM Program. December, 2007. Hawai'i Ocean Resources Management Plan 2007 Status Report to the Twenty-Third Legislature, Regular Session of 2008.

Hawai'i CZM Program. January, 2009. Hawai'i Ocean Resources Management Plan 2008 Status Report to the Twenty-Third Legislature, Regular Session of 2009.

Hawai'i CZM Program. March, 2008. Towards the Development of an Integrated Planning Framework for Natural and Cultural Resources Management in Hawai'i Place, Culture, and Community Based Approaches.

Holthus, P., N. Daschbach, K. Des Rochers, T. Donaldson, and P. Rappa. November, 1993. Marine Research Plan 1992-1996. Insular Pacific Regional Marine Research Program.

Mitchell, C., C. Ogura, D. Meadows, A. Kane, L. Strommer, S. Fretz, D. Leonard, and A. McClung. October, 2005. Hawaii's Comprehensive Wildlife Conservation Strategy.

National Oceanic and Atmospheric Administration Coastal Services Center. October, 2006. IOOS Regional Association Needs Assessment Final Report.

National Research Council. 2007. A Review of the Ocean Research Priorities Plan and Implementation Strategy, National Academies Press, Washington, D.C.

NOAA's Coral Reef Conservation Program. January, 2007. Coral Reef Ecosystem Research Plan for Fiscal Years 2007 to 2011.

NOAA's Coral Reef Health and Monitoring System. Accessed on December 15, 2010. http://www.coralreef.noaa.gov.

NSTC Joint Subcommittee on Ocean Science and Technology. January, 2007. Charting the Course for Ocean Science for the United States for the Next Decade: An Ocean Research Priorities Plan and Implementation Strategy. Accessed on December 13, 2012. http://www.whitehouse.gov.

Obama (July 19, 2010). "Executive Order - Stewardship of the Ocean, Our Coasts, and the Great Lakes." The White House.

Pacific Islands Fisheries Science Center, National Marine Fisheries Service. February, 2008. Hawaiian Archipelago Marine Ecosystem Research.

Richards, K. 2004. The Impact of Stirring and Mixing on the Marine Ecosystem. Geophysical Research Abstracts, Vol. 6, 01672.

Sea Grant South Atlantic Research Priorities Needs Assessment Draft 6/04/07. Accessed on May 30, 2009. http://www.gcrc.uga.edu/SARRP/Documents/NeedsAssessment_ju07.pdf.

Sempier, S. H., K. Havens, R. Stickney, C. Wilson, and D. L. Swann. September, 2009. Gulf of Mexico Research Plan (GMRP). MASGP-09-024.

Starmer, J. 2009. Northern Mariana Islands Needs Assessment for the Pacific Islands Ocean Observing System. Pacific Marine Resources Institute, Saipan, Commonwealth of the Northern Mariana Islands.

The Micronesia Challenge. Accessed on July 01, 2009. http://www.micronesiachallenge.org/.

The White House Council on Environmental Quality. July, 2010. Final Recommendations of the Interagency Ocean Policy Task Force.

United States Commission on Ocean Policy. July, 2004. An Ocean Blueprint for the 21st Century. Final Report. Washington, D.C.

United States Government Printing Office. January, 2007. H.R. 21: Oceans Conservation, Education, and National Strategy for the 21st Century Act. 110th Congress 1st Session.

Photo: Chip Fletcher

APPENDICES

APPENDIX A: State of Hawai‘i Research Needs Prioritization Survey

Understanding Research Priorities

UH Sea Grant has been tasked with developing a metric that helps prioritize ocean research needs in Hawai‘i to focus management attention and research funding on the most important issues facing the state. During most of 2009, Hawai‘i’s marine and coastal-oriented research, management, cultural, commercial, and recreational communities were engaged with developing a set of questions to understand the relative importance of a variety of issues. Using the Hawai‘i ORMP as a framework, the five themes that were developed for the Insular Pacific (see methods section) were used in designing an internet survey using the SurveyMonkey platform. The 82 research priorities identified from the workshops were distributed in one of the five main themes (Table A-1). These 82 priorities as well as several demographic questions constituted the survey questions. The survey was directly distributed to 302 individuals. Two follow-up email reminders, with the survey link embedded, were also sent to these recipients. In addition, respondents were solicited via appropriate email listservs, a press release, the UH Sea Grant website, and through direct contact. The response duration was 90 days.

Table A-1. The Five Thematic Areas (the number of priorities in each theme is shown in parentheses).

Theme 1:	Connecting Land and Ocean (17)
Theme 2	Preserving Ocean Heritage (20)
Theme 2(a)	Preserving Ocean Heritage – Northwestern Hawaiian Islands (10)
Theme 3	Understanding Climate Change Impacts and Adaptation (9)
Theme 4	Promoting Collaborative Governance and Stewardship (11)
Theme 5	Supporting and Enhancing Ocean Observations and Data Management (15)

Response and Sample Demographics

There were 219 respondents who answered all questions. The single largest group of respondents was from the island of O‘ahu. Figure A-1 shows the distribution of respondents among islands as follows: O‘ahu (65.3%), Hawai‘i (16.0%), Maui (12.4%), Kaua‘i (5.1%), Lāna‘i (1.1%), and Moloka‘i (0.8%). In addition, we also received responses from a few non-Hawai‘i locations from respondents who have a current or previous connection to the state.

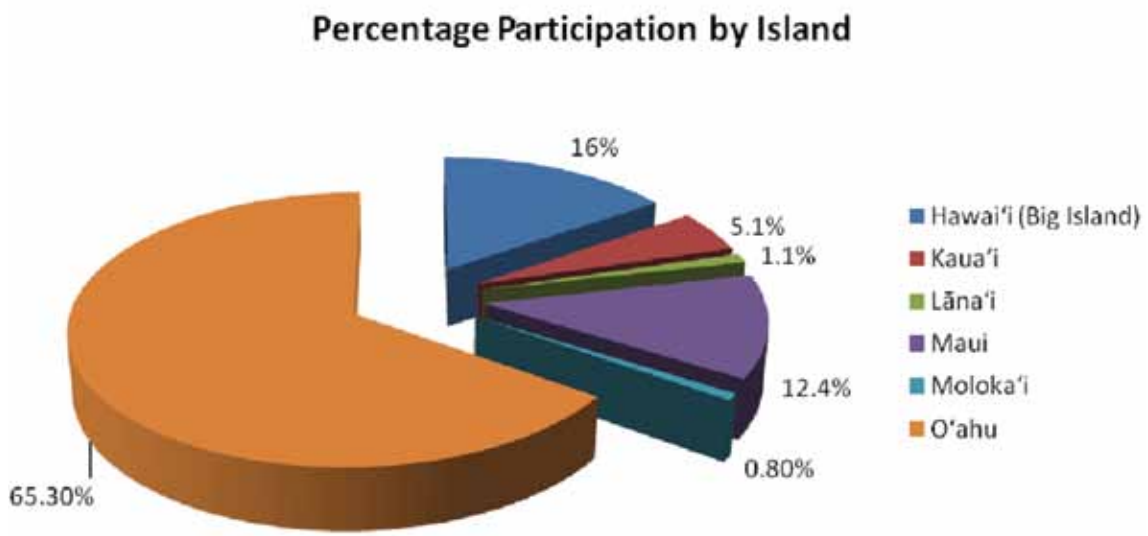


Figure A-1. Participation by major islands in the State of Hawai‘i.

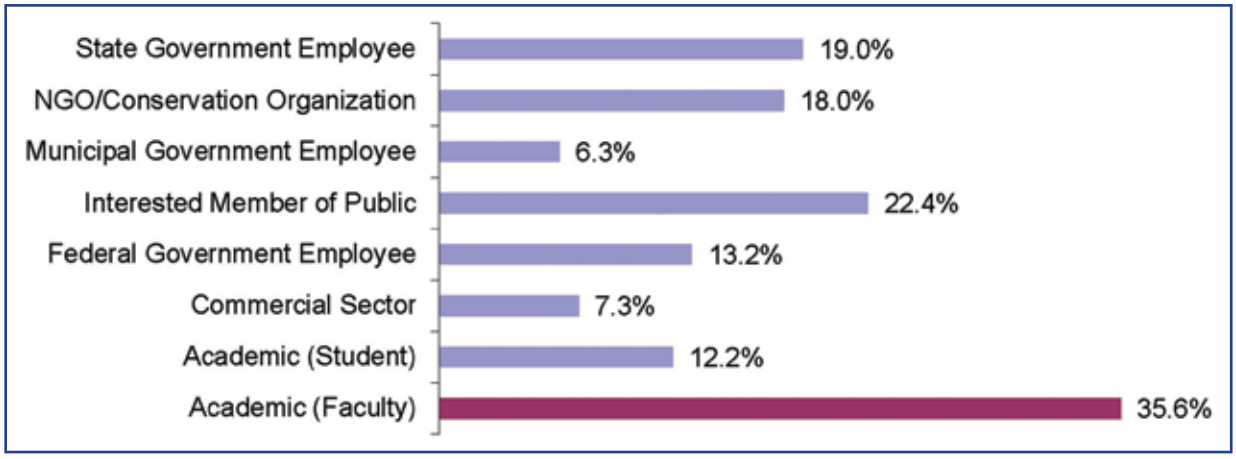


Figure A-2. Percentage of participation by various professional sectors.

Figure A-2 shows the distribution of response by different sectors. The highest participation came from academia (35.6%) followed by interested members of the public (22.4%), state government employees (19.0%), and NGOs and conservation organizations (18.0%). In terms of professional affiliation, respondents identified themselves as follows: marine and/or coastal researchers (34.4%), university professional staff (16.7%), government professional staff (16.7%), and several other professions (Figure A-3).

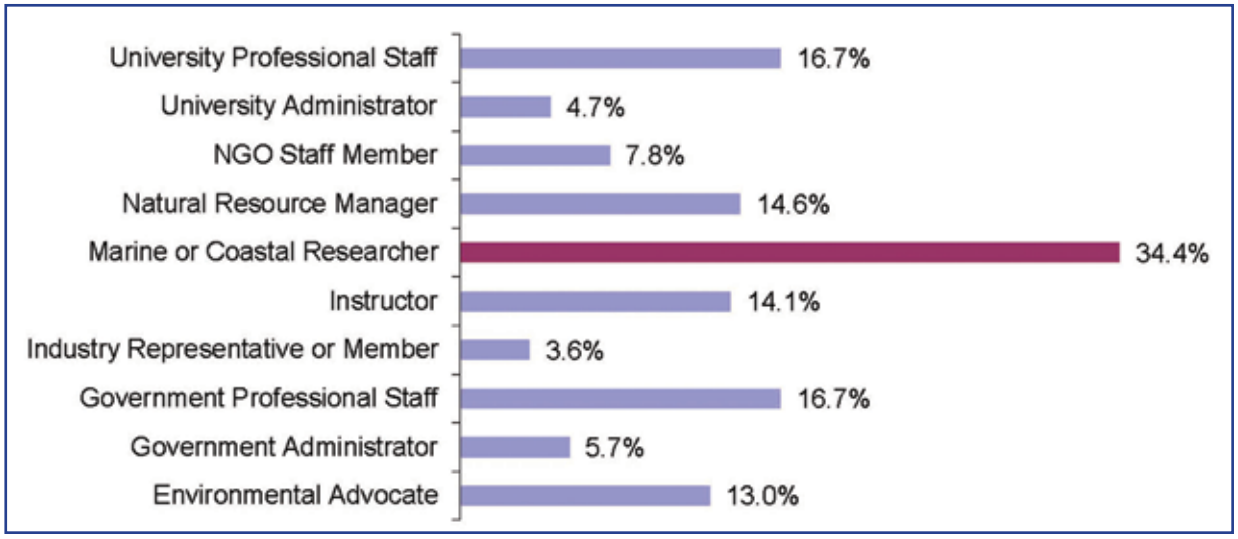


Figure A-3. Percentage of participation by professional affiliation.

Photo: Dolan Eversole

Analysis

For each research priority, respondents were given six response options: "not a priority" (1), "low priority" (2), "medium priority" (3), "high priority" (4), "very high priority" (5), and "no opinion" (0).

Because this report is to be used to help prioritize research focus over the next five to six years, we are particularly interested in those priorities that respondents collectively identified on a mean weighted average basis as the highest priorities.

Across the 82 questions, six items (less than 8%) were selected by respondents as being very high priorities. An additional 15 items in order of rank score constitute the top quartile. ***These 21 items constitute the highest research priorities for the state of Hawai'i as identified by survey respondents. These represent primary targets for implementation by government institutions going forward.***

It is important to note that as expected none of the 82 research needs identified received a response of "no opinion" or "low priority." All were considered priority items and over half (48) are listed as Region-wide Priorities in this report.

In terms of specific items that were evaluated as very high priorities, survey respondents seemed most concerned about issues that had system-linkages, such as the relationship between terrestrial and marine systems, between human land-use activities and the environment, and various components of fishery ecosystems (Table A-2).

Table A-2. Very High Priority Research Needs for the State of Hawai'i as Evaluated by Survey Respondents and by Overall Ranking.

VERY HIGH PRIORITIES

THEME 1	CONNECTING LAND AND OCEAN
	Improve methods to minimize long-term impacts to coral reefs from shoreline projects (e.g., stream channels, dredging, beach replenishment, and harbor development).
	Assess the impacts of shoreline projects (e.g., stream channels, dredging, beach replenishment, and harbor development) on coral reef productivity.
	Relate various impacts of land use and development practices to localized degradation of environmental quality, including marine ecosystems.
THEME 2	**PRESERVING OCEAN HERITAGE**
	Develop science-based criteria and best management practices for ecosystem-based approaches for nearshore fisheries management in Hawai'i.
THEME 3	**UNDERSTANDING CLIMATE CHANGE IMPACTS AND ADAPTATION**
	Understand the impacts of climate change on island carrying capacity (e.g., potable water, waste disposal, energy use and production, transportation, economics, and living space).
	Understand and map major impacts (e.g., sea-level rise, saltwater intrusion, and weather conditions) of climate change on shorelines and infrastructure.

All themes are well-represented in terms of high priority items scoring in the top quartile. Although high priority items were more varied in scope than very high priority items, groupings did emerge. Major high priority groupings include **spatial information** pursuant to decisions about conservation (e.g., MPAs), offshore energy, and other uses, various data **monitoring** needs, the impacts of **climate change** to both society and ecology, and **governance** integration and engagement (Table A-3).

Table A-3. High Priority Research Needs for the State of Hawaiʻi as Evaluated by Survey Respondents that Constitute High Priority Needs in the Top Quartile.

HIGH PRIORITIES

THEME 1	CONNECTING LAND AND OCEAN
	Understand the dynamics of, and model pollutant and nutrient loads from, point or non-point sources to receiving waters as a function of land use and development patterns.
	Model and map soil erosion patterns and sediment loads to receiving waters as a function of land use and development patterns.
	Determine impacts of land use and development patterns on hydrology, water resources, and related infrastructure (solid waste, sewers, treatment plants, etc.).
	Assess, predict, and map beach erosion trends, including potential impacts of sea-level rise, for use in shoreline management plans.
	Determine sources and impacts of illegal storm-water discharge on the sewage system and coastal waters.
THEME 2	**PRESERVING OCEAN HERITAGE**
	Develop science-based and management criteria for siting new MPAs.
	Evaluate the potential of ocean alternative energy sources based on cost-benefit analyses, siting criteria, and environmental impacts.
	Identify innovations and best practices to improve enforcement capacity and voluntary compliance with existing rules and regulations for ocean resource protection.
	Develop protocols and tools to monitor and control the introduction and spread of marine alien and invasive species into the Hawaiian Archipelago.
THEME 3	**UNDERSTANDING CLIMATE CHANGE IMPACTS AND ADAPTATION**
	Understand and predict future climate change patterns for Hawaiʻi.
	Develop adaptation and mitigation protocols in response to climate change.
THEME 4	**PROMOTING COLLABORATIVE GOVERNANCE AND STEWARDSHIP**
	Develop a research and implementation framework for development and implementation of an ahupuaʻa (uplands to the sea) model of management for priority watersheds.
	Develop outreach and education tools to build knowledge and capability for public understanding of the importance of natural and cultural resources including their management.
THEME 5	**SUPPORTING AND ENHANCING OCEAN OBSERVATIONS AND DATA MANAGEMENT**
	Identify and map sites and corridors of biological importance (e.g., coral reefs, whale migration routes, bird flyways, seal pupping grounds, fish migration patterns and spawning sites, mangrove cover, etc.)
	Establish a university-state-federal partnership framework for standardized data management and information transfer for coordinated decision-making across management jurisdictions.

With regard to the quartile ranking, we employed a rating average technique to all items in our survey. In addition to assisting with intra-theme prioritization, this technique allowed us to standardize and evaluate the relative priority of each item across all themes. The rating average method is a weighted mean technique, so some data points contribute more than others. It was calculated as follows: For each question, each response category's weight is first multiplied by the number of people that chose that response. Second, these numbers are summed. Finally, this sum is divided by the total number of respondents to that question. For example, consider the following hypothetical distribution pattern for 10 answers to the same question. The number on the left represents the weight given to the response category (e.g., 1 = "not a priority") and the number on the right is the number of individuals that chose that response category: (1){2}, (2){0}, (3){5}, (4){2}, (5){1}. For this hypothetical item, the rating average would be 30 / {10} = 3. "No opinion" responses are excluded from rating average analysis.

Conclusions

In this type of survey research, the concern often exists that respondents may be inclined to evaluate all the items as highly important. When this occurs, the tool is of lesser value as a way to prioritize effort and funding, as the overall distribution will be fairly tight. However, the fact that only 6 of 82 questions (less than 8%) were evaluated as "very high" priority in this survey indicates that respondents thought critically about the relative importance of each item.

In general, our results suggest that more information about ecosystem linkages, including the relationships between ecological components and between social and ecological systems, is needed. As expected for insular jurisdictions, respondents rated a number of climate change theme items in the first quartile. Similarly, marine ecosystems adjacent to steep islands tend to be relatively more sensitive to land-based activities; the response pattern for Theme 1 seems to validate this concern (Table A-2). Of note, none of the respondents felt that *governance and stewardship or observation and management* themes contained issues that were of very high priority. Nonetheless monitoring and assessment are critical to coastal management and policy.

While management decisions concerning prioritization of research effort depends on strategic and mission mandates, it is critical that allocation of resources be strategically focused on the most important identified research needs. The approach taken here is both strategic (focus on the first quartile of rankings) and diverse as applied to critical thematic areas.

Photo: Paul Brown

Pago Pago, American Samoa

APPENDIX B: Northwestern Hawaiian Islands Research Priorities (arranged in order of ranking from the highest to lowest)

- Identify and implement effective restoration, recovery, and remediation strategies to address human impacts, including marine debris, ship groundings, and hazardous waste in the NWHI.
- Assess the effectiveness of MPAs in conserving ecologically important species and their habitats in the NWHI.
- Map, characterize, and assess coral reefs and their associated habitats in the NWHI.
- Describe species diversity, trophic structure, and associated dynamics (including habitat linkages with other ecosystem components) of coral reef ecosystems in the NWHI.
- Identify robust metrics to assess coral reef ecosystems (e.g., biodiversity and other statistical measures of assemblage structure, biomass size spectra, and life history responses to keystone species such as apex predators) that are consistent with existing mandates.
- Understand the population structures of bottomfish, lobsters, reef fish, endemic coral species, and adult predator species in the NWHI.
- Characterize and assess oceanographic factors that influence the distribution and abundance of biotic components of coral reef ecosystems in the NWHI.
- Understand the potential effects of coral disease on population dynamics, community structure and ecosystem function in the NWHI.
- Characterize and map genetic diversity of coral reefs and their associated habitats in the NWHI.
- Identify the distribution and occurrence of deepwater reef-building corals and their habitats.

Guam *Photo: Jason S. Biggs*

APPENDIX C: Glossary of Abbreviations

CMSP	Coastal and Marine Spatial Planning
CNMI	Commonwealth of the Northern Mariana Islands
CSP	NOAA Coastal Storms Program
CZM	Coastal Zone Management
EEZ	Exclusive Economic Zone
FSM	Federated States of Micronesia
GMRP	Gulf of Mexico Research Plan
HAMER	Hawaiian Archipelago Marine Ecosystem Research
IOOS	Integrated Ocean Observing System
IUU	Illegal, Unregulated, and Unprotected
JSOST	Joint Subcommittee on Ocean Science and Technology
MPAs	Marine Protected Areas
NGOs	Non-governmental Organizations
NOAA	National Oceanic and Atmospheric Administration
NWHI	Northwestern Hawaiian Islands
OPTF	Ocean Policy Task Force
ORMP	Hawaiʻi Ocean Resources Management Plan
ORPP	U.S. Ocean Research Priority Plan
PacIOOS	Pacific Islands Ocean Observing System
PaCIS	Pacific Climate Information System
PRiMO	Pacific Risk Management Ohana
PROP	U.S. Pacific Islands Regional Ocean Partnership
RMI	Republic of the Marshall Islands
UH Sea Grant	University of Hawaiʻi Sea Grant College Program
USCOP	U.S. Commission on Ocean Policy

Photo: Dolan Eversole