Information Needs For Conservation Science and Management of the Northwestern Hawaiian Islands:

A product of the *I Ke Āmio O Nā Wa`a* Workshop

August 2004

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service
Office of Ocean and Coastal Resource Management
Marine Sanctuaries Division

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Photographs provided by NOAA's National Marine Sanctuary Program, the Office of Ocean Exploration, and James Watt/NOAA.

Cover photograph by James Watt/NOAA depicts an 'iwa (*Frigata minor*) on French Frigate Shoals, HI.

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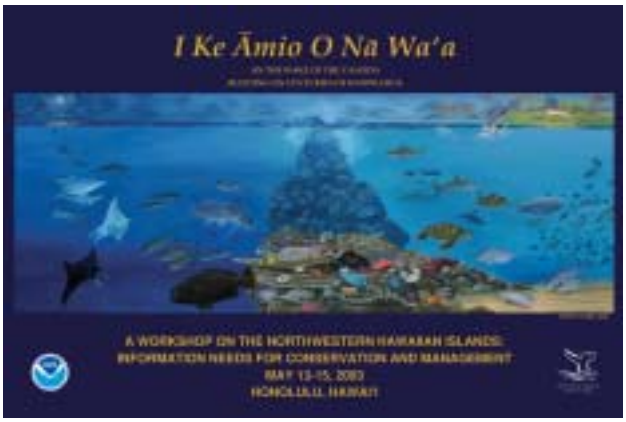
Preface

Studies of geological, biological, and oceanographic processes in the Northwestern Hawaiian Islands (NWHI) date to the earliest Polynesian explorers. Relying on keen observational and analytical skills, Native Hawaiians collected environmental information and interpreted their observations using algorithms passed down from prior generations in chants and oral histories. These expert navigators and natural scientists regularly voyaged thousands of miles across open ocean to link remote islands and atolls with a culture whose existence depended on the acquisition, accumulation, and analysis of information about the oceanic environment. Based on centuries of observation, their style of natural resource management was characterized by the seamless integration of marine, coastal, and offshore environments, and recognized the flow of energy and nutrients among these habitats.

The gathering and use of information about our natural world continues to this day. Our reliance on the land and sea underscores the importance of acquiring and utilizing information about our environment in order to manage resources and our relationship with them in the best possible manner. In the NWHI, agencies that bear the responsibility for management of marine resources include the State of Hawai`i, the US Fish and Wildlife Service (USFWS), and NOAA Fisheries. With the establishment of the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (NWHICRER) in 2000, NOAA's National Marine Sanctuary Program (NMSP) and the NWHICRER provide an umbrella under which coordinated research, management, and planning is encouraged and facilitated. Equipped with the best of both traditional and Western epistemologies and with an eye on the present and towards the future, cooperative multi-agency management in the NWHI proceeds with the long-term protection and conservation of its resources as a principal goal. While significant steps in reaching this goal will be the integration of people, use, and management, a primary key to success lies in the nature and quality of information upon which managers can base decisions. This assessment is designed to support this critical aspect of resource protection and management.



This document presents an analysis of results from a workshop held in May 2003 (*I Ke Āmio O Nā Wa`a*) focusing on information needs for management in the NWHI. It is intended to bring the workshop results into sharper focus and provide a basis for the development of a regional "action plan" for the NWHI to help coordinate characterization, research, and monitoring activities.

The name, *I Ke Āmio O Nā Wa`a* (In the Wake of the Canoes), was selected for the May 2003 workshop. For Native Hawaiians, the giving of a name, whether to a person, other living being, place, object, or even a significant gathering, conveys the giving of life beyond the literal. A carefully chosen name, distinct from a title or a literal description of an event,

gives that gathering a philosophical context for its existence. The title also embodies the goals of the workshop. In Hawai`i, an oceanic voyaging canoe is often used as a metaphor for an island, an isolated ecosystem that requires careful management to ensure the sustainability of its resources. The phrase "in the wake of…" is an acknowledgement that we follow and build upon the achievements of all that have come before us, from the earliest Polynesian navigators to the most recent research efforts. Finally, an image of canoes in forward motion suggests progress along multiple paths toward a common destination or goal.

Contents

Introduction

In December 2002, the National Marine Sanctuary Program (NMSP) and the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve (NWHICRER) convened a meeting in Honolulu, HI, to discuss management needs, science, and the status of the existing information base on the Northwestern Hawaiian Islands (NWHI). In attendance were representatives of State and Federal agencies with jurisdictions or responsibilities in the NWHI, researchers representing the academic community, and representatives of non-governmental organizations and other stakeholder groups.

Participants noted that while research has been an ongoing activity in the NWHI (see Appendix IV for area map) for many years, a handful of noteworthy research initiatives or syntheses punctuated this long timeline of information gathering. Among these landmarks were the Tanager Expedition in 1923, the Smithsonian's Atoll Research Bulletin publications of the mid-1960, the Tripartite expeditions of the late 1970's and early 1980's, and the Tripartite Symposia resulting from those expeditions. Participants also recognized the increase in research interest in the NWHI in recent years, concurrent with the return of Midway Atoll to the USFWS and the issuance of Executive Orders 13178 and 13196 that established the NWHICRER and a system of Reserve Preservation Areas. The rate of accumulation of information on the NWHI, as well as the needs of managers for sound information on which to base management decisions, had both increased significantly.

Lastly, participants noted that a comprehensive review and assessment of the existing knowledge base for the NWHI had not occurred since the Tripartite Symposia nearly two decades ago. Thus, the consensus of the group was that an assessment of both the existing information base on the NWHI, as well as an identification of gaps in that information base, would be both timely and productive. A comprehensive workshop to identify information and science needs and resources for effective conservation and management of the NWHI was identified as an efficient means to achieve this end.

Workshop and Assessment Highlights

- For the first time since the Tripartite Symposia in the 1980s, experts on the Northwestern Hawaiian Islands (NWHI) convened in May 2003 to discuss critical information needs related to long-term conservation of this enormous and important region.
- This assessment presents the results of the workshop in functional groups that should improve the ability of responsible agencies and other interested parties to plan, coordinate, and conduct conservation science and management activities in the NWHI.
- The intent of this assessment is to support the development of a regional action plan for the NWHI, which may call for joint planning and coordination of field efforts, periodic consultation and symposia, and regional integration of observations and information management.
- The results will also support the development of a draft environmental impact statement and draft management plan for the proposed designation of a NWHI National Marine Sanctuary.

This assessment presents the results of a May 2003 workshop conducted for this purpose. The results are in a restructured format designed to facilitate the incorporation of information into planning and coordination of science and management activities in the NWHI. This format does not include any prioritization of workshop results beyond what was done by workshop participants during the workshop itself. Instead, this assessment documents an analysis of the workshop results conducted to:

- bring additional clarity to the original recommendations of the workshop participants;
- facilitate the incorporation of this information into on-going planning and coordination activities in the NWHI including NWHIRER operations and the development of an environmental impact statement and management plan for the proposed designation of a Northwestern Hawaiian Islands National Marine Sanctuary; and
- provide a basis for the development of a new regional action plan for coordinated science in the NWHI.

This assessment may also serve as a substantive reference of the pertinent issues of concern and relevant information needs that should be addressed to best support coordinated studies, management, and protection of the resources of the NWHI. Individual researchers, organizations, and agencies involved with any activities addressing the NWHI can use this information to support their work.

This needs assessment and all other products relating to the May workshop are available on the web at http://www.hawaiireef.noaa.gov.

Workshop Overview, Planning, and Process

Overview

To help bring existing and emerging NWHI resource management questions into sharper focus - particularly with respect to research and investigations - NOAA's National Marine Sanctuary Program, the responsible office for the NWHICRER, hosted a workshop in Honolulu, HI in May 2003. The workshop was conducted in collaboration with regional partners, including NOAA Fisheries, US Fish and Wildlife Service (USFWS), the State of Hawaii (HI), the University of Hawaii (UH), the Bishop Museum, and the Western Pacific Regional Fishery Management Council. The purpose was to identify priority issues of concern and associated information and science needs across nine broad topic areas related to the long-term conservation and protection of natural resources and cultural legacy of the NWHI. Specific objectives for this workshop were to:

~ Take steps towards assisting all parties involved in the conservation management, protection, and study of resources in the Northwestern Hawaiian Islands in drafting a regional action plan for priority information needs.

~ Build the foundation for establishing similar priorities to support the current and future management of NOAA's NWHI Coral Reef Ecosystem Reserve.

~ Identify a specific set of recommendations on information needs associated with the characterization, monitoring, and research of the marine waters, habitats, and resources of the NWHI.

~ Draft associated strategies or actions across a broad set of disciplines and practices that includes hypothesis driven science as well as native cultural traditions.

Planning

A steering committee established by the NMSP began meeting in January 2003 to commence planning for the May 2003 workshop. This committee consisted of recognized experts and agency representatives with vested interest in the NWHI. Among their tasks was to compile a list of potential local, national, and international participants with expertise or experience relevant to management issues in the NWHI. The steering committee also contributed to the organizational structure of the workshop by reviewing the structural design of the workshop prepared by the NMSP and evaluating how this would generate the desired goals and outcomes. Further, steering committee members solicited preliminary lists of topics of concern from the agencies and groups represented on the committee. Each list documented roles, responsibilities, mandates, and or interests and concerns regarding the NWHI, as well as the conservation, protection, and management activities relating to these resources. These lists were used to generate a set of nine broad topic areas that would become the designations for working group topics during the workshop as well as provide background for participants.

Process

The three-day workshop was conducted in Honolulu, HI from May 13-15, 2003 to identify priority issues of concern, information needs, and strategies across nine broad topic areas related to the long-term conservation and protection of natural resources and the cultural legacy of the NWHI. Over 100 scientists and resource managers attended, representing a majority of the actively involved federal, state, and local agencies, universities, organizations, and interest groups.

The workshop opened with a three-hour public session highlighted by remarks from Hawaii's Governor Linda Lingle. This public session also included discussions by two panels; the first representing regional managers and the second representing regional field investigators. Complete transcripts of these discussions are available on the workshop website at http://www.hawaiireef.noaa.gov. Following the public meeting, participants were introduced to the structural and procedural design of the workshop and the expected outcomes. They were then separated into nine functional groups (termed topic areas) based on their expertise and professional interests in the NWHI (most workshop attendees participated in two workgroups). General descriptions of the working group topics are provided below.

1. ***Oceanographic Regime***
   Understanding the characteristics and qualities of the ocean and atmosphere that influence the region's resources.

2. ***Habitat Delineation***
   Determining the location and extent of biotic and abiotic components of the region's habitats, and relationships between habitat and living resources.

3. ***Living Marine Resources***
   Determining the dynamics of structure and function through assessments of status and trends in distribution, abundance, community composition, and relationships among living resources and their environment.

4. ***Threatened, Endangered and Terrestrial Resources***
   Determining distribution, abundance, community composition, and fitness of individuals and populations, and understanding the environmental influences on these parameters.

5. ***Cultural Heritage***
   Preserve and perpetuate ancestral relationships, activities and practices by understanding the characteristics, and qualities of traditional resource use by native Hawaiian populations, including conservation practices and ethics.

6. ***Stresses on Living Resources***
   Understanding and tracking fitness and factors affecting the fitness of individuals, populations, and communities.

7. ***Commercial and Recreational Uses***
   Determining impacts, intended and unintended, of natural resource extraction and use; identifying the effects of limiting or eliminating extraction, and the information necessary to select appropriate locations and sizes of areas established for such purposes; characterize and quantify the economic contributions of commercial and recreational activities in the region.

8. ***Damage Assessment, Response and Restoration***
   Understanding and responding to the physical, chemical and biological impacts of human activities such as vessel groundings, shipwrecks, spills, military activities, marine debris, entanglement, and strandings, and using the most appropriate means to minimize damage, clean, restore, or enhance recovery in degraded environments.

9. ***History and Archaeology***
   Understanding the history and material culture of human populations and activities, including economies, trade, and living conditions.

Each working group met during two separate sessions. During the first session, working group members defined and prioritized issues of concern within each topic area, and the associated information needs that would enable resource managers to better understand and address those issues. Workshop participants identified 119 issues of concern and 333 associated information needs across the nine topic areas (Table 1). The first session concluded with each working group prioritizing the issues of concern and information needs for use in the second session.

Table 1. Summary of participation and outcomes from each of the working groups. A complete record of the results is presented in Appendix I. A full record of the 99 strategies is available on the workshop website.

Workshop Topic	Number of Participants[1]	Issues of Concern	Info Needs	Strategies
Oceanographic Regime	12	9	30	6
Habitat Delineation	21	15	39	15
Living Marine Resources	32	22	42	12
Threatened, Endangered & Terrestrial Resources	9	7	37	17
Cultural Heritage	15	13	24	8
Stresses on Living Resources	33	7	42	19
Commercial and Recreational Uses	19	16	52	8
Damage Assessment, Response, and Restoration	11	12	47	6
History and Archaeology	16	18	30	8
	Total	**119**	**333**	**99**

[1] *Most workshop attendees participated in two topic-working groups.*

During the second session, each working group developed preliminary science-based strategies to address the prioritized information needs developed during the first session. These strategies included objectives for addressing the needs, the type and location of work required to address the needs, the amount of time and money required, and potential partners and data holders. In many cases, information needs identified by a working group were similar or thematic in nature and were addressed with a single strategy. A total of 99 strategies were developed during the second session of the workshop (Table 1).

Analysis

The objective of this assessment was to characterize the workshop results in a way that could readily support the development of a NWHI regional science action plan, as well as support regional managers, scientists, and individuals with specific interests in the NWHI. It was also intended to support the operations of the NWHICRER and the possible designation of a NWHI National Marine Sanctuary. To accomplish this, it was necessary to organize needs in a way that could translate easily to operations, particularly with respect to short and long-term planning, funding decisions (e.g., developing annual operating plans), and organization of field activities. In the course of processing the information needs and associated strategies, no effort to filter or prioritize this data was made. All workshop results (Issues of concern, information, needs, and strategies) are presented in this assessment as they were recorded in the workshop.

The 119 issues and 333 information needs were first organized into functional categories based on their similarities. Needs of a similar type or based on common concerns (e.g., those related to human use) were grouped together. These categories were termed "Themes," and could represent general focus areas for planning, funding, and conducting science operations. The proposed Themes are described in Table 2.

Table 2. Theme titles and summary descriptions.

Theme[1] Title	Description
Culture	Hawaiian cultural relationship to the NWHI
Ecosystem Characterization	Characterizing and understanding ecosystem resources and processes
History/Archaeology	Study of historical and archaeological resources
Tools	Improvement of capabilities for conducting science, resource protection, or mitigation
Monitoring	Monitoring status or trends of resources and processes, and the factors controlling them, through repeated observation and analysis
Use	Human use of and impacts to the environment

1. *Note: Workshop results generated by each workshop Breakout Group were analyzed and recast into Themes that are more functional for management planning rather than issue-based.*

The information needs within each Theme were further grouped into "sub-themes" representing needs with common requirements, such as activities, products, or analysis. For example, some involve field studies on particular aspects of the environment, such as habitat or water quality. Others require effort to develop ecosystem models. Still others call for improvements to existing technologies. The sub-themes (Table 3) will enable greater refinement of planning efforts resulting in improved coordination among partners in the management and research community working in the NWHI. Figure 1 shows the two-step process used to reorganize the workshop results. Figure 2 provides details for each step.

A number of results from the workshop were not included in the six Themes, as they did not appear to represent information needs as defined for this effort. They were grouped into a separate category termed "Other" (see Table 3 for the reasons for exclusion). They are legitimate issues and needs that should be addressed but were not incorporated into this analysis.

Figure 1. Overview of process used to analyze workshop results.

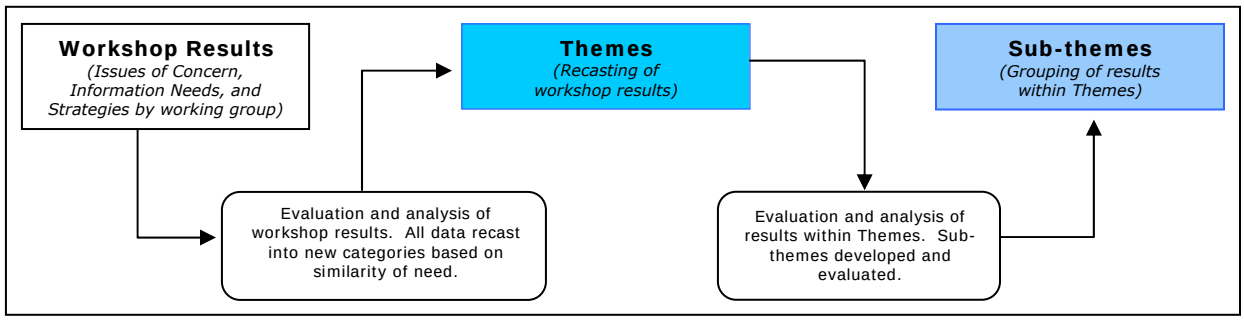
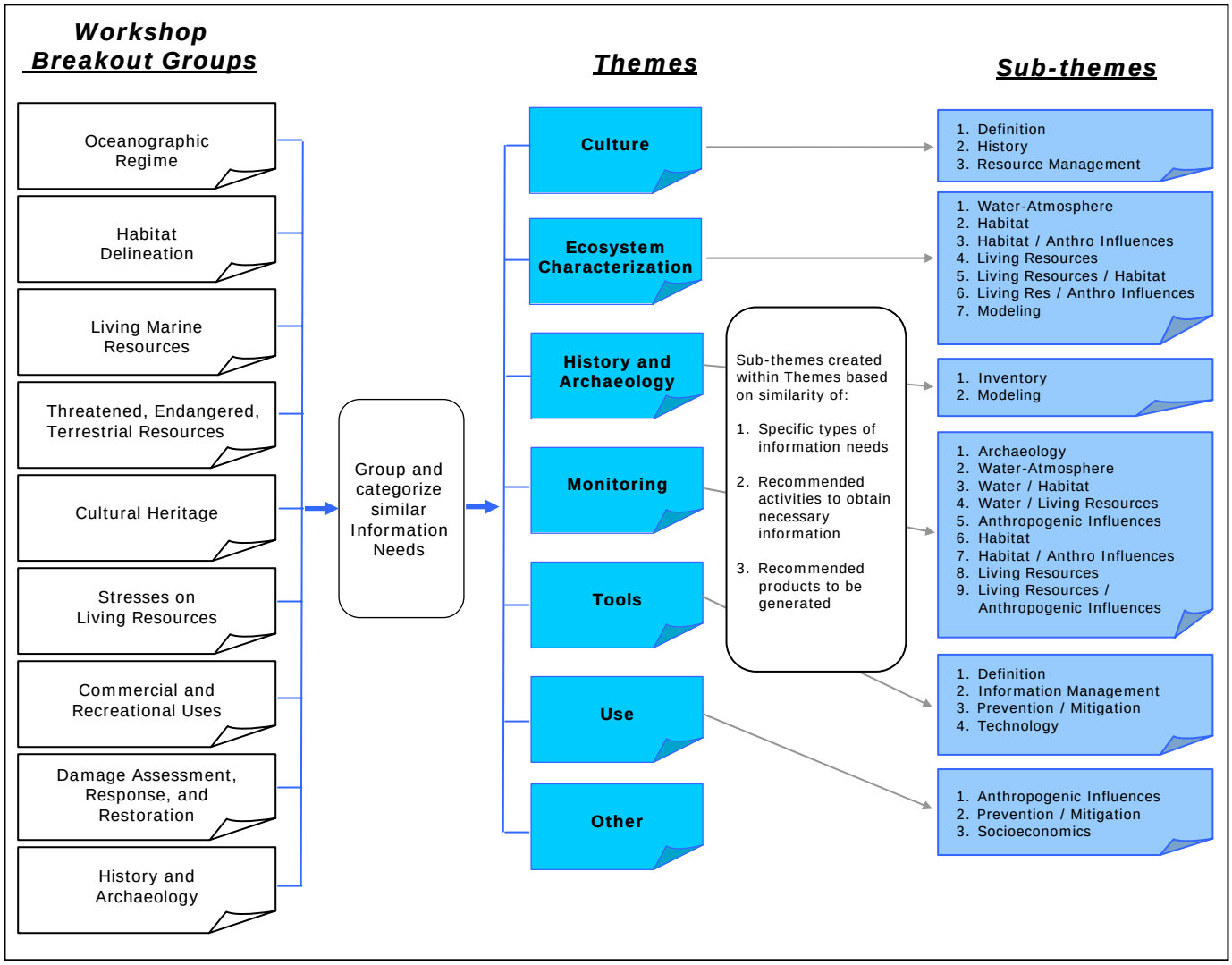


Figure 2. Analytical processing of original workshop results resulting in the creation of Theme/sub-theme Combinations.



Analysis of the workshop results revealed that for some Themes, sub-themes of information needs paralleled elements of a conceptual marine ecosystem framework with three primary compartments that describe the major structural and functional aspects of a marine ecosystem: water-atmosphere, habitat, and living resources (Figure 3). Some also addressed a fourth compartment pertaining to anthropogenic influences that affect ecosystem structure and function. Information needs associated with the Ecosystem Characterization, Monitoring, and Use Themes followed closely with the ecosystem framework. The other Themes (Tools, Culture, and History-Archaeology) contained some overlap with this framework, but other unique sub-themes as well (see Table 3).

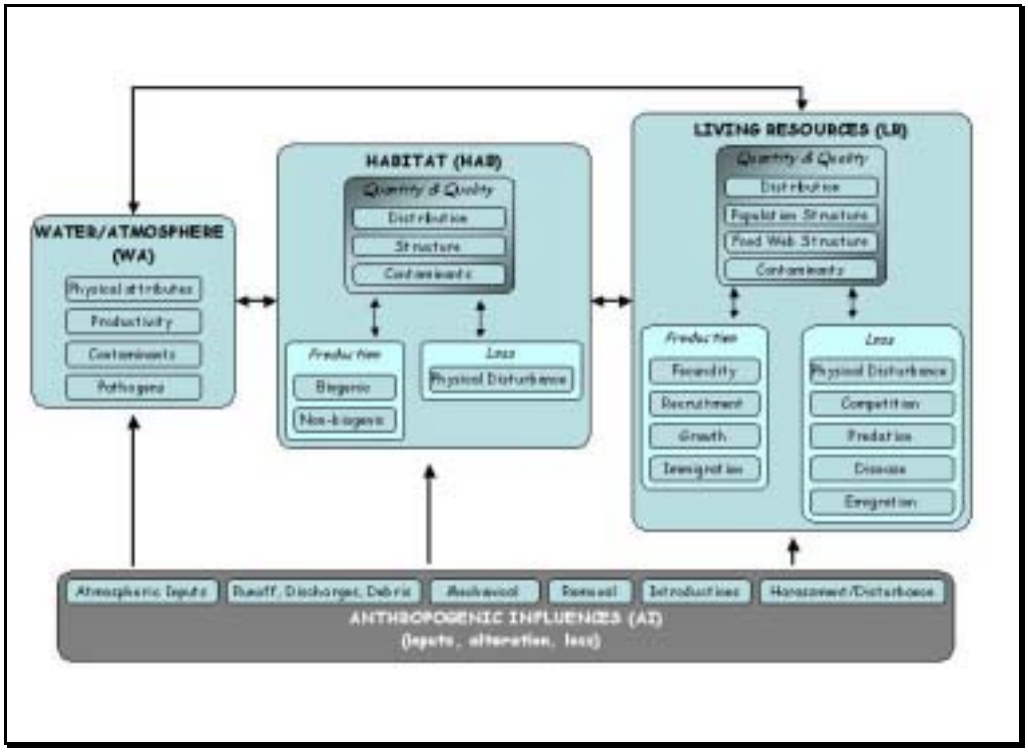
Table 3. Descriptions of sub-themes developed to categorize information needs across Themes. Shaded area at the bottom explains the reasons for excluding certain data from the assessment.

Sub-theme Descriptors	Abv	Definition
Anthropogenic Influences [1]	AI	Includes impacts associated with human use
Archaeology	AR	Study of material remains of past human life and activities
Definitions	DEF	Defining one or more aspects of a topic such as goals/objectives
Habitat [1]	HAB	Habitat status, production, and/or loss
History	HIST	Studying present and past native cultures
Information Management	IM	Organizing, managing, & mobilizing information for management
Inventory	INV	Inventories related to natural or historical resources
Living Resources [1]	LR	Living resource status, production, and/or loss
Modeling	MOD	Modeling ecosystem dynamics or predict likelihood of historical finds
Prevention and Mitigation	PM	Prevention or mitigation of human use impacts
Socioeconomics	SOC	Relating to, or involving a combination of social and economic factors
Technology	TECH	Improving existing or developing new technology
Water-Atmosphere [1]	WA	Physical processes related to water movement, water quality, and/or atmospheric processes
Categories for excluded Information Needs [2]	***Abv***	***Explanation for Exclusion***
Duplicative	*DUP*	*Overarching need whose parts are addressed elsewhere*
Outreach	*OUT*	*Responsibilities of an outreach program*
Policy	*POL*	*Needs better addressed in a policy setting*
Management	*MGT*	*Management activities or requirements*
Strategy	*STRAT*	*Needs that more appropriately would be part of a strategy*

[1] Sub-themes related to a component of the conceptual marine ecosystem framework.

[2] Issues and needs excluded from evaluation and grouped into "Other" category.

Figure 3. Conceptual framework for a generalized marine ecosystem.



Thirteen sub-themes were identified to further characterize information needs within the six Themes (Tables 3 and 4). In some cases, multiple sub-themes applied. For example, some needs grouped in the Habitat (HAB) sub-theme made specific reference to anthropogenic influences (AI); therefore, two classifications were used to group these needs. In this case, the sub-theme designation HAB/AI was used. The analysis resulted in 28 separate sub-themes containing up to 51 information needs (Table 4). Note that some needs applied to multiple sub-themes, and are therefore duplicated in Appendix I (e.g., an information need on the "effects of invasive species on the ecosystem" could apply to sub-themes related to habitats, living resources, and water quality).

Finally, the workshop results within each Theme/sub-theme combination were retraced to the original working groups that identified them (Table 5). This crosswalk illustrated that the information needs in most Themes originated from multiple working groups, highlighting similar needs and gaps in the existing information base for the NWHI extending across a broad range of topics. Further, it suggests that there are fundamental aspects of the NWHI resources that are central to resource conservation, research, and management across many topic areas. It is possible, therefore, that these proposed Theme/sub-theme combinations provide a suitable and substantive basis for the organization of a regional action plan for the NWHI, mentioned earlier in this assessment.

Table 4. Proposed Themes, sub-themes, and number of associated issues, information needs, and strategies developed by workshop participants.

Theme *(Issues/Info Needs/Strategies)* [1]	**Sub-theme or Combination** [2]	**Issues of Concern**	**Info. Needs**	**Strategies** [3]
Culture (14/19/9)	DEF	6	9	6
	HIST	4	4	0
	RM	4	6	3
Ecosystem Characterization *(92/132/73)*	WA	11	14	8
	HAB	18	18	14
	HAB/AI	4	6	6
	LR	21	51	18
	LR/HAB	5	5	6
	LR/AI	11	15	10
	MOD	22	23	11
History & Archeology (10/12/2)	INV	8	10	2
	MOD	2	2	0
Tools (19/23/16)	DEF	1	1	1
	IM	4	7	3
	PM	9	12	11
	TECH	5	3	1
Monitoring (65/75/ 44)	ARCH	2	0	0
	WA	4	4	4
	WA/HAB	2	2	1
	WA/LR	4	5	2
	WA/AI	9	8	6
	HAB	5	4	2
	HAB/AI	14	20	11
	LR	11	13	9
	LR/AI	14	19	9
Use (24/42/15)	AI	15	33	13
	PM	2	4	1
	SOC	7	5	1
Other [4] (25/30/11)	MGT	7	9	1
	OUT	4	5	1
	POL	11	12	7
	STRAT	2	3	1
	DUP	1	1	1

[1] *Some needs and strategies applied to multiple sub-themes and therefore appear more than once in Appendix 1.*
[2] *These abbreviations are also those used in Appendix I.*
[3] *Some strategies applied to multiple information needs and appear more than once in Appendix I.*
[4] *Sub-themes and counts for issues and needs excluded from evaluation and grouped into "Other" category.*

Table 5. Apportionment of information needs identified by working groups among the six proposed Themes.

	Workshop Topic Areas									
Proposed Theme	Cultural Heritage	History & Archaeology	Living Marine Resources	Damage Assessment & Restoration	Comm. / Rec. Uses	Habitat Delineation	Oceanographic Regime	Threatened/Endang. & Terrestrial Species	Stresses	**Total**
Culture	15	3	1							**19**
Ecosystem Characterization			34	11	20	18	25	11	13	**132**
History/Archaeology		12								**12**
Tools		1	2	2	1	7		4	6	**23**
Monitoring			2	20	6	3	4	21	19	**75**
Use			1	4	24	8		1	4	**42**
Other	*9*	*14*	*2*		*1*	*3*	*1*			***30***
Total	**24**	**30**	**42**	**37**	**52**	**39**	**30**	**37**	**42**	**333**

Theme Descriptions

In this section, information needs and strategies are summarized for each Theme/sub-theme combination. These summaries document salient points and significant trends within each collection of information needs. Associated strategies are also described. For specific language of information needs see Appendix I, and for specific language regarding the strategies developed, visit the workshop website.

Theme: CULTURE

General Description

Three working groups identified 19 information needs relating to cultural aspects of the NWHI. Most (15) came from the Cultural Heritage working group. Given the importance of the historical relationship between the Hawaiian people and the NWHI, and the unique dependence of island people on natural resources, it is clear that this Theme warrants serious consideration and effort. It may be sensible to incorporate traditional knowledge and approaches into modern resource management in the region. It also is certainly critical to involve stakeholders in decision-making. But to do so requires that conservation and management objectives are clearly understood, that terms of art for social and natural sciences are defined and used consistently, and that there is a full appreciation for approaches to and effectiveness of historical resource management efforts.

The information needs identified from this working group are preliminary since members of the Native Hawaiian community were not adequately represented at this workshop. A similar workshop will be conducted in mid-2004 to bring the Native Hawaiian community together in order to identify information needs for resource management from a traditional knowledge perspective.

Sub-themes

Three sub-themes emerged among the information needs related to cultural heritage. The first focused on the needs for improved communication among stakeholders through clarification of terms, issues, and objectives commonly used. The second addressed the need to gather information on the past to better understand the relationships between Native Hawaiians and the NWHI. The third focused on the application of traditional knowledge and practices to modern resource management, where appropriate.

Definition (DEF) – Participants identified the need to improve communications among stakeholders through clarification of words, terms, and issues. They recommended clarifying and standardizing the use of terms related to resource conservation and management. Words and phrases such as "culture," "heritage," "history," "sense of place," "full participation," "traditional ecological knowledge," and even "Native Hawaiians" mean different things to different people, leading to some confusion and miscommunication. Standardizing these important terms is essential before unambiguous and agreeable direction for research and management can be achieved.

History (HIST) – Most information needs identified focused on the need to gather and organize historic information to better understand the relationships between Native Hawaiians and the NWHI. There is a critical need to document and preserve the historical relationship between Native Hawaiians and the NWHI in order to appreciate traditional insights that integrated subsistence, religious, and cultural values in resource management. These efforts may result in substantial influence regarding implementation of current resource management directives.

Management (MGT) – Information needs in this sub-theme are based on the application of traditional knowledge and practices to modern resource management. Some traditional conservation practices might be effectively applied to selected resource management activities; these potential connections need to be better understood. Further, these investigations should include evaluating how these practices can be perpetuated in a manner that is complementary to other social and natural sciences used for conservation. A key component of the successful application of traditional practices is the prediction of future resource uses and activities.

Strategies

A principal focus centered on coming to a common understanding about the meanings of phrases and conservation objectives, and ensuring people are included and continuously committed to these efforts. Seven strategies were developed, addressing two of the three sub-themes above. Nearly all involved social science approaches such as surveys, literature searches, and interviews. Suggested actions include consensus building among

diverse stakeholders, and a recommendation for the integration of social and natural sciences in a pilot effort to demonstrate the feasibility and value of such collaboration.

Definition (DEF) – Six strategies were developed. Each would require the collective involvement of the region's stakeholders. In all cases, success will require multi-organizational cooperation. Documents are proposed that will clearly define terms and phrases used throughout the resource management community and those involved in native cultures. Preparation of the documents would require a mix of conventional literature review and the oral acquisition of information about traditional native values and practices. It was anticipated that these documents could help reconcile differences in understanding among stakeholders.

History (HIST) – Though no specific strategies were proposed for the information needs in this sub-theme, it is clear that they will need to be developed. The information needs clearly called for documentation of historical practices and values through oral and written histories, and archaeological research, to more fully understand the relationship between Native Hawaiians and the NWHI. Subsistence practices, spiritual influences, and interpersonal approaches that affected how Native Hawaiians relate to their environment must be considered, both for the lessons they teach about resource management practices and to ensure that modern approaches are, to the extent possible, culturally appropriate and acceptable.

Management (MGT) – The principal objective is to increase the effectiveness of decisions by enhancing the roles of social sciences, consideration of traditional and modern cultural values, and participation of key individuals and groups in the process. One strategy calls for a pilot project that demonstrates the mechanisms by which social and natural sciences can work synergistically to address a problem. Its intent is to establish a social science program within the framework for management of the NWHI. Another involves investigating how and to what degree traditional practices and native cultures have been included in resource management in places other than the Hawaiian Islands. The third noted the need to predict future uses and activity levels for the region in order to prepare for expected changes.

Considerations for Next Steps

- Social sciences can and should have a significant role in the future protection and management of natural and cultural resources in the NWHI. Specifically, these types of efforts can:
  - ~ help us understand regional history;
  - ~ support current management with strategies based on historic practices;
  - ~ promote collaboration among Native Hawaiians and other trustees; and
  - ~ integrate information from the current social settings into the decision-making process.

- Further explore the issues and information needs identified in the workshop by the Culture working group, as many focused on needs relating to policy and outreach and were not evaluated in this assessment. These needs identified are significant and warrant additional consideration. See the Analysis section and Table 3 for more information.

- Develop strategies for the History sub-theme to promote the inclusion of this important aspect in future science and management activities.

- Continue the dialog from the Cultural working group with the Native Hawaiian community, as well as developing new and enhancing existing partnerships with Native Hawaiian organizations.

- Interested parties should attend the workshop (to be hosted by the NWHICRER) that will be conducted in mid-2004 and focus on identifying information needs for resource management from a traditional knowledge perspective.

- See the Discussion section for other considerations for next steps.

Theme: ECOSYSTEM CHARACTERIZATION

General Description

About 40% of all information needs identified at the workshop related in some way to the characterization of ecosystems of the NWHI, making it the largest of the six proposed Themes. Only two of the nine working groups (Cultural Heritage and History/Archaeology) did not specify information needs in this category.

Sub-themes

Many of the information needs for ecosystem characterization aligned well with the compartments of the ecosystem framework shown in Figure 1. Four broad sub-themes were identified, three of which match the ecosystem framework. These were Water-Atmosphere, Habitat, and Living Resources. The fourth contains a substantial number of information needs (23) related to modeling of ecosystems and processes. Numerous needs also required information on human activities and impacts.

Water-Atmosphere (WA) – Several issues of concern dominated this sub-theme, and the information needs reflected this. The issues included understanding ocean processes that influence populations of key species like commercially targeted fish as well as the distribution and dispersal of debris, pollutants, and invasive species. In a larger sense, a significant issue discussed was the connectivity among the NWHI and between the NWHI and the main Hawaiian Islands. The other involved improving our understanding of historical climate changes and significant catastrophic events (e.g., tsunamis and storms).

Habitat (HAB) – Broadly ranging habitat-related information needs were identified at the workshop. They included mapping at numerous spatial scales; habitat quantification and classification (based on type, but also to document sensitive areas or those places critical for certain life stages of key species); ground-truthing; collecting baseline data; and documenting terrestrial/marine connections and interactions. Needs

were also identified that related to human influences on habitats. Priority anthropogenic issues were the impacts of marine debris, and vessel operations (pollutants, alien species, lights, and anchoring), as well as the activities of organizations responsible for protecting resources and conducting research.

Living Resources (LR) – This is another extremely broad sub-theme with wide ranging needs. Over half the Ecosystem Characterization needs and over 20% of all needs identified at the workshop were grouped in this sub-theme. A majority indicated the need for basic information on living resources to support biogeographic assessments, the development of descriptive and predictive models for key species (e.g., commercial stocks, vulnerable, and alien species), and enhancing the effectiveness of marine protected areas. Some of the needs included information on life histories, disease impacts, movement, predator-prey relationships, population dynamics, stock identification, extinction thresholds, the effects of extreme events, and recovery potential. With respect to anthropogenic influences, information needs focused on improving understanding of the population dynamics of managed species, the effects of existing regulations, determining environmental sensitivity, and ranking threats. Several also had to do with identifying critical habitats for different life stages of key species.

Modeling (MOD) – The development of comprehensive ecosystem models was seen as necessary to support decision-making for resources of the NWHI. These will be needed principally to determine the probable impacts of management actions, and evaluate what ecosystem components and processes may change or be particularly sensitive to certain activities or natural environmental changes. In addition to data on ocean, habitat, and living resource structure and function, models should incorporate, to the extent possible, existing data and user knowledge of resource natural history and relationships of species to each other and to their habitats.

Strategies

Fifty separate ecosystem characterization strategies, some of which overlapped significantly, were recommended by seven of the nine working groups. There was widespread agreement as to the need to gather and make available existing information, collect new field and laboratory data, integrate across disciplines (particularly physical and biological), and develop decision tools (e.g., maps and ecosystem models) that support resource protection goals for the NWHI (Appendix I).

Water-Atmosphere (WA) – Seven strategies were developed to address a number of the information needs in this category. Most require field data on mechanisms that control the distribution and dispersal of key species, debris, pollutants, and alien species. Integrated observations involving both remote and in situ measurements were identified as necessary, as was multi-organization cooperation. Developing models that describe and predict patterns of movement at multiple spatial scales was

recommended, particularly to address questions about connectivity among the NWHI and between the NWHI and the main Hawaiian Islands. These would support a wide array of resource management decisions, including those related to commercial harvesting. Compilation of historical data would provide information to support models and address questions about climate change and the effects of acute catastrophic events, again necessitating multiple spatial and temporal scales.

Habitat (HAB) – Eighteen strategies were proposed, the majority of which clearly referenced the need for a large scale, multi-organizational effort to map and characterize terrestrial and marine habitats based on an agreed-upon classification that considers species associations and sensitivity. The strategies call for using both archived data and new information collected using appropriate platforms, followed by ground-truthing. They also indicate the need for collaboration with strategies related to living resource data collection and monitoring, as well as the need for improving information management and data quality assurance procedures. Vulnerability of habitats to particularly important anthropogenic influences that may cause undesired changes (e.g., marine debris as a vector for alien species introductions) should be considered in assessing environmental sensitivity, as should the distribution of on-going human activities, such as vessel traffic and research.

Living Resources (LR) – A comparatively large number of strategies (32) were developed to address the diverse information needs in this category. Seven of the nine working groups submitted strategies that are included in this sub-theme. Many strategies proposed by the different working groups overlapped to a large degree and could be combined. Most recommended field assessments, but the objectives and approaches varied considerably. Some targeted information on life histories for key species. Others focused on inventories, distributions, species interactions, population and community dynamics, gene flow and dispersal, source-and-effect studies (contaminants, toxins, and diseases), and issues related to rehabilitation of stressed populations (e.g., translocation protocols and natural recovery potential). Risk assessments that involved identification of potential sources and transport vectors were recommended for certain stressors, including alien species, marine toxins (e.g., ciguatera), and debris. This work would be supplemented with laboratory analyses to better understand pathways and compare impacts across taxa, and support geo-referenced assessments of environmental sensitivity. Work on living resources would also be conducted through literature review, expert consultation, and model development. Considerable data already exists for many information needs, allowing investigators to identify gaps and focus their efforts more effectively. Developing databases that 1) accommodate disparate historical data as well as information collected in the future, and 2) have universal access will be critical to effective utilization and dissemination among researchers and resource managers operating in the NWHI.

Modeling (MOD) – Two of the nine working groups identified 10 strategies that involved the development of models to describe ecosystem functions and relationships among

components. Some were recommended to support specific management actions, such as the establishment of marine protected areas or regulating extraction levels. Others were deemed necessary to describe connectivity within the Hawaiian archipelago. Thus, spatial and temporal scales varied among strategies. Nevertheless, most recognized the need to integrate observations on hydrodynamic, climatic, and biological systems, both historical and recent, in order to describe critical controlling processes (e.g., dispersal, recruitment, movement, predator/prey dynamics, extraction, and disturbance events). Models that deal with establishing protected areas should be able to inform decisions about not only where best to establish them, but also whether a few large areas or numerous smaller ones are likely to be more effective at meeting resource protection goals. It was also suggested that existing ocean/atmosphere models that describe the equatorial Pacific could be extended and adapted to the Hawaii region rather than developing new ones independently. Their utility, of course, would require the ability to scale the models to appropriately account for archipelago-wide, inter-island, or atoll-specific processes and questions. For nearly all strategies, it was recognized that substantial, but insufficient data already exist to support the development of functional models. It will be useful for identification of data gaps, but the effort will also require new field and laboratory data collection, enhancing integration between observing systems, and improving information management, access, and dissemination systems.

Considerations for Next Steps

- Further evaluation of the needs of these Theme/sub-themes combinations should be considered. The needs for ecosystem characterization are so broad that many separate efforts will be necessary to address them. Nevertheless, integration of efforts to the extent possible will be required to reduce costs and maximize output.

- Develop more comprehensive strategies to deal with the breadth of needs identified in this theme. Significant progress was made in developing focused strategies during the workshop; however, these must be enhanced with more detail and thorough planning. This will be necessary in order to properly address the recommendations developed during the workshop.

- Develop information management systems to support the execution and coordination of activities in the NWHI. These systems should focus on storage, access, and dissemination capabilities. It will be critical to make data available to the research community as soon as possible after results are generated. Many of the proposed strategies recognized the need for a multi-disciplinary approach in order to understand the functioning of NWHI ecosystems. Any failure to provide access to critical information would diminish the effectiveness of a regional research approach.

- Coordinate with any activities put into motion pursuant to recommendations included in the Tools/Information Managements sub-theme.

- Increase the level and frequency of interaction among investigators working in the NWHI. Providing regular opportunities for information transfer and planning to ensure efficiency in implementing regional activities may be one of the most important roles of the NWHICRER.

- See the Discussion section for other considerations for next steps.

Theme: HISTORY/ARCHAEOLOGY

General Description

Workshop participants pointed to fundamental needs to understand management responsibilities on historical and archaeological resources in the NWHI. Further, developing inventories of known resources and potential targets was discussed. Workshop participants from the like-titled working group developed twelve information needs and two strategies associated with History/Archaeology sub-theme. Many needs also developed by this group were not addressed in this assessment as they focused on needs pertaining to management, outreach, and policy. See the Analysis section and Table 3 for more information.

Sub-themes

Inventory (INV) – Information needs in this sub-theme emphasized understanding and fulfilling mandates to conduct inventories of historic resources. The most important recommendation was to improve the overall understanding of and commitment to inventorying and characterizing historic sites and other associated historic resources in the NWHI. This would include a careful documentation of existing mandates and how they apply to different types of historic resources as well as a detailed assessment of existing knowledge - a gap analysis to help establish priorities for future investments. A careful review of past management practices was also recommended as a component of an overall approach to managing historic resources in this region.

Modeling (MOD) - Developing a predictive model was recommended for supporting mandates to inventory and protect historic maritime sites and artifacts. This type of tool would also help establish priorities for field activities by indicating likely locations for characterization and associated management (e.g., documentation, enforcement, etc.).

Strategies

Inventory (INV) – Participants emphasized the importance of fulfilling mandates by evaluating existing information on historic resources and surveying/characterizing other historic resources as part of an overall management strategy. Besides suggesting a more systematic approach to documenting existing historic resources using GIS and other tools and conducting surveys for other resources, participants recommended a stronger integration of field activities such that mandates for historic documentation and characterization are better understood and more likely to be included as a component of all research and survey missions in the NWHI region. Participants saw conducting and creating the inventory of resources as a critical step in preserving, protecting, and managing historic resources, as well as defining agency responsibility. A key consideration in this strategy would include traditional cultural properties/sites along with historical archeological sites.

Modeling (MOD) - No strategies were developed under this sub-theme.

Considerations for Next Steps

- All activities implemented relative to this theme should incorporate the needs to:
  - ~ improve the overall understanding of management responsibilities for these resources as defined in existing laws and regulations; and
  - ~ promote more systematical and deliberate documentation of known sites, and surveying/characterization of other candidate sites.

- Conduct further evaluation of the issues and information needs identified in the workshop by the History/Archaeology working group that were not addressed in this assessment in order to link them to any future actions relative to this sub-theme. These needs identified are significant and warrant additional consideration. See the Analysis section and Table 3 for more information.

- Develop strategies for the Modeling sub-theme to encourage inclusion of this recommendation in future planning activities.

- Ensure that when limited resources are mobilized for field activities in this region, opportunities to conduct historic investigations in partnership with other research will increase.

- Encourage targeted investments that improve the overall understanding of existing resources, including improved access to information via GIS and other tools.

- See the Discussion section for other considerations for next steps.

Theme: MONITORING

General Description

Workshop participants strongly emphasized the need to monitor the condition and trends in NWHI resources and the processes affecting them. Seventy-five information needs were included in this Theme. Eight of the nine working groups listed either issues of concern or information needs related to monitoring. Most had to do with tracking the status of the resources themselves and human activities that impact resources, or determining the effect of human activities on the resources. It also was recognized that monitoring would be required to assess impacts of many suspected or known stressors. One working group listed and ranked these stressors as part of their deliberations (see Appendix III).

Sub-themes

Four sub-themes were evident in the workshop results. One involved monitoring of archaeological resources. The three others (Water-Atmosphere, Habitat, and Living Resources) matched three of the compartments of the ecosystem framework depicted in Figure 1. The needs associated with the main compartments of the ecosystem framework contained a variety of focus areas. For example, while some were fairly specifically focused on the status of living resources themselves, others addressed the need to track the status of more complex aspects of ecosystem condition such as the relationship between the living resources and their habitat, or the impacts of certain human activities on the living resources. Further, it must be recognized, that there was considerable overlap between

the needs, particularly among those that address the effects of human activities on natural resources. Thus, while separate sub-themes are proposed, complete separation of the strategies produced for each sub-theme is not reasonable.

Archaeology (ARCH) – Monitoring of archaeological assets was recommended to evaluate changes in the condition of these significant resources. This includes impacts caused by human activities, such as vandalism, research, restoration, and natural events (e.g., storms and structural degradation).

Water-Atmosphere (WA) – This sub-theme is a combination of a wide variety of needs. Some relate to regular gathering of information on basic oceanographic and weather conditions that affect water quality and, by extension, the habitats and living resources of the region. Others involve assessments of contaminant levels resulting from historical or extant human activities such as cruise ships or research activities. The remainder relate to specific linkages among living resources and natural and anthropogenic changes in water quality, such as factors affecting coral bleaching, and the impacts of invasive species on productivity, and the distribution and abundance of pathogens or ecotoxins. Also recommended were activities to identify specific indicators that can be used to predict, detect, or track changes.

Habitat (HAB) – Three main areas of need addressed in this sub-theme include trend assessments, impacts, and recovery. Participants identified the need to establish baseline information for many resources and to use monitoring activities to track changes and detect trends in the conditions of those resources. Fluctuations in these trends may be natural or anthropogenic; however, the ability to quantify them is critical. Further, trend assessments should support evaluations of the effectiveness of mitigation and prevention activities in responding to impacts and threats. Monitoring impacts to habitat, both natural and anthropogenic, was a recurring need within this sub-theme. Impacts stemming from marine debris (e.g., presence/absence, removal vs. non-removal), research activities, invasive species, and commercial activities, as well as storm and significant oceanographic events were all noted as requiring monitoring to support effective management. Similarly, these and other activities (see Appendix III) were recorded as being major sources of total habitat destruction and loss, processes that must be monitored. Remote sensing and advanced tracking systems were recommended as methods to track and monitor impacts to and destruction of habitat as well as establishing rates of occurrence and distribution of such events. Finally, information and an understanding of rates of recovery from habitat destruction and loss resulting from natural events, research, and commercial activities are necessary to inform restoration decisions and support incident or case management.

Living Resources (LR) – The living resource information needs that require monitoring stem from two overlapping groups of needs. One involves tracking the status of species without specifically considering anthropogenic influences. The other involves tracking particular species or activities expressly because of certain human behaviors or actions. The large number of information needs in this category reflect the diversity throughout the archipelago, and the importance of a wide variety of species, such as fished stocks or other key species (e.g., benthic algae, invasive species, or key components of a trophic assemblage), indicator species, or disease incidence and other indicators of stress, and the direct effects of the activities of concern (e.g., debris, sunken vessels, research, fishing, transiting vessels; see Appendix III).

Strategies

Below are summaries of the strategies prepared for the information needs related to monitoring.

Archaeology (ARCH) – No strategies were developed for the two information needs in this sub-theme, but the needs clearly call for regular field-based assessments at selected sites of archaeological significance to assess both natural and human caused disturbance. Supplemental measurements of certain environmental parameters would be required to distinguish between causes of disturbance and to select appropriate mitigation measures.

Water-Atmosphere (WA) – Ten strategies were proposed. Several recommended long-term, field-based measurements (in situ and remote) and/or compilations of historic information to establish baselines and input for models describing variation in the physical environment of the NWHI. Those containing field measurements invariably noted the need for multi-agency cooperation and linkages to regional observing systems, as they develop. The need to identify and track species and measures that are indicative of potential or known stresses and threats (e.g., invasive species and sedimentation) was also noted in some strategies. There were also recommendations for risk assessments for the numerous types of human activities that take place in the NWHI, along with appropriate monitoring of these activities. Coordination of these efforts with management to enhance prevention and mitigation through permit conditions, inspections, education, and other mechanisms was also recommended.

Habitat (HAB) – Thirteen strategies were prepared. A number of them overlapped with other monitoring sub-themes, particularly those relating to water and living resources. As with those sub-themes, some proposed multi-organizational cooperation in the collection of information over the long term using consistent protocols, and through acquisition of historical information, to establish baseline conditions and document trends for NWHI habitats. More targeted strategies were recommended as well, focusing on debris impacts, alien species, and vessels. In each case, the varieties of

threatening activity require risk assessment and evaluation. Recommended monitoring strategies included assessments on location (e.g., debris impacts), remote sensing (some effects of alien species), and tracking (vessels), as well as experimental work on certain impacts of alien species and debris.

Living Resources (LR) – The diversity of life in the NWHI and the variety of threats to certain species resulted in a high number of proposed strategies (17) being developed by the working groups. Most involved multi-organizational cooperation in field-based assessments, but some also included the collection of historical demographic data, the development of new indicator measures, and laboratory work (e.g., biomedical research on diseases). Stock assessments are necessary not only to track the condition of fished species, but also to enhance the value of assessments in the main Hawaiian Islands, and to compare population dynamics and ecological controls between the two regions. It was also recommended that new, robust and valid fisheries-independent assessment methods be incorporated into future monitoring; both for fished stocks and to evaluate the effectiveness of specially protected areas. Such methods might incorporate important ecological controls, such as forage bases, competition, and habitat relationships. Similar considerations should be given to acquisition of demographic information on other species that are indicative of environmental quality or that require special monitoring (e.g., certain birds, plants, turtles, and monk seals). The future of these species can only be predicted and managed with a thorough understanding of key aspects of life history, such as reproductive dynamics, survivorship, and recruitment, as well as disease incidence and effects, predator-prey relationships, spatial and temporal variation among prey species, and foraging energetics. Strategies also recognized the need for investigations of disease pathology, impacts of debris ingestion and removal, and the effects of alien species introductions.

Considerations for Next Steps

- Ensure cooperation among the numerous organizations that operate in the NWHI. This should be more than the recognition of multiple authorities and acknowledgement of efforts among colleagues. Instead, steps towards joint development of project plans and sharing of responsibility for funding and action should be taken. This will require well-developed and integrated monitoring strategies.

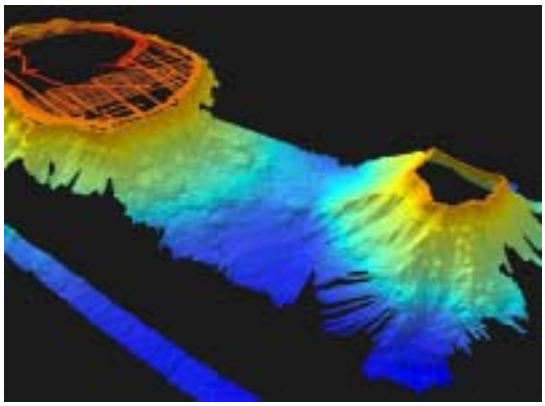
- Information needs must be considered when planning and conducting monitoring activities in an area as vast and remote as the NWHI. Further, these needs cannot be addressed effectively by single entities. Maximizing the resources available from multiple agencies and organizations should be considered a priority.

- Encourage and explore multiple approaches to monitoring, in terms of ecosystem components, parameters assessed, and temporal and spatial scales. This was a consistent recommendation recorded during the workshop.

- Promote the development of long-term data sets generated using comparable protocols, as well as links to management, either for purposes of controlling events like disease outbreaks or species invasion, or in order to control human activities that are affecting resources.

- See the Discussion section for other considerations for next steps.

Theme: TOOLS



General Description

Workshop participants recognized that certain "tools" would need to be developed to address many of the issues of concern and information needs. The nature of these tools varied widely and included generating operational definitions or common terms (e.g., MPA, reserve), developing standards for monitoring and data collection, and constructing comprehensive data inventories and database frameworks. The Tools Theme is based on 26 information needs and 16 strategies. Half of the information needs stemmed from discussions in the Stresses and Habitat Delineation working groups. The remainder was generated equally across the other six working groups. Because of the need for management of and access to historical data and the need to manage and disseminate information in coming years, information management prevailed as a common requirement across all working groups. Nine of the information needs identified at the workshop reflected a fundamental requirement for effective information management and efficient mechanisms for access and dissemination.

Sub-themes

Within the Tools Theme, all information needs and associated strategies were grouped into four sub-themes: Definitions, Information Management, Prevention and Mitigation, and Technology. Information Management and Prevention and Mitigation are the more substantive, and represent over 80% of the needs in this Theme.

Definitions (DEF) – This sub-theme addresses the need for clear and concise language and definitions of terms commonly used in the MPA arena. The single need in this sub-theme indicates that clear definitions and statement of goals and objectives concerning MPAs would enable interested parties to more readily collaborate and work towards a common goal. These definitions should apply to all MPAs in the NWHI. Further, clear language should be generated that lays out, in detail, the fundamentals of the regulatory regime of the NWHI.

Information Management (IM) – Workshop participants identified both basic and substantial information needs regarding information management. Nine information

needs focused on fundamentals of managing, providing access to and disseminating information. Conducting data synthesis activities to organize and assess existing data holdings, development of data standards, and development of infrastructure to enable reliable access and dissemination were among the most significant of the needs identified.

Prevention and Mitigation (PM) - During the workshop, 12 information needs pertaining to this sub-theme of Tools were identified. Participants focused on the need to develop methods of detection, prevention, mitigation, and eradication of invasive species and diseases in the NWHI. Other requirements were identified relative to methods to monitor and assess impacts of vessel traffic. Specific reference was made to vessels transiting to, from, and through the NWHI, as well as research activities conducted on and around the NWHI. The establishment of biological thresholds and impact control measures was identified as a priority for potential activities to be conducted in the region.

Technology (TECH) – Only three information needs identified were grouped in the Technology sub-theme. They involved evaluating and developing surveillance technology to monitor activities on and around the NWHI as well as enforce applicable regulations. Further, two issues of concern related to this sub-theme involved the need to increase collaboration between the scientific and fishing communities in the development of harvest technologies, reporting mechanisms, and methods of assessing stocks.

Strategies

The strategies associated with the Tools theme focused on products that would enhance the management and protection of NWHI resources as well as maximize the utility of data and information collected historically and in the future by all relevant parties.

Definitions (DEF) - Strategies recommended identifying goals and objectives for current and future marine protected areas. Such protected areas could be administered by various agencies (e.g., USFWS, NMSP, and NMFS). Information regarding the roles and responsibilities should be established and readily available. This effort could apply to any and all regulatory regimes.

Information Management (IM) – Executing broad data and information synthesis exercises to bring together as much of the current information as possible was identified as a critical first step. With a better understanding of what has been done and where, gap analyses and future planning efforts could proceed more efficiently.

Developing standards for future data generation was identified as critical. Standards would enable data from different programs (e.g., CRAMP), organizations and universities, and government bodies (e.g., Federal and State) to be compatible and thus more broadly applicable. Specific aspects to be addressed by standardization may include collection techniques, inventory methods, and metadata documentation.

Second to the issue of data standards, was the organization of data and data accessibility. Workshop participants indicated that there is a clear need to maintain up-to-date inventories and develop database infrastructures that will facilitate the

management and dissemination of information pertaining to the NWHI and the main Hawaiian Islands.

Prevention and Mitigation (PM) – Workshop participants generated 15 strategies within the sub-theme of prevention and mitigation. Within these, four main areas were addressed: invasive species, marine debris, infectious diseases, and vectors for these threats.

In several strategies, developing methods of controlling the transfer and introduction of invasive species proved significant. Suggested avenues of research included sterilization techniques (fumigants and autoclaves), monitoring records of authority, and maintaining and enforcing accurate records of visitation to the islands (both professional and recreational).

This sub-theme also includes strategies and recommendations on issues relating to infectious diseases and their impacts on a wide array of species including monk seals, marine and terrestrial birds, corals and fish. Partners in this work might include the State of Hawaii, the US Fish and Wildlife Service, or the World Wildlife Federation.

For the prevention and mitigation of marine debris and controlling associated impacts, suggested avenues of activity include assessing possible accumulation rates, and characterizing distributions, types, sources and potential. All mitigation efforts and programs should incorporate measures of effectiveness and cost/benefit evaluations.

Assessment of the potential vectors for invasive species and infectious diseases was also addressed. Vectors identified included vessels and passengers associated with research activities as well as commercial and recreational uses. For these vectors, tracking systems, modeling activities, and enhanced reporting requirements were listed as possible approaches to understanding the extent of potential influence.

Technology (TECH) – The single strategy developed focused on gathering information on vessel traffic to assess potential impacts on the resources of the NWHI. The strategy recommended developing surveillance and permitting systems that could generate information on activities, personnel numbers, cargo, and potential discharges or other impacts. Key partners include the State of Hawaii and NOAA agencies.

Considerations for Next Steps

- Recommendations from nearly every breakout group at the workshop included specific guidance to:
  - ~ develop standards and protocols for data collection and research methodologies;
  - ~ design and implement systems to effectively collect, manage, and distribute information to a wide audience of users; and

~ develop mechanisms to measure the effectiveness of existing or proposed guidelines, protocols, or methodologies.

- Fully addressing all of these during the workshop was not feasible; however, it was clear that strategies and proposed activities of every Theme presented in this assessment would benefit from considering aspects of information management, standards, and the use of common methodologies. Such considerations should be incorporated in all future planning and management activities whenever possible.

- Develop guidelines and methods to control the effects of anthropogenic activities, as well as develop methods of effective mitigation of these effects.

- Develop performance measures to evaluate progress and effectiveness of programs, regulations, or guidelines. This could play critical roles in virtually all activities and planning efforts.

- See the Discussion section for other considerations for next steps.

Theme: USE

General Description

The Use Theme stems from concern for the potential impacts and threats to the resources of the NWHI from commercial and recreational uses, and the need to develop methodologies to assess, monitor, and limit those threats and impacts. In total, forty-two information needs were identified. A majority came from the Commercial and Recreational Uses working group (24 of 42). Other significant contributions came from the Damage Assessment and Restoration and the Habitat Delineation working groups.

Sub-themes

The information needs within the Uses Theme have been grouped into three thematic categories. The most substantive is Anthropogenic Influences (33 information needs), and is based on the like-titled component of the ecosystem framework presented earlier in this report. The remaining sub-themes include Prevention and Mitigation, and Socioeconomics.

Anthropogenic Influences (AI) – Aspects of the 33 information needs included in this sub-theme were, in many cases, identified by several different working groups, indicating a wide spread recognition of their importance. In general, they confirmed the need for robust inventories and assessments of past and present human activities as well as predictions of future use, demand, and impacts. Attention was paid to three main areas of potential anthropogenic influences; fishing and harvesting, vessels, and threats.

As one of the main activities to take place around the NWHI, there was considerable interest in better understanding fishing and harvesting activities. Participants indicated the need to characterize impacts of various types of both commercial and recreational fishing, including allowable types, sources, intensity, and distribution for bottom fish, lobsters, and pelagic and recreational species. Assessing stock recovery times of both target and non-target species was also noted in several cases as a distinct need. The need for current stock assessment information (species, size, number, populations) was discussed. These assessments should be completed for current stocks but should be conducted based on past catch data and predicted future demand. This would enable managers and stakeholders to better understand the potential levels of demand and the magnitude of extraction as well as the associated activity. Further, potential impacts from illegal fishing for lobster, live fish, pelagic species, and others were identified as an information gap that should be addressed. This should include an analysis of recorded fishing and other violations of existing regulations.

Linked to nearly everything relating to humans in the NWHI is the issue of vessels. Past, present, and predicted data on vessel type, cargo, fuel capacity, destination, frequency of visits, total numbers and distributions were of interest to many working groups. Other characterizations and assessments that need be conducted would address potential threats from vessel activity including pollution, invasive species, groundings, and other impacts to the resources of the NWHI. Two reporting needs included 1) a vessel-reporting requirement that would provide data on vessel numbers, frequency, destination, anchorage, cargo, discharges, missions, and number of people; and 2) a vessel monitoring system (VMS) that could provide remotely sensed data on vessel location, duration, and activity.

Another consistent component of the Anthropogenic Influences sub-theme was that of actual and potential threats. Nearly all activities related to the presence of humans were identified as threats, including fishing, marine debris, toxics and other hazardous waste, research activities, military activities, and recreational impacts (consumptive and non-consumptive; see Appendix III). Characterizations of threats and assessments of potential impacts were identified as priority information needs by workshop participants.

Prevention and Mitigation (PM) – Four information needs related to prevention and mitigation were identified. Three focused on enforcement: assessing and evaluating the cost and effectiveness of the various enforcement measures, analyzing past violations documented in the NWHI, and developing new methods of enforcement. Other needs included maps delineating the jurisdictional boundaries around the NWHI and assessments of sources and mitigation of marine debris in the region.

Socioeconomics (SOC) – Five information needs fell into the socioeconomics sub-theme. They addressed the need to conduct analyses of the potential economic impacts of non-commercial uses as well as the potential socioeconomic impacts of current and future management actions.

Strategies

Thirteen strategies were developed to address information needs in the Use Theme. This pattern indicates the potential importance of these strategies as most addressed similar needs identified by many workshop participants in several working groups.

Anthropogenic Influences (AI) – Most strategies addressed three areas of concern: fishing, vessels and related traffic, and threats, including toxic materials and marine debris. Those that focused on fishing addressed information needs relating to legal and illegal commercial and recreational fishing for both target and non-target species. Participants proposed stock assessments, inventories of gear types, evaluations of impacts to target species and by-catch, and surveys of critical habitat for specific target species. Efforts to quantify the amount and significance of illegal fishing were proposed as well. Most Use related strategies included discussions of monitoring and tracking of vessel activity as well as enforcement of existing regulations. Vessels and vessel traffic were consistently cited with regard to the need to monitor activities and threats to NWHI resources. Characterizing potential threats of vessels as vectors for invasive species and pollution, and vessel groundings, were all deemed necessary. Most proposed work requires a combination of fieldwork and data processing/synthesizing efforts. Limited data sets appear to be available to support initial synthesis and evaluation. Those that were mentioned at the workshop are managed by NOAA Fisheries, the State of Hawaii, and several research institutions.

Prevention and Mitigation (PM) – Only one strategy was developed for this sub-theme, but it addressed seven information needs. It focused on monitoring vessel activity, a topic addressed in a majority of the working groups. Proposed steps included assessing historical records of vessel traffic and activities, collecting information on all current and future vessels transiting the NWHI, conducting analyses of potential threats associated with this traffic, and developing a permitting and monitoring system for future vessels traveling to or through the NWHI. The strategy requires fieldwork as well as data synthesis and analysis.

Socioeconomic (SOC) – One strategy was developed that related directly to socioeconomics. It addressed five information needs and focused on defining potential demand for recreational activities in the NWHI and the potential implications of these activities from a socioeconomic perspective. Suggested steps included assessing past recreational activities in the NWHI, and surveying current user groups and service providers regarding current and potential future uses. This is a data synthesis and analysis exercise as opposed to a field-oriented study.

Considerations for Next Steps

- Significant attention should be directed towards characterizing, monitoring and tracking issues stemming from commercial, recreational, and illegal fishing. Efforts to collect and evaluate data on fishery stocks for both target and non-target species should be made.

- Develop methodologies to assess, monitor, and limit threats and impacts (e.g., pollution, introduced species) from research activities and other sources of vessel traffic.

- Construct inventories and assessments of past and present human activities as well as predictions of future use, demand, and impacts to the resources of the NWHI.

- All work relating to the Use Theme should consider several key characteristics when evaluating activities including socioeconomic impacts, stresses to the natural or cultural resources, threats, potential damage, and subsequent mitigation and restoration requirements.

- See the Discussion section for other considerations for next steps.

Discussion and Next Steps

As mentioned earlier, the primary purpose of this assessment was to provide input for a multi-agency regional action plan for the NWHI. There are, of course, many ways to organize and evaluate the workshop results and move them into a regional action plan. Regional managers and planners may choose to recast this assessment to better suit their goals. Regardless, this assessment represents one of the possibilities for managing and applying the workshop results in research and management activities in the NWHI.

This assessment is also intended to promote the use of the workshop results by all parties interested in the NWHI. For example, the NMSP will be incorporating this information, to the extent possible, in the development of the environmental impact statement and issue based management plan for a possible NWHI National Marine Sanctuary. For these reasons, the original needs identified by workshop participants were retained (Appendix I) as well as reorganized into categories that better lend themselves to regional planning for conservation science, and NWHICRER or NMSP operations.

The organizational structure of the workshop results presented in this assessment separates information needs into new categories with common themes. However, some of these categories may need further refinement as several contain an extensive range of needs and suggested actions. For example, the Living Resource sub-theme under Ecosystem Characterization contains 51 information needs. This could present logistical or operational obstacles when trying to prepare strategies and action plans to address those needs. One of the more important steps in designing a regional action plan will be to determine the most practical groupings of information needs so strategies can be effectively implemented.

Another aspect of the results that will require attention pertains to the strategies developed during the workshop. A total of 99 strategies were developed addressing over 200 information needs. Workshop participants were instructed to provide as much information as possible in the time allotted regarding the general nature of what should be addressed for a particular need or set of needs. It was not intended for participants to develop comprehensive and detailed strategies for all of the information needs identified. While these strategies do contain some valuable information on how specific needs can/should be addressed, most of the strategies will need to be supplemented with more substantial information regarding objectives, methodologies, partnerships, resources required, and timeframes. Further, more attention to coordinating with existing agency and institutional activities, resources, and strategic plans will be necessary.

The organization of the workshop results presented in this assessment is based on similarities of issues and needs, not on priority. It also should be noted that issues of agency and institutional priority, as well as prioritization for planning purposes will need to be addressed when applying these results to any research or management activities. While workshop participants did prioritize issues and needs during the workshop, that step was designed to facilitate the creation of strategies for the most significant needs as determined by workshop participants. It was not intended to develop prioritized lists of activities and funding recommendations for agency planning purposes. Efforts to develop agency specific documents, or a multi-agency regional action plan will need to consider this.

In general terms, a regional action plan should include guidance and demonstrate commitments from key partners as well as recommendations to others on how to best support the work defined within the plan. This would likely include information about goals and objectives, funding and other resources required (e.g., equipment or personnel), scheduling, anticipated products, and, perhaps most important, responsibility for implementation among one or more of the associated regional organizations and agencies (NOAA Fisheries, U.S. Fish and Wildlife Service, Western Pacific Fisheries Management Council, Hawaii Department of Land and Natural Resources, etc.). Some of the possible outcomes from such a regional plan might include joint planning and coordination of cruises, annual science and research meetings, a regional information management system, and a joint planning committee. Key steps in the process of developing a regional action plan may also include aligning existing strategic plans and established operational priorities of regional partners with the identified information needs addressed in this assessment. The development of a regional action plan is not intended to supercede existing strategic plans or identified priorities of any agency or organization. Instead, it should focus on coordinating partner activities in order to maximize efficiency and effectiveness.

Appendix I: Themes, Sub-themes, and Workshop Results

This table categorizes workshop results (issues of concern, information needs, and strategies) into the planning components of Themes and sub-themes.

At the workshop, participants identified issues of concern within nine topic areas. Then they identified information needs required to better understand and address those issues and developed initial strategies that characterized actions necessary to address the information needs. These results are listed in the four columns of this table.

The shaded rows represent proposed Themes and sub-themes that can be used to develop plans for a coordinated multi-organizational approach to research and management in the NWHI.

In the process of categorizing the information needs and associated strategies into Theme and sub-theme combinations, no effort to filter or prioritize this data was made. All workshop results (issues of concern, information, needs, and strategies) are presented as they were recorded in the workshop.

Data in this table, as well as the associated strategies (referenced in the last column), are available on the web at http://www.hawaiireef.noaa.gov.

Topic		Issue of Concern	Information Need	Strategies
Culture: Definition				
	Cultural Heritage	Who will define 'Cultural Heritage' for NWHI?		
	Cultural Heritage	Respect & promote native Hawaiian sense of place, values, rights & responsibilities in NWHI; accessability; connectivity; lineal	Definitions of terms from/with Native Hawaiians and are any of those terms (sense of place, values, rights, responsibilities) missing	Cultural-4
	Cultural Heritage	Full participation of NH in the "process" of management	Identify/summarize definition of term: Native Hawaiian	Cultural-6
	Cultural Heritage	Politics: how to ensure native Hawaiian issues will be part of mgmt/action plan	Identify Native Hawaiian issues	Cultural-4
	Cultural Heritage	Respect & promote native Hawaiian sense of place, values, rights & responsibilities in NWHI; accessability; connectivity; lineal	Review contemporary documents for attempts to achieve this objective	Cultural-4
	Cultural Heritage	Full participation of NH in the "process" of management	Define what "full participation" means with input from Native	Cultural-5
	Cultural Heritage	Developing an effective cultural science program	How different participants interpret cultural meaning of EO	Cultural-3
	History/Archaeology	Boundaries surrounding the use of the terms- history, culture and heritage	List of and definition/use of the terms (history, culture, heritage) in various laws, regs, rule at State/Federal etc. levels: A glossary	History-8
	History/Archaeology	Boundaries surrounding the use of the terms- history, culture and	Comment or review from key stakeholders	
	History/Archaeology	Boundaries surrounding the use of the terms- history, culture and	Identification of interested parties/stakeholders	History-6
Culture: History				
	Cultural Heritage	Identifying historic and cultural activity; targeted cultural archaeology surveys		
	Cultural Heritage	Assess accuracy of history		
	Cultural Heritage	What was and is the relationship of native Hawaiians to NWHI?	Identify non-commercial, subsistence, religious and cultural	
	Cultural Heritage	What was and is the relationship of native Hawaiians to NWHI?	Oral history/written history database (with bibliography), archaeological research (land and marine), oral history studies, translation of written Hawaiian materials and compile primary and historical documents	
	Cultural Heritage	What was and is the relationship of native Hawaiians to NWHI?	Understanding native Hawaiian relationships to NWHI through experiential voyaging	
	Living Marine Resources	MPA design and evaluation, including goals and design criteria, monitoring, and using hydrodynamic models for decisions about	Identify existing cultural and traditional knowledge through stakeholder input	
Culture: Resource Management				
	Cultural Heritage	Access to information		
	Cultural Heritage	Developing an effective cultural science program	Side by side social scientific investigations scientists and cultural (social and biological) practioners	Cultural-2
	Cultural Heritage	Developing an effective cultural science program	Look at how other groups are integrating social science into natural resource management	Cultural-3
	Cultural Heritage	Developing an effective cultural science program	Look at existing government policies/laws for incorporating TEK	Cultural-3
	Cultural Heritage	Full participation of NH in the "process" of management	Identify key community leaders and seek participation	Cultural-6
	Cultural Heritage	Developing an effective cultural science program	What types of uses/activities are being planned	Cultural-3
	Cultural Heritage	Full participation of NH in the "process" of management	Identify how Native Hawaiians want to be involved	
	Living Marine Resources	Understand traditional conservation practices		

Topic		Issue of Concern	Information Need	Strategies
Ecosystem Characterization: Habitat				
	Comm/Rec Uses	Incomplete information on natural ecosystem characteristics (improve characterization)	Quantification of habitat (benthic, pelagic)	ComRec - 3
	Habitat Delineation	Habitat classification		Habitat - 1
	Habitat Delineation	Mapping to support management needs (e.g., RPA boundaries)		Habitat - 1
	Habitat Delineation	Identifying appropriate spatial and temporal scales		Habitat - 1
	Habitat Delineation	Representative and special habitats		
	Habitat Delineation	Pelagic habitat mapping		
	Habitat Delineation	Mapping of marine-terrestrial interactions		
	Habitat Delineation	Baseline data for habitat monitoring	Baseline habitat data	Habitat - 13
	Habitat Delineation	Priority areas	Integrate community to define mapping priorities	Habitat - 6??
	Habitat Delineation	Baseline data for habitat monitoring	Inventory of existing data sets	Habitat - 13
	Habitat Delineation	Priority areas	Mapping to support management needs: RPA boundaries	Habitat - 8
	Habitat Delineation	Ecological significance of habitat	Linking visual and acoustic/spectral data	Habitat - 9
	Habitat Delineation	Baseline data for habitat monitoring	Create information from data inventories	Habitat - 13
	Habitat Delineation	Baseline data for habitat monitoring	Bathymetry, substrate, groundtruthing	Habitat - 10
	Habitat Delineation	Ecological significance of habitat	Define habitats based on species	Habitat - 9
	Habitat Delineation	Coordination of mapping efforts	Common data, map, and product standards	Habitat - 8
	Habitat Delineation	Ecological significance of habitat	What are the habitats? (algae, coral)	Habitat - 9
	Habitat Delineation	Priority areas	Mapping of sensitive areas (e.g., erosion, coral bleaching)	Habitat - 7
	Living Marine Resources	Basic assessement (taxonomy) including habitat relationships	Comprehensive habitat inventory	LMR - 6
	Living Marine Resources	MPA design and evaluation, including goals and design criteria, monitoring, and using hydrodynamic models for decisions about	Generate habitat maps (including abiotic and biotic features)	
	Living Marine Resources	Biogeography, including connectivity within NWHI and between the NWHI and MHI including a focus on exploited species and endemics.	Habitat distribution/availability, especially that essential to reproduction, recruitment, and feeding	LMR - 5
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Describe habitats within each ecosystem	LMR - 8
	Oceanographic Regime	Current geomorphological and sedimentological processes influencing reefs and emergent lands		
	Stresses	Natural stressors and climate change	Characterize vulnerable habitats and species, including synergistic effects and interactions	Stress-1,2
	Threat/End. & Terr Res	Ability to detect change that requires management action	Habitat characterization data	Threatened-2
Ecosystem Characterization: Habitat / Anthropogenic Influences				
	Damage Asses./Rest	Marine debris – habitat damage	Maps of locations of debris	Damage-2,3,6
	Damage Asses./Rest	Vessel traffic and operations (lights, discharges of pollution, alien species, anchor damage, etc)	Baseline georeferenced habitat data in impacted area	Damage-6
	Damage Asses./Rest	Vessel traffic and operations (lights, discharges of pollution, alien species, anchor damage, etc)	Updated accurate charts	
	Damage Asses./Rest	Marine debris – habitat damage	Marine debris characterizations	Damage-1,3
	Habitat Delineation	Coordination of mapping efforts	Agency activities and data holdings	Habitat - 1
	Stresses	Debris impacts, including fishing and non-fishing debris	Characterize types, sources, impacts, frequencies, intensity, and distribution	Stress-9

Topic	Issue of Concern	Information Need	Strategies
Ecosystem Characterization: Living Resources			
Comm/Rec Uses	Extinction threshold for various species		
Comm/Rec Uses	Incomplete information on natural ecosystem characteristics (improve characterization)	Life history information on key species	ComRec - 1
Comm/Rec Uses	Incomplete information on natural ecosystem characteristics (improve characterization)	Trophic dynamics	ComRec - 3
Comm/Rec Uses	Lack of population and trophic structure information of economic and ecologically important species (pelagic and demersal)	Genetic and environmental marker data indicating transport	ComRec - 4
Comm/Rec Uses	Lack of population and trophic structure information of economic and ecologically important species (pelagic and demersal)	Life history parameters (age, growth, mortality, etc.)	ComRec - 4
Comm/Rec Uses	Incomplete information on natural ecosystem characteristics (improve characterization)	Spatial and temporal estimates of abundance	ComRec - 1
Comm/Rec Uses	Incomplete information on natural ecosystem characteristics (improve characterization)	Community metrics (e.g., species diversity)	ComRec - 3
Comm/Rec Uses	Incomplete information on natural ecosystem characteristics (improve characterization)	Species movement, migration, and dispersal	ComRec - 1
Comm/Rec Uses	Incomplete information on natural ecosystem characteristics (improve characterization)	Population replenishment and connectivity	ComRec - 4
Damage Asses./Rest	Extreme oceanographic atmopsheric events	Physical/biological linkage between extreme events and ecosystems	
Habitat Delineation	Ecological significance of habitat	Basic biology by species/lifestage	Habitat - 9
Habitat Delineation	Priority areas	Mapping of invasive species for removal and restoration	Habitat - 6
Habitat Delineation	Priority areas	Mapping of biodiversity, particularly endemics	Habitat - 6
Living Marine Resources	Comparative role of top level predators in the NWHI versus MHI		
Living Marine Resources	Disease threats and vectors		
Living Marine Resources	Evaluate factors affecting resilience of habitat and biota		
Living Marine Resources	Biogeography, including connectivity within NWHI and between the NWHI and MHI including a focus on exploited species and endemics.	Patterns and scales of movement/dispersal at various life stages	LMR - 1,5
Living Marine Resources	Basic assessement (taxonomy) including habitat relationships	Comprehensive taxonomic list, including managed stocks	LMR - 6
Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Identify key species	LMR - 8,10
Living Marine Resources	Biogeography, including connectivity within NWHI and between the NWHI and MHI including a focus on exploited species and endemics.	Population structure and demography	LMR - 1
Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Basic life history information (e.g. growth, reproductive status, larval dispersal mechanisms, etc.)	LMR - 8,10
Living Marine Resources	MPA design and evaluation, including goals and design criteria, monitoring, and using hydrodynamic models for decisions about	Identify key biological considerations for species (e.g., spawning aggregations, population sizes, diversity, endemism, life histories)	LMR - 4
Living Marine Resources	Biogeography, including connectivity within NWHI and between the NWHI and MHI including a focus on exploited species and endemics.	Characterization of population genetic structure	LMR - 5
Living Marine Resources	Basic assessement (taxonomy) including habitat relationships	Identify vulnerable species (e.g. endemics, rare, listed [endangered, threatened, migratory], apex predators [fish, cetaceans, seals, birds], sensitive [range limited by temperature,	LMR - 6
Living Marine Resources	Biogeography, including connectivity within NWHI and between the NWHI and MHI including a focus on exploited species and endemics.	Population spatial distribution (connected or not), including genetics	LMR - 1
Living Marine Resources	Biogeography, including connectivity within NWHI and between the NWHI and MHI including a focus on exploited species and endemics.	Movement effects on distribution; dispersal and its genetic consequences	LMR - 1

Topic		Issue of Concern	Information Need	Strategies
	Living Marine Resources	Biogeography, including connectivity within NWHI and between the NWHI and MHI including a focus on exploited species and endemics.	Population sources, sinks for key species	
	Living Marine Resources	Biogeography, including connectivity within NWHI and between the NWHI and MHI including a focus on exploited species and endemics.	Basic life histories, with reproduction relative to population structure and function (viability), movement, dispersal	
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Prey data (e.g. stomach contents)	LMR - 8,10
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Consumption rates	LMR - 8
	Living Marine Resources	Biogeography, including connectivity within NWHI and between the NWHI and MHI including a focus on exploited species and endemics.	Temporal (seasonal to interdecadal) information on reproduction, dispersal, recruitment, survival, and population distribution	
	Living Marine Resources	MPA design and evaluation, including goals and design criteria, monitoring, and using hydrodynamic models for decisions about locations and sizes	Information on resistance and resilience of populations in various areas to select areas for MPAs that will have robust populations in the face of natural and anthropogenic stress	
	Living Marine Resources	Biogeography, including connectivity within NWHI and between the NWHI and MHI including a focus on exploited species and endemics.	Population vulnerability assessments, especially for endemics and isolated species	LMR - 1
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Spatial and temporal distribution of predators and prey	LMR - 8,11
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Abundance of trophic components	LMR - 8,11
	Oceanographic Regime	Stocks or management units of fished and other resources	Genetic data related to spatial criteria	
	Oceanographic Regime	Stocks or management units of fished and other resources	Life history information	
	Oceanographic Regime	Larval dispersal and recruitment	Spatial distribution of organisms	
	Oceanographic Regime	Stocks or management units of fished and other resources	Spatial distribution of organisms	
	Oceanographic Regime	Larval dispersal and recruitment	Environmental marker data (e.g., trace elements)	
	Oceanographic Regime	Connectivity (between MHI and NWHI, and between islands and banks within the NWHI)	Genetic data related to spatial criteria	Ocean - 6
	Oceanographic Regime	Larval dispersal and recruitment	Life history information	
	Oceanographic Regime	Connectivity (between MHI and NWHI, and between islands and banks within the NWHI)	Life history information	Ocean - 6
	Oceanographic Regime	Larval dispersal and recruitment	Genetic data related to spatial criteria	
	Oceanographic Regime	Larval dispersal and recruitment	Larval behavior	
	Stresses	Wildlife health, including diseases	Establish a baseline for types, prevalence, morbidity and mortality	Stress-16,18
	Stresses	Wildlife health, including diseases	Characterize threats according to likelihood of exposure and susceptibility	Stress-16,18
	Stresses	Wildlife health, including diseases	Identify threat posed by cumulative effects	Stress-17
	Stresses	Natural stressors and climate change	Compare relative environmental sensitivity across taxa	Stress-1
	Stresses	Wildlife health, including diseases	Establish epidemiology by type of disease, including life history, vectors and pathways	Stress-17
	Stresses	Wildlife health, including diseases	Determine potential contaminant sources (types, frequency, biogeochemcial pathways) for selected contaminants.	
	Threat/End. & Terr Res	Species inventory		
	Threat/End. & Terr Res	Ability to detect change that requires management action	Sources of nutrients	Threatened-3
	Threat/End. & Terr Res	Recovery of critically endangered species	Limitations to reproductive success	
	Threat/End. & Terr Res	Recovery of critically endangered species	Inventory of unknown species	
	Threat/End. & Terr Res	Recovery of critically endangered species	Genetic information	

Topic	Issue of Concern	Information Need	Strategies
Ecosystem Characterization: Living Resources / Anthropogenic Influences			
Comm/Rec Uses	Evaluating the efficacy of management actions (spatial management)	Compare stocks and available habitat in MHI to NWHI	ComRec - 5
Comm/Rec Uses	Impacts of NWHI regulation on main Hawaiian Islands	Compare stocks and available habitat in MHI to NWHI	ComRec - 5
Comm/Rec Uses	Utilizing management results from NWHI to better manage MHI	Compare stocks and available habitat in MHI to NWHI	ComRec - 5
Comm/Rec Uses	Lack of population and trophic structure information of economic and ecologically important species (pelagic and demersal)	Long term monitoring of populations and fisheries	
Damage Asses./Rest	Alien species - terrestrial and marine	Threat ranking terrestrial/marine - by species	Damage-3,4
Damage Asses./Rest	Alien species - terrestrial and marine	Current inventory of all species in NWHI (alien and traditional) and origin points	Damage-4,6
Damage Asses./Rest	Alien species - terrestrial and marine	Current inventory of all species in main HI (alien and potentially invasive to NWHI) and origin points + Link to 3.7	Damage-4
Damage Asses./Rest	Vessel traffic and operations (lights, discharges of pollution, alien species, anchor damage, etc)	ESI index for marine as well as terrestrial (not current product) includes habitats of particular concern, cultural and historical areas, also active research sites	Damage-6
Living Marine Resources	Evaluate threats posed by aquatic nuisance species, including those in MHI, including understanding of vectors		
Stresses	Impacts of terrestrial and marine alien or invasive species	Characterize types, sources and vectors, frequencies, intensity, and distribution	Stress-3,4,6
Stresses	Impacts of terrestrial and marine alien or invasive species	Evaluate the likelihood for establishment of invasives	Stress-3,5
Threat/End. & Terr Res	Invasive species	Inventory of known invasive species	Threatened-13
Threat/End. & Terr Res	Invasive species	Distribution and abundance of known invasive species	Threatened-13
Threat/End. & Terr Res	Ability to detect change that requires management action	Sources of mortality	Threatened-4
Threat/End. & Terr Res	Recovery of critically endangered species	Identify threats to survival	
Threat/End. & Terr Res	Invasive species	Potential sources/vectors of invasive species	Threatened-14
Ecosystem Characterization: Living Resources / Habitat			
Comm/Rec Uses	Incomplete information on natural ecosystem characteristics (improve characterization)	Species habitat utilization by lifestage	ComRec - 1
Habitat Delineation	Mapping living resource distributions		Habitat - 15
Habitat Delineation	Priority areas	Mapping to refine EFH designation for existing FMPs	Habitat - 6
Habitat Delineation	Ecological significance of habitat	Juvenile spawning areas, movements	Habitat - 9
Habitat Delineation	Ecological significance of habitat	Interaction of habitat utilization (species crossing habitats)	Habitat - 9
Threat/End. & Terr Res	Recovery of critically endangered species	Habitat requirements	Threatened-9,17
Ecosystem Characterization: Modeling			
Comm/Rec Uses	Evaluation of probable impacts of management decisions prior to implementation		
Comm/Rec Uses	Evaluating the efficacy of management actions (spatial management)	Define risks associated with management decisions	
Comm/Rec Uses	Impacts of NWHI regulation on main Hawaiian Islands	Define risks associated with management decisions	
Comm/Rec Uses	Utilizing management results from NWHI to better manage MHI	Define risks associated with management decisions	

Topic		Issue of Concern	Information Need	Strategies
	Comm/Rec Uses	Incomplete information on natural ecosystem characteristics (improve characterization)	Synthesize existing data into spatially structured ecosystem model	
	Damage Asses./Rest	Vessel traffic and operations (lights, discharges of pollution, alien species, anchor damage, etc)	Oceanographic models	
	Habitat Delineation	Ecological modeling		
	Living Marine Resources	Relationships between ecosystems (e.g., nearshore and offshore) including endogenous and exogenous production		
	Living Marine Resources	Drawing on the knowledge of resource users (present and past) re: resources and relationship with their environment		
	Living Marine Resources	Climate change influences on key processes (e.g., coral growth).		
	Living Marine Resources	Evaluate the possibility and nature of discrete ecological subunits within the NWHI (e.g., Kure, Midway, and Pearl and Hermes as an ecological unit)		
	Living Marine Resources	Patterns and processes related to primary production and its changes on ecosystems		
	Living Marine Resources	Transferability of trophic and other data when so many species and so much biomass is endemic species		
	Living Marine Resources	Annual to decadal changes related to energy flow and ecosystem structure		
	Living Marine Resources	MPA design and evaluation, including goals and design criteria, monitoring, and using hydrodynamic models for decisions about locations and sizes	Connectivity (oceanographic data and models incorporating recruitment, larval dispersal, sources and sinks, habitat diversity, and requirements at all stages of species of concern)	LMR - 3
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Habitat requirements and relationships for each life history stage of key species	LMR - 8,11
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Understand oceanographic and climatic events (e.g. nutrients, reproductive cues)	LMR - 8,7
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Inter-specific relationships	LMR - 8,11
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Connectivity at all spatial scales and life history stages	LMR - 8,11
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Define and quantify impacts caused by extraction	LMR - 8,7
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Determine functional roles	LMR - 8,10
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Define and quantify biotic/abiotic components of each ecosystem	LMR - 8
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Describe controls and effects of oceanographic processes	LMR - 8,7
	Living Marine Resources	Development of functional relationship models, including information on trophic structure to facilitate ecosystem based management	Define management objectives for development of ecosystem models	LMR - 8
	Oceanographic Regime	Connectivity (between MHI and NWHI, and between islands and banks within the NWHI)	Hydrodynamic models	Ocean - 1
	Oceanographic Regime	Acute anthropogenic effects	Environmental sensitivity using data from hydrodynamic models, ocean/atmosphere models, empirical data, and life history	
	Oceanographic Regime	Larval dispersal and recruitment	Hydrodynamic models	Ocean - 6
	Oceanographic Regime	Connectivity (between MHI and NWHI, and between islands and banks within the NWHI)	Linked ocean/atmospheric models (past/present/future) using appropriate physical and chemical parameters	

Topic		Issue of Concern	Information Need	Strategies
	Oceanographic Regime	Impacts of climate change	Coupled hydrodynamic ecosystem models	Ocean - 2
	Oceanographic Regime	Connectivity (between MHI and NWHI, and between islands and banks within the NWHI)	Comprehensive empirical data (physical/chemical variables and process data) at appropriate spatial and temporal scales	Ocean - 3
	Oceanographic Regime	Impacts of climate change	Linked ocean/atmospheric models (past/present/future) using appropriate physical and chemical parameters	Ocean - 5
	Stresses	Impacts of research activities	Characterize vulnerability of habitats and species, including synergistic/cumulative impacts	
	Threat/End. & Terr Res	Carrying capacity for targeted species		
Ecosystem Characterization: Water-Atmosphere				
	Comm/Rec Uses	Lack of population and trophic structure information of economic and ecologically important species (pelagic and demersal)	Oceanographic studies of larval transport	ComRec - 4
	Comm/Rec Uses	Incomplete information on natural ecosystem characteristics (improve characterization)	Characterization of oceanography	
	Damage Asses./Rest	Extreme oceanographic atmopsheric events	Complete oceanographic atlas	
	Living Marine Resources	Biogeography, including connectivity within NWHI and between the NWHI and MHI including a focus on exploited species and endemics.	Oceanographic patterns and processes	
	Oceanographic Regime	Larval dispersal and recruitment	Spatial and temporal patterns of currents within the archipelago at a range of scales	
	Oceanographic Regime	Impacts of climate change	Paleoclimate studies (cores, etc) longterm temporal	
	Oceanographic Regime	Stocks or management units of fished and other resources	Environmental marker data (e.g., trace elements)	Ocean - 4
	Oceanographic Regime	Effects of episodic natural effects	Compilation of data on historical catastrophic natural events	Ocean - 5
	Oceanographic Regime	Connectivity (between MHI and NWHI, and between islands and banks within the NWHI)	Paleoclimatic data (spatial primarily)	
	Oceanographic Regime	Larval dispersal and recruitment	Comprehensive empirical data (physical/chemical variables and process data) at appropriate spatial and temporal scales	
	Oceanographic Regime	Connectivity (between MHI and NWHI, and between islands and banks within the NWHI)	Environmental marker data (e.g., trace elements)	Ocean - 6
	Oceanographic Regime	Connectivity (between MHI and NWHI, and between islands and banks within the NWHI)	Spatial and temporal patterns of currents within the archipelago at a range of scales	Ocean - 1
	Stresses	Natural stressors and climate change	Characterize natural climate variation and oscillations (short and long-term)	Stress-1
	Stresses	Debris impacts, including fishing and non-fishing debris	Oceanographic processes that influence the distribution of debris	Stress-9,11
History / Archeaology: Inventory				
	History/Archaeology	Terrestrial vs. marine		
	History/Archaeology	Defining and prioritizing the range of historical/archaeological resources we're talking about		
	History/Archaeology	Battlefield at Midway (National Memorial)		
	History/Archaeology	Status of informational sources		
	History/Archaeology	Grave sites (other than battlefields)		
	History/Archaeology	Status of inventory of resources and what laws have been applied (ongoing)	List of available resources	History-1
	History/Archaeology	Realistically completing Federal mandate to inventory	List of available resources	History-1
	History/Archaeology	Lack of coordination between natural scientists and social scientists in surveys,mapping	Review of natural science survey areas	
	History/Archaeology	Lack of coordination between natural scientists and social scientists in surveys,mapping	Identify who, where and methods of surveys are being planned to incorporate historical/archaeological needs	History-3
	History/Archaeology	Status of inventory of resources and what laws have been applied (ongoing)	Gap ananlysis	
	History/Archaeology	Realistically completing Federal mandate to inventory	Gap ananlysis	

Topic		Issue of Concern	Information Need	Strategies
	History/Archaeology	Status of inventory of resources and what laws have been applied (ongoing)	Review of past management actions	
	History/Archaeology	Realistically completing Federal mandate to inventory	Review of past management actions	
	History/Archaeology	Status of inventory of resources and what laws have been applied (ongoing)	List of laws that have been applied and to which resources	
	History/Archaeology	Realistically completing Federal mandate to inventory	List of laws that have been applied and to which resources	
History / Archaeology: Modeling				
	History/Archaeology	Status of inventory of resources and what laws have been applied (ongoing)	Predictive model/survey design for candidate locations	
	History/Archaeology	Realistically completing Federal mandate to inventory	Predictive model/survey design for candidate locations	
Monitoring: Archaeology				
	History/Archaeology	Adverse effects of research, vandalism, and restoration on historical/archaeological resources		
	History/Archaeology	Environmental disturbance of excavated study sites		
Monitoring: Habitat				
	Damage Asses./Rest	Extreme oceanographic atmopsheric events	Secondary anthropogenic (shipwreck movement and discarge) and natural (boulder movement) impacts	
	Habitat Delineation	Data synthesis (old and new), including metadata	Historical data on distribution of habitats	Habitat - 13
	Habitat Delineation	Baseline data for habitat monitoring	Repeat data collection	Habitat - 12
	Habitat Delineation	Baseline data for habitat monitoring	Shifting baseline	Habitat - 13
	Oceanographic Regime	Changing distribution and abundance of organisms and habitats		
	Threat/End. & Terr Res	Habitat loss		
Monitoring: Habitat / Anthropogenic Influences				
	Damage Asses./Rest	All gear impacts (commercial and research)		
	Damage Asses./Rest	Anthropogenic caused habitat shift		
	Damage Asses./Rest	Marine debris – habitat damage	Extent of the impacts of debris	Damage-1,2,3
	Damage Asses./Rest	Marine debris – habitat damage	Vector ecology - marine debris as a vector	Damage-1,3
	Damage Asses./Rest	Marine debris – habitat damage	Debris time at sea and origin	Damage-1
	Damage Asses./Rest	Marine debris – habitat damage	Rates of accumulation of debris	Damage-2,3
	Damage Asses./Rest	Alien species - terrestrial and marine	Understand rate and other parameters of habitat shifts	Damage-4
	Damage Asses./Rest	Marine debris – habitat damage	Fate of debris in lagoon	Damage-1,3
	Damage Asses./Rest	Marine debris – habitat damage	Surveillance of marine debris at sea (remote sensing)	Damage-1,2,3
	Damage Asses./Rest	Marine debris – habitat damage	Recovery for affected organisms and habitats	Damage-1,3
	Damage Asses./Rest	Marine debris – habitat damage	Baseline georeferenced habitat data in impacted area	

Topic		Issue of Concern	Information Need	Strategies
	Damage Asses./Rest	Marine debris – habitat damage	Ecological impacts of marine debris removal v. non-removal	Damage-1,3
	History/Archaeology	Environmental threat from Heritage vessels		
	Living Marine Resources	Evaluate the impact of humans on the ecosystems		
	Oceanographic Regime	Chronic anthropogenic effects		
	Stresses	Debris impacts, including fishing and non-fishing debris	Impact of debris, focusing on quantification of existing data over qualitative assessement	Stress-10
	Stresses	Impacts of vessels, including transiting vessels such as cruise ships	Evaluate impacts by types	Stress-7
	Stresses	Impacts of fishing, legal and illegal	Habitat and community impacts caused by various fishing (e.g., anchor damage, interactions with endangered and threatened species, by-catch)	Stress-14
	Stresses	Impacts of terrestrial and marine alien or invasive species	Determine ecosystem consequences of various types of alien and invasive spp.	Stress-5
	Stresses	Impacts of research activities	Characterize impacts by type	
	Threat/End. & Terr Res	Human impacts	Assessing potential impacts of human activities	Threatened-8
	Threat/End. & Terr Res	Human impacts	Characterization of unknown impacts	Threatened-7
	Threat/End. & Terr Res	Human impacts	Efficacy of prevention and mitigation options	Threatened-7
	Threat/End. & Terr Res	Human impacts	Impacts on the ecosystem	
	Threat/End. & Terr Res	Invasive species	Impacts of invasive species on the ecosystem	Threatened-12
Monitoring: Living Resources				
	Comm/Rec Uses	Evaluating the efficacy of management actions (spatial management)	Status of recovery of stocks	ComRec - 5
	Comm/Rec Uses	Impacts of NWHI regulation on main Hawaiian Islands	Status of recovery of stocks	ComRec - 5
	Comm/Rec Uses	Utilizing management results from NWHI to better manage MHI	Status of recovery of stocks	ComRec - 5
	Comm/Rec Uses	Evaluating the efficacy of management actions (spatial management)	Abundance, CPUE, SPR, inside and outside of no fishing areas	ComRec - 5
	Comm/Rec Uses	Impacts of NWHI regulation on main Hawaiian Islands	Abundance, CPUE, SPR, inside and outside of no fishing areas	ComRec - 5
	Comm/Rec Uses	Utilizing management results from NWHI to better manage MHI	Abundance, CPUE, SPR, inside and outside of no fishing areas	ComRec - 5
	Living Marine Resources	Seasonality of benthic algae and its influences		
	Living Marine Resources	Long term monitoring of natural and human-caused variation at relevant spatial and temporal scales.	Decide on key taxa (e.g. endemics, commercially harvested, protected and endangered, spp that integrate information at relevant scales, variety of trophic levels, larvae)	LMR - 9
	Living Marine Resources	MPA design and evaluation, including goals and design criteria, monitoring, and using hydrodynamic models for decisions about locations and sizes	Evaluate effectiveness (e.g. pre-designation baseline, reference comparisons, time-series monitoring, well designed studies of cause and effect)	LMR - 12
	Oceanographic Regime	Changing distribution and abundance of organisms and habitats		
	Stresses	Wildlife health, including diseases	Identify indicators of stress	Stress-17,18
	Threat/End. & Terr Res	Recovery of critically endangered species	Determination of predation rates on green sea turtle hatchlings in near shore, beach, and pelagic habitats	Threatened-15
	Threat/End. & Terr Res	Ability to detect change that requires management action	Long-term demographic data	Threatened-5
	Threat/End. & Terr Res	Recovery of critically endangered species	Characterization of monk seal prey population	Threatened-16
	Threat/End. & Terr Res	Invasive species	Pathogens	Threatened-10
Monitoring: Living Resources / Anthropogenic Influences				
	Damage Asses./Rest	Marine debris – organisms (entanglements, ingestibles and habitat)	Quantification of impacts (particularly endangered and protected species)	Damage-1,3
	Damage Asses./Rest	Marine debris – organisms (entanglements, ingestibles and habitat)	Linkage of source, size, and type to impact	Damage-1,3
	Damage Asses./Rest	Marine debris – organisms (entanglements, ingestibles and habitat)	Degradation time period and fate of types of debris	Damage-1,3

Topic		Issue of Concern	Information Need	Strategies
	Damage Asses./Rest	Marine debris – organisms (entanglements, ingestibles and habitat)	Cascaded effects of marine debris on the entire ecosystem (trophic interaction)	Damage-1,3
	Damage Asses./Rest	Alien species - terrestrial and marine	Long-term monitoring	
	History/Archaeology	Environmental threat from Heritage vessels		
	Living Marine Resources	Evaluation of secondary impacts of research on marine living resources		
	Living Marine Resources	Evaluate the impact of humans on the ecosystems		
	Oceanographic Regime	Chronic anthropogenic effects		
	Stresses	Debris impacts, including fishing and non-fishing debris	Impact of debris, focusing on quantification of existing data over qualitative assessement	Stress-10
	Stresses	Impacts of vessels, including transiting vessels such as cruise ships	Evaluate impacts by types	Stress-7
	Stresses	Impacts of fishing, legal and illegal	Habitat and community impacts caused by various fishing (e.g., anchor damage, interactions with endangered and threatened species, by-catch)	Stress-14
	Stresses	Impacts of terrestrial and marine alien or invasive species	Determine ecosystem consequences of various types of alien and invasive spp.	Stress-5
	Stresses	Impacts of research activities	Characterize impacts by type	
	Stresses	Impacts of terrestrial and marine alien or invasive species	Distinguish natural range extensions from unnatural invasions	
	Stresses	Wildlife health, including diseases	Identify contaminant effects thresholds for selected biota.	
	Threat/End. & Terr Res	Human impacts	Assessing potential impacts of human activities	Threatened-8
	Threat/End. & Terr Res	Human impacts	Characterization of unknown impacts	Threatened-7
	Threat/End. & Terr Res	Human impacts	Efficacy of prevention and mitigation options	Threatened-7
	Threat/End. & Terr Res	Human impacts	Impacts on the ecosystem	
	Threat/End. & Terr Res	Human impacts	Impacts on native species	
	Threat/End. & Terr Res	Invasive species	Impacts of invasive species on the ecosystem	
	Threat/End. & Terr Res	Invasive species	Impact of invasive species on native species	Threatened-12
Monitoring: Water-Atmosphere				
	Damage Asses./Rest	Extreme oceanographic atmopsheric events	Long-term oceanographic monitoring	
	Oceanographic Regime	Effects of episodic natural effects	Rapid response documentation and monitoring (remote and in situ)	Ocean - 5
	Stresses	Natural stressors and climate change	Characterize types of natural stressors; their baselines and temporal and spatial variations	Stress-1,2
	Threat/End. & Terr Res	Ability to detect change that requires management action	Long-term physical/environmental data	Threatened-1
Monitoring: Water Atmosphere / Anthropogenic Influences				
	History/Archaeology	Environmental threat from Heritage vessels		
	Living Marine Resources	Evaluate the impact of humans on the ecosystems		
	Oceanographic Regime	Chronic anthropogenic effects		
	Stresses	Impacts of vessels, including transiting vessels such as cruise ships	Evaluate impacts by types	Stress-7
	Stresses	Impacts of terrestrial and marine alien or invasive species	Determine ecosystem consequences of various types of alien and invasive spp.	Stress-5
	Stresses	Impacts of research activities	Characterize impacts by type	
	Stresses	Natural stressors and climate change	Assess anthropogenic effects that exacerbate natural impacts	Stress-1
	Threat/End. & Terr Res	Human impacts	Assessing potential impacts of human activities	Threatened-8
	Threat/End. & Terr Res	Human impacts	Characterization of unknown impacts	Threatened-7
	Threat/End. & Terr Res	Human impacts	Impacts on the ecosystem	
	Threat/End. & Terr Res	Invasive species	Impacts of invasive species on the ecosystem	Threatened-12

Topic		Issue of Concern	Information Need	Strategies
Monitoring: Water-Atmoshpere / Habitat				
	Damage Asses./Rest	Extreme oceanographic atmopsheric events	Secondary anthropogenic (shipwreck movement and discarge) and natural (boulder movement) impacts	
	Oceanographic Regime	Effects of episodic natural effects	Grain size analysis to determine frequency of energy changes (i.e., storm events)	Ocean - 5
Monitoring: Water-Atmosphere / Living Resources				
	Damage Asses./Rest	Extreme oceanographic atmopsheric events	Relationship of climatic effects to coral bleaching	
	Damage Asses./Rest	Extreme oceanographic atmopsheric events	Understanding NWHI coral bleaching	
	Oceanographic Regime	Effects of episodic natural effects	Long term monitoring of physical and biological indicators	
	Oceanographic Regime	Impacts of climate change	Long term monitoring of physical and biological indicators	Ocean - 4
	Stresses	Natural stressors and climate change	Identify species that are appropriate indicators of stresses	Stress-1
Tools: Definitions				
	Living Marine Resources	MPA design and evaluation, including goals and design criteria, monitoring, and using hydrodynamic models for decisions about locations and sizes	Define goals for MPAs (biodiversity conservation, fisheries rehabilitation, threatened and endangered spp protection, habitat rehabilitation, fisheries enhancement, etc.)	LMR - 2
Tools: Information Management				
	Habitat Delineation	Data synthesis (old and new), including metadata	Historical data on distribution of habitats	Habitat - 13
	Habitat Delineation	Data synthesis (old and new), including metadata	Infrastructure and funding to support data synthesis	Habitat - 11
	Habitat Delineation	Data synthesis (old and new), including metadata	Metadata - evaluation of content and quality	Habitat - 13
	Habitat Delineation	Data synthesis (old and new), including metadata	Development of data standards	Habitat - 12
	Habitat Delineation	Data synthesis (old and new), including metadata	Identifying data gaps	Habitat - 13
	Habitat Delineation	Baseline data for habitat monitoring	Database infrastructure	Habitat - 11
	Living Marine Resources	Making data (historical and future) available and complementary		
	Living Marine Resources	MPA design and evaluation, including goals and design criteria, monitoring, and using hydrodynamic models for decisions about locations and sizes	Existing data and information (historical) that can be used in MPA design	
Tools: Prevention and Mitigation				
	Comm/Rec Uses	Past and future recreational use (consumptive and nonconsumptive): understanding scale and impacts	Development of harvest control strategies with appropriate biologica	ComRec - 6
	Damage Asses./Rest	Marine debris – habitat damage	Development of enforcement regulations	Damage-1,3
	Stresses	Impacts of vessels, including transiting vessels such as cruise ships	Identify and evaluate prevention and mitigation methods, including penalty schedule based on habitat valuation.	Stress-8
	Stresses	Debris impacts, including fishing and non-fishing debris	Identify and evaluate methods of mitigation	Stress-11
	Stresses	Impacts of terrestrial and marine alien or invasive species	Identify and evaluate prevention and mitigation alternatives	Stress-4,6
	Stresses	Impacts of research activities	Identify prevention and mitigation measures	
	Stresses	Impacts of terrestrial and marine alien or invasive species	Identify early warning/detection alternatives	
	Stresses	Wildlife health, including diseases	Identify detection, prevention and mitigation measures	Stress-17
	Threat/End. & Terr Res	Invasive species	Methods of prevention of invasive species	Threatened-11
	Threat/End. & Terr Res	Invasive species	Methods of control of invasive species	Threatened-14
	Threat/End. & Terr Res	Invasive species	Methods of eradication of invasive species	Threatened-11
	Threat/End. & Terr Res	Recovery of critically endangered species	Translocation methods	Threatened-17

Topic		Issue of Concern	Information Need	Strategies
Tools: Technology				
	Comm/Rec Uses	Fusion of science with existing fisheries (onboard observers, better collection and analysis of fishery data, characterization of catch)		
	Comm/Rec Uses	Understanding changes in fishing technology on standard assessments (e.g., CPUE)		
	Damage Asses./Rest	Vessel traffic and operations (lights, discharges of pollution, alien species, anchor damage, etc)	Best management practices for ship ops (protocols for managing light, discharges, wildlife interactions, etc.)	Damage-5
	Habitat Delineation	Threats to habitats (e.g., vessel traffic and activities, toxic chemicals)	Surveillance technology for enforcement	
	History/Archaeology	Preservation/protection/enforcement (lack of management presence)	Evaluation of "technology" available to track visitation	
Use: Anthropogenic Influences				
	Comm/Rec Uses	Past and future recreational use (consumptive and nonconsumptive): understanding scale and impacts	Characterization of recreational consumptive and nonconsumptive us	ComRec - 6
	Comm/Rec Uses	Monitoring and enforcement of existing fisheries	Vessel traffic and activity reporting requirements	ComRec - 7
	Comm/Rec Uses	Threat assessment of vessel traffic impacts (e.g., cruise ships, fishing, aquarium trade)	Vessel traffic and activity report requirements (type, location, time)	ComRec - 7
	Comm/Rec Uses	Past and future recreational use (consumptive and nonconsumptive): understanding scale and impacts	Analysis of impacts of recreational consumptive and nonconsumptive	ComRec - 6
	Comm/Rec Uses	Monitoring and enforcement of existing fisheries	Vessel traffic monitoring (location, activity) by VMS, observers, etc.	ComRec - 7
	Comm/Rec Uses	Threat assessment of vessel traffic impacts (e.g., cruise ships, fishing, aquarium trade)	Characterize threats from vessels and activities (e.g., human presence, research, effluents, species introductions)	ComRec - 7
	Comm/Rec Uses	Past and future recreational use (consumptive and nonconsumptive): understanding scale and impacts	Survey interest levels in future use	ComRec - 6
	Comm/Rec Uses	Monitoring and enforcement of existing fisheries	Estimates of CPUE of harvested species	ComRec - 8
	Comm/Rec Uses	Threat assessment of vessel traffic impacts (e.g., cruise ships, fishing, aquarium trade)	Magnitude of extraction on individual species and ecosystem structu	ComRec - 8
	Comm/Rec Uses	Monitoring and enforcement of existing fisheries	Analysis of records of fishing violations in NWHI	
	Comm/Rec Uses	Threat assessment of vessel traffic impacts (e.g., cruise ships, fishing, aquarium trade)	Impacts of fishing gear	ComRec - 8
	Comm/Rec Uses	Threat assessment of vessel traffic impacts (e.g., cruise ships, fishing, aquarium trade)	Response of species to fishing pressure	ComRec - 8
	Comm/Rec Uses	Monitoring and enforcement of existing fisheries	Characterize commercial catch (species, size, number, pop.structure	ComRec - 8
	Comm/Rec Uses	Threat assessment of vessel traffic impacts (e.g., cruise ships, fishing, aquarium trade)	Characterize non-permitted fishing by foreign and domestic vessels	ComRec - 8
	Comm/Rec Uses	Monitoring and enforcement of existing fisheries	Analysis of potential recreational uses (preemptive analysis)	
	Comm/Rec Uses	Monitoring and enforcement of existing fisheries	Retrospective analysis of catch data (e.g., black pearl)	ComRec - 8
	Damage Asses./Rest	Oil sources (terrestrial and marine)		
	Damage Asses./Rest	Human visitation - terrestrial or shallow water areas		
	Damage Asses./Rest	Vessel groundings (non-oill spill impacts)		
	Damage Asses./Rest	All sources of hazmat (non-oil)		
	Damage Asses./Rest	Military operations		
	Damage Asses./Rest	Alien species - terrestrial and marine	Potential vector sources	Damage-3,4,6
	Damage Asses./Rest	Vessel traffic and operations (lights, discharges of pollution, alien species, anchor damage, etc)	Vessel activity (number, frequency, destination, anchorage and identification of vessels, cargo, discharges, missions, no. of people)	Damage-5
	Damage Asses./Rest	Vessel traffic and operations (lights, discharges of pollution, alien species, anchor damage, etc)	Fishing (collateral or recreational fishing by crew - not ship's mission - this can refer to a fishing vessel)	

Topic		Issue of Concern	Information Need	Strategies
	Damage Asses./Rest	Vessel traffic and operations (lights, discharges of pollution, alien species, anchor damage, etc)	Ship traffic and source quantitites (reporting)	Damage-5
	Habitat Delineation	Threats to habitats (e.g., vessel traffic and activities, toxic chemicals)	Vessel traffic and activities	Habitat - 5
	Habitat Delineation	Threats to habitats (e.g., vessel traffic and activities, toxic chemicals)	Toxics, hazardous waste, unexploded ordnance	Habitat - 3
	Habitat Delineation	Threats to habitats (e.g., vessel traffic and activities, toxic chemicals)	Vessel groundings	Habitat - 5
	Habitat Delineation	Threats to habitats (e.g., vessel traffic and activities, toxic chemicals)	Tourism, particularly cruise ships (locations and activities)	Habitat - 5
	Habitat Delineation	Threats to habitats (e.g., vessel traffic and activities, toxic chemicals)	Marine debris	Habitat - 5
	Habitat Delineation	Threats to habitats (e.g., vessel traffic and activities, toxic chemicals)	Military activities	
	Habitat Delineation	Threats to habitats (e.g., vessel traffic and activities, toxic chemicals)	Fishing activities	Habitat - 4
	Habitat Delineation	Threats to habitats (e.g., vessel traffic and activities, toxic chemicals)	Research activities	Habitat - 5
	Stresses	Impacts of vessels, including transiting vessels such as cruise ships	Characterize types, sources, frequencies, intensity and distribution	Stress-7
	Stresses	Impacts of fishing, legal and illegal	Characterize allowable types, sources, intensity and distribution (bottomfish, recreational fishing, pelagic longline, lobsters, trolling, handline)	
	Stresses	Impacts of research activities	Characterize types, locations, and durations	
	Stresses	Impacts of fishing, legal and illegal	Characterize poaching types (lobster, live fish, pelagic, aquarium trade), sources, intensity and distribution	Stress-15
	Threat/End. & Terr Res	Human impacts	Inventory of human activity by time/location	Threatened-6
Use: Prevention and Mitigation				
	Comm/Rec Uses	Threat assessment of vessel traffic impacts (e.g., cruise ships, fishing, aquarium trade)	Analysis of violatons in NWHI and in other regions	ComRec - 7
	Comm/Rec Uses	Monitoring and enforcement of existing fisheries	Map delineating jurisdictional boundaries	ComRec - 7
	Comm/Rec Uses	Monitoring and enforcement of existing fisheries	Cost effectiveness of enforcement measures	ComRec - 7
	Comm/Rec Uses	Threat assessment of vessel traffic impacts (e.g., cruise ships, fishing, aquarium trade)	Source and mitigation of marine debris	
Use: Socioeconomic				
	Comm/Rec Uses	Establishing social and economic baselines for NWHI		
	Comm/Rec Uses	Impacts of socio-economic activities in NWHI and relation to MHI		
	Comm/Rec Uses	Evaluating the efficacy of management actions (spatial management)	Socioeconomic assessment of management actions	
	Comm/Rec Uses	Impacts of NWHI regulation on main Hawaiian Islands	Socioeconomic assessment of management actions	
	Comm/Rec Uses	Utilizing management results from NWHI to better manage MHI	Socioeconomic assessment of management actions	
	Comm/Rec Uses	Past and future recreational use (consumptive and nonconsumptive): understanding scale and impacts	Analysis of potential economic impacts of non-commercial uses	ComRec - 6
	Living Marine Resources	MPA design and evaluation, including goals and design criteria, monitoring, and using hydrodynamic models for decisions about	Identify existing uses and potential conflicts (including socio-economic and cultural)	
Other: Duplicative				
	Living Marine Resources	Long term monitoring of natural and human-caused variation at relevant spatial and temporal scales.	Spatial and temporal variation of key taxa and indicator spp (abundance, distribution, population size distribution, recruitment, reproduction, community structure, biodiversity, health/condition/disease, habitat and water quality, human uses and activities)	LMR - 9
Other: Management				
	Comm/Rec Uses		Lobster fishery closure - clarification of Executive Order	
	History/Archaeology	Archaeological/historical resources and must be a resource management priority	Assessment of existing priority status (e.g. management plans, etc.)	History-4

Topic		Issue of Concern	Information Need	Strategies
	History/Archaeology	Lack of coordination between natural scientists and social scientists in surveys,mapping	Identify potential for cross-disciplinary training of survey personnel	History-2
	History/Archaeology	Preservation/protection/enforcement (lack of management presence)	Ranking of priorities	
	History/Archaeology	Preservation/protection/enforcement (lack of management presence)	Review of enforcement needs vs. capabilities	History-7
	History/Archaeology	Public interpretation and education	Identify linkage to ecosystem management	
	History/Archaeology	Preservation/protection/enforcement (lack of management presence)	Management plan	
	Living Marine Resources	MPA design and evaluation, including goals and design criteria, monitoring, and using hydrodynamic models for decisions about	Evaluate enforcement (viability, clarity of boundaries, commitment, resources)	
	Oceanographic Regime	Acute anthropogenic effects	Contingency plan development	
Other: Outreach				
	Cultural Heritage	Create sense of place		
	Cultural Heritage	Communication/outreach		
	History/Archaeology	Possible negative impacts to ecosystem management of publicity on potential spectacular finds		
	History/Archaeology	Public interpretation and education	Identify outreach audience and venues/opportunities	History-5
	History/Archaeology	Public interpretation and education	Opportunities/locations for exhibits	
	History/Archaeology	Public interpretation and education	Overview of existing outreach/education programs	
	History/Archaeology	Public interpretation and education	Identify appropriate partners	
	History/Archaeology	Public interpretation and education	Identify public current understanding and interest in the NWHI	
Other: Policy				
	Comm/Rec Uses	Lack of clear, ecosystem-based definitions of conservation, management, and sustainable yield		
	Cultural Heritage	Cultural issues often do not fit well into government framework		
	Cultural Heritage	Politics: how to ensure native Hawaiian issues will be part of mgmt/action plan	Identify how Native Hawaiians want to be involved	Cultural-5
	Cultural Heritage	Full participation of NH in the "process" of management	Identify ways that other government include native cultures in decision-making process	Cultural-7
	Cultural Heritage	Developing an effective cultural science program	Training for natural resource managers	Cultural-1
	Cultural Heritage	Respect & promote native Hawaiian sense of place, values, rights & responsibilities in NWHI; accessability; connectivity; lineal	Identify appropriate avenues for demonstrating respect and promotion of these concepts	Cultural-4
	Cultural Heritage	Politics: how to ensure native Hawaiian issues will be part of mgmt/action plan	Process to identify and include Native Hawaiian communities in process	Cultural-6
	Cultural Heritage	Respect & promote native Hawaiian sense of place, values, rights & responsibilities in NWHI; accessability; connectivity; lineal	Identify ways that other governments respect and promote…	Cultural-7
	Cultural Heritage	Politics: how to ensure native Hawaiian issues will be part of mgmt/action plan	How to ensure Native Hawaiian rights/responsibilities receive equal or more structural/procedural recognition with respect to management of the Reserve	
	Cultural Heritage	Developing an effective cultural science program	How government/groups are "persuading" government to support this with funds	Cultural-3
	Cultural Heritage	Politics: how to ensure native Hawaiian issues will be part of mgmt/action plan	Coordination of Native Hawaiian issues across multiple jurisdictions (e.g. terrestrial/USFWS)	
	History/Archaeology	Position of social science in NWHI		
	History/Archaeology	Issue of jurisdiction (e.g. Federal. State) and what laws apply/coordination		

Appendix II: Workshop Participants

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Appendix III: Stresses

The following list of actual and potential stresses to the resources of the NWHI was developed by the Stresses on Living Resources working group at the May 2003 workshop. This step was not part of the original workshop process and the Stresses working group was the only group to take this approach. The result is an efficient method to determine issues of concern and information needs, and develop strategies regarding a very broad range of stresses.

The working group determined that issues of concern, information needs, and strategies to address these are relatively common across many stresses and that addressing these for each stress would be redundant. To avoid this and streamline their task, the group first established a master list of actual and potential stresses. The group then focused on the issues of concern, information needs, and strategies for these stresses in general terms such that for any stress identified in this table, the appropriate issues, needs, and strategies could be found in the workshop results.

Stresses Identified: Listed by ranked importance within issue of concern	
Rank	Source
1	**Impacts of fishing, legal and illegal**
1	Pelagic longline – Distant
2	Poaching
3	Lobsters
4	Bottom-fish
5	Aquarium trade
6	Pelagic trolling
7	Precious coral
7	Cultural subsistence fishing
8	Live fish (for food)
9	Recreational fishing
9	Artisanal
10	Squid jigging
10	Pearl oysters
2*	**Sources & vectors of terrestrial & marine invasive & alien species**
1	Fishing boats
2	Ecotourists, Ecotourist vessels
2	Cargo containers, personal gear
2	Grounded vessels
3	Research vessels/researchers /people
4	Marine debris
5	Cruise ships

5	Trespassers
6	Research activities, dive gear
6	Natural: Oceanographic currents, winds, hurricanes
7	Migratory biota (Birds, mammals, fish, etc)
7	Airplanes
8	Deliberate introductions
9	Floating instruments
2*	**Wildlife health, including diseases**
1	Contaminants
2	Microorganisms (viruses, bacteria, fungi, plankton)
3	Oil spills
4	Trauma
5	Toxic blooms
5	Parasites
3	**Natural stressors and climate change**
1	Elevated temperature
2	Storms
2	Sea level rise
3	Sediment shifting
4	UV increase
4	PDO (Pacific Decadal Oscillation)
5	Winter swells/waves
6	ENSO
7	Ocean acidification
8	Tsunamis
9	Drought
9	Tidal flux
10	Abnormal calms
11	Heavy rainfall
4	**Debris sources**
1	Trawlers – Distant
2	Cargo ships
2	Unknown sources
3	Drift Netters
4	Cruise ships
5	DOD
6	Long-liners
7	Research vessels/researchers/activities
8	Ecotourist vessels

8	Recreational fishers
8	Trappers
9	Trespassers
10	Grounded vessels
5	**Impacts of vessels**
1	Groundings
2	Bilge discharge
3	Garbage
4	Anchor impacts
5	Sewage
5	Ballast waste
5	Derelict vessels (long-term impacts)
6	Biofouling
7	Fuel leaks
7	Vectors of invasive delivery
8	Light
9	Contaminants (e.g., photographic chemicals)
10	Noise
11	Speed and marine mammal collisions
11	Tank washing
11	Pathogens
11	Loss of cargo overboard
11	Pathogens
12	Wake effects
12	Exhaust emissions
6	**Research activities that may have impact**
1	Research facilities and structures (tents, etc)
2	Collections (species, dredge)
3	Bioprospecting
4	Anchoring
5	Instrumentation (buoys, markers, transect lines)
6	Monk seals
7	Sea bird
8	Atmospheric
8	Use of chemicals
8	Human waste
9	Coral reefs
9	Coring
10	Sea turtles

10	Acoustics (high frequency)
11	Sub-bottom (low frequency)
12	Archeological
12	Diving
13	Fish
13	Sonar
14	Seaweed
14	Shark
14	Oceanographic
15	Marine mammals (cetaceans)
15	Geological
15	Mapping
15	Submersibles/ROVs
15	Air strips, planes

***** These two groups of stressors tied in the voting process to rank importance.

Appendix IV: Map of the Area