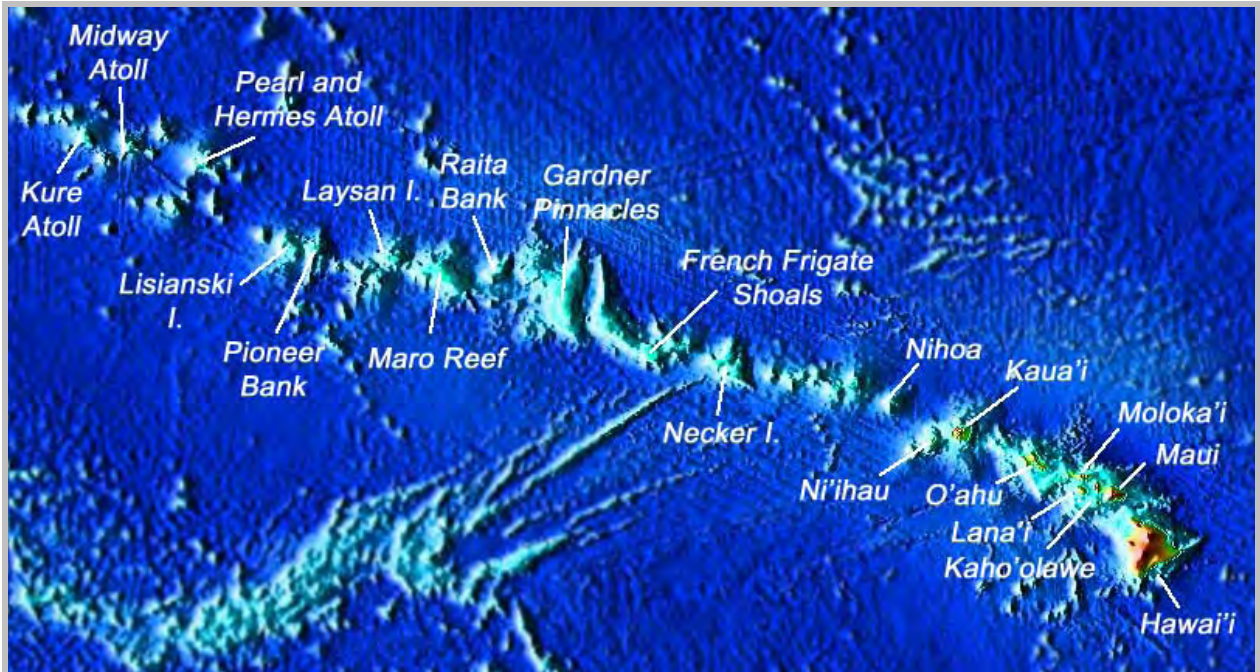


Hawaiian Islands Benthic Habitat Mapping and Classification



Sixth Semi-Annual Progress Report for the period 1 April 2007 through 30 September 2007

NOAA - CEROS Cooperative Agreement NA04NMF4630366

Federal Program Officer:
Dr. Andy Bruckner, NOAA NMFS
Office of Habitat Conservation

Principal Investigator:
Richard A. Hess, Technical Director, CEROS

30 October 2007



**National Defense
Center of Excellence for Research in Ocean Sciences**

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Introduction

A cooperative agreement was established on 1 October 2004 between the National Oceanic and Atmospheric Administration (NOAA) and the National Defense Center for Excellence for Research in Ocean Sciences (CEROS), an agency of the State of Hawaii, for support of benthic habitat mapping and classification in the waters of the Hawaiian Islands. This program uses available equipment resources within NOAA and the University of Hawaii's Joint Institute for Marine and Atmospheric Research (JIMAR) to support collaborative habitat mapping efforts being carried out by the Pacific Islands Benthic Habitat Mapping Center (PIBHMC). This agreement provides personnel and office analysis support for benthic mapping and classification efforts.

This document is the sixth Semi-Annual Progress Report required under the terms and conditions of the cooperative agreement. The eleventh and twelfth Quarterly Progress Reports submitted by JIMAR to CEROS are appended to this report. The first through tenth Semi-annual Progress Report were submitted to the NOAA Program Officer on 30 April 2005, 30 October 2005, 30 April 2006, 30 October 2006, and 30 April 2007.

Project Background

The project was mandated in the FY 2002 Supplemental Appropriations Act, Public Law 107-206, sec. 209, which reads in its entirety as follows:

Of the amounts appropriated in Public Law 107-77, under the heading "Department of Commerce, National Oceanic and Atmospheric Administration, Operations, Research, and Facilities", for coral reef programs, \$2,500,000, for a cooperative agreement with the National Defense Center of Excellence for Research in Ocean Sciences to conduct coral mapping in the waters of the Hawaiian Islands and the surrounding Exclusive Economic Zone in accordance with the mapping implementation strategy of the United States Coral Reef Task Force.

An overall guidance document for the mapping of U. S. coral reefs was provided in *Coral Reef Mapping Implementation Plan*¹ of 1999, which described preferred tools, methods, products, and also set broad priorities for geographic areas to be mapped. That plan was supplemented for the Pacific Islands by another implementation plan issued in August 2003² following collaborative meetings of interested parties; this implementation plan identified areas where "moderate depth" (between 20m and 200m depth) data were needed. Further refinement of the geographic needs and priorities has continued with stakeholder meetings of federal, regional, and state agencies and organizations.

¹ *Coral Reef Mapping and Implementation Plan (2nd Draft)*. Nov 1999. U. S. Coral Reef Task Force, Mapping and Information Synthesis Working Group. Washington DC: NOAA, NASA, and USGS (Work Group Co-Chairs). 17pp. <http://biogeo.nos.noaa.gov/MIP/MIP.pdf>.

² *Mapping Moderate Depth Habitats of the U.S. Pacific Islands with Emphasis on the Northwestern Hawaiian Islands: an Implementation Plan (Version 2)*. Aug 2003. NOAA, Coral Reef Ecosystem Division, Honolulu HI. 23pp. <http://biogeo.nos.noaa.gov/projects/mapping/>

CEROS contracted with the University of Hawaii's Joint Institute for Marine and Atmospheric Research (JIMAR) for the execution of the program. The newly-created Pacific Islands Benthic Habitat Mapping Center (PIBHMC) was formed from elements of the University of Hawaii's Hawaii Mapping Research Group (HMRG) and NOAA's Coral Reef Ecosystems Division to focus on benthic habitat mapping in the Hawaiian and other Pacific Islands. The university and its specialty research divisions will manage the operation of NOAA's ship-based mapping systems and transform the resulting data into useful products that meet the conservation, management, and research needs of NOAA and its partner agencies in the Pacific Islands.

A one-year, no-cost contract extension was requested by JIMAR in early 2006 and was implemented effective 11 September 2006. The extension was necessary because NOAA ship priorities and schedules, which are beyond the control of either JIMAR or CEROS, were both reduced and modified such that the required number of ship-days were not available within the original contract period. The JIMAR contract period of performance now ends on 30 Sep 2007.

This report represents the final Progress Report to be submitted under this contract between NOAA and CEROS. A final project report will be prepared and submitted on or before 29 December 2007.

Progress During this Review Period

The significant events that occurred during this semi-annual review period or that were pertinent to the period include:

1. Continuation of data processing and posting to public-access web sites
2. Program review with JIMAR principals held (01 November 07).
3. Receipt of Eleventh Quarterly Report from JIMAR (15 July 07).
4. Receipt of Tenth Quarterly Report from JIMAR (10 October 07).

A updated Gantt chart showing the program timelines by major tasks and subtasks is provided at the end of this report. It also shows the completed and anticipated multibeam and ground-truth cruise schedules, as well as deliverable reports and review meetings.

A summary of progress by major work task is provided in Table 1. More detailed descriptions of progress can be found in the JIMAR ninth and tenth Quarterly Reports (attached as Appendices A and B). Also attached to this report are (1) Appendix C, with updated pages from the PIBHMC website showing newly released data products, (2) Appendix D, with the cruise report from *R/V Hi'ialakai* cruise HI-06-02, (3) Appendix E, the cruise report from cruise AHI-06-12, and (4) Appendix F, the cruise report from the *R/V Hi'ialakai* cruise HI-06-14.

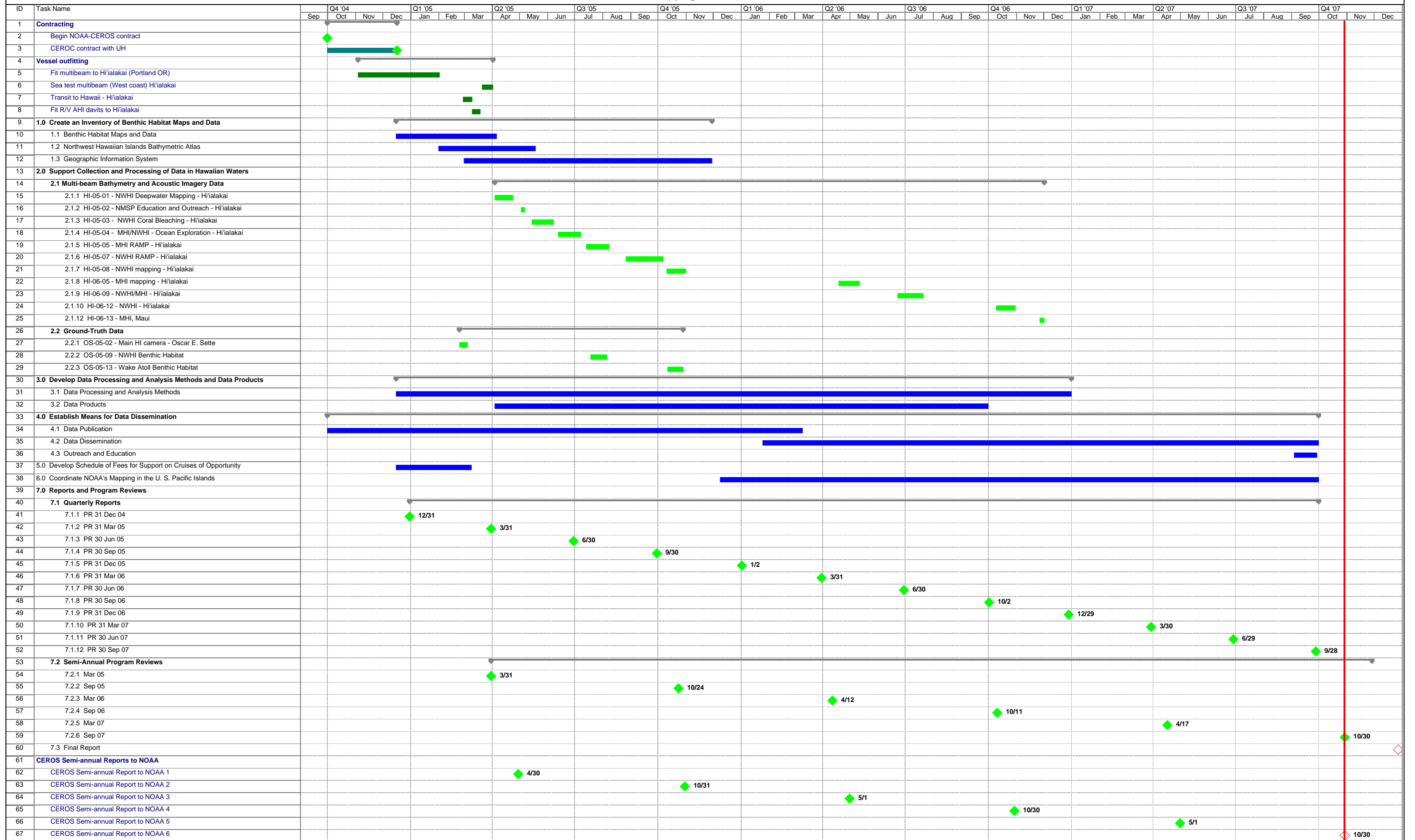
Technical and Administrative Problems

No significant problems occurred during this semi-annual review period.

Table 1
Summary of Progress by Task
Period: 1 April 2007 – 30 September 2007

Task	Progress
1.0 Develop a Hawaiian Archipelago Atlas	
	Habitat data and information collected in the Main Hawaiian Islands have been provided to resource managers at the State of Hawaii's Department of Land and Natural Resources. That state agency has, however, requested that the detailed mapping not be made public until it has had the opportunity to evaluate the data and implement appropriate resource conservation measures. All NWHI data collected to date are available on the PIBHMC website.
2.0 Collect Acoustic Mapping Data	
	No MHI or NWHI cruises were completed during this reporting period. The vessel <i>Hi'ialakai</i> was assigned to mapping cruises in other parts of the Pacific basin during this review period.
3.0 Collect Ground-Truth Data	
	Analysis and generation of metadata was completed for optical ground-truth data collected previously at French Frigate Shoals.
4.0 Develop Analytical Methods and Data Products	
	Data processing methods continue to be developed and refined for both multibeam and backscatter data collected on multibeam mapping cruises during earlier contract periods. All data processing and analysis methods for multibeam, backscatter, and optical data classification have been documented and are available on the PIBHMC website.
5.0 Data Products, Data Dissemination, Outreach and Education	
	Gridded bathymetric data from all cruises have been made to collaborating agencies, and data from the NWHI is available for download on the PIBHMC website. Numerous presentations of the mapping program and products have been made by JIMAR staff to state and federal agencies, Pacific Island states representatives, and the public.
6.0 Allow for Cruises of Opportunity	
	A schedule of cost recovery fees has been developed by PIBHMC for use when program resources are used for mapping and analysis of non-priority areas by other agencies. The schedules of fees for use in contracting outside work has been published on the PIBHMC website.
7.0 Coordinate NOAA's Mapping in the U. S. Pacific Islands	
	PIBHMC personnel have been and continue to work closely with other agencies to coordinate mapping activities in the Pacific Basin; other agencies and partners include NOAA's Integrated Ocean Mapping (IOM) committee, NOAA's Office of Coast Survey (OCS), the Naval Oceanographic Office (NAVOCEANO), NOAA Fisheries Pacific Islands Regional Office (PIRO), the U.S. Fish and Wildlife Service (USFWS), the Hawaii Department of Land and Natural Resources (DLNR), NOAA's National Marine Sanctuary Program (NMSP).

Benthic Habitat Mapping in the Hawaiian Islands EEZ



Appendix A

**JIMAR Quarterly Report
For Period Ending 30 June 2007**

Quarterly Report for Period Ending
June 30, 2007

Benthic Habitat Mapping Support for
National Oceanic and Atmospheric Administration
Activities in the Hawaiian Archipelago and
Other U.S. Pacific Island Areas

A Contract Between:

CEROS – National Defense Center of
Excellence for Research in Ocean Sciences

And

University of Hawaii’s Joint Institute
For Marine and Atmospheric Research

Dr. Bruce Appelgate, Principal Investigator



Quarterly Report – June 30, 2007

Benthic Habitat Mapping Support for National Oceanic and Atmospheric Administration Activities in the Hawaiian Archipelago and Other U.S. Pacific Island Areas

This report is submitted in partial fulfillment of the requirements of the contract entitled “Benthic Habitat Mapping Support for National Oceanic and Atmospheric Administration Activities in the Hawaiian Archipelago and Other U.S. Pacific Island Areas” between the Natural Energy Laboratory of Hawaii National Defense Center of Excellence for Research in Ocean Sciences (CEROS) and the University of Hawaii under the direction of Dr. T. Bruce Appelgate, principal investigator for this project from the Joint Institute of Marine and Atmospheric Research. This report documents the following: (1) progress to date under each task listed under the contract’s Scope of Services, patents, trademarks, copyrights and publications; (2) schedule; (3) problems; and (4) financial status. This 11th quarter report documents the progress between April 1 and June 30, 2007.

PART (I): PROGRESS UNDER EACH TASK

Task 1: Create an Inventory of Benthic Habitat Maps and Data

Subtask 1.1: Benthic Habitat Maps and Data

Primary efforts at PIBHMC over the past quarter have been focused on preparing previously collected acoustic and optical data for the website. Bathymetric grids have been updated for the NWHI to incorporate all data collected during cruises in 2006. Metadata for these grids have also been updated to reflect recently collected data. Additions to the PIBHMC web site include bathymetric data from UTM Zones 3 and 4 for the NWHI. Maps showing underwater camera sled tow track locations for Ni’ihau, Kaua’I, O’ahu, and Moloka’i have also been posted. Cruise metadata for datasets from AHI0609, AHI0612, HI0612, and HI0614 were also added to the web site.

Backscatter data for Maro Reef has been submitted to our webmaster and a new format for backscatter data display is under development. Processing of backscatter data from Kure Atoll is now underway and it is anticipated that this processing will be completed in the 3rd quarter.

Subtask 1.2: Northwestern Hawaiian Island Bathymetric Atlas

The updated bathymetric grids mentioned above for the NWHI include 5 m, 20 m (Figure 1), and 60 m resolutions. These have been updated for UTM zones 1 through 4. Zones 3 and 4 have been hosted on the website, along with their associated metadata. Collaborative work on the MHI data synthesis continues and all MHI data collected by PIBHMC in waters shallower than 100 m is available as part of this on-going synthesis at a collaborative website at:

www.soest.hawaii.edu/hmrg (Figure 2).

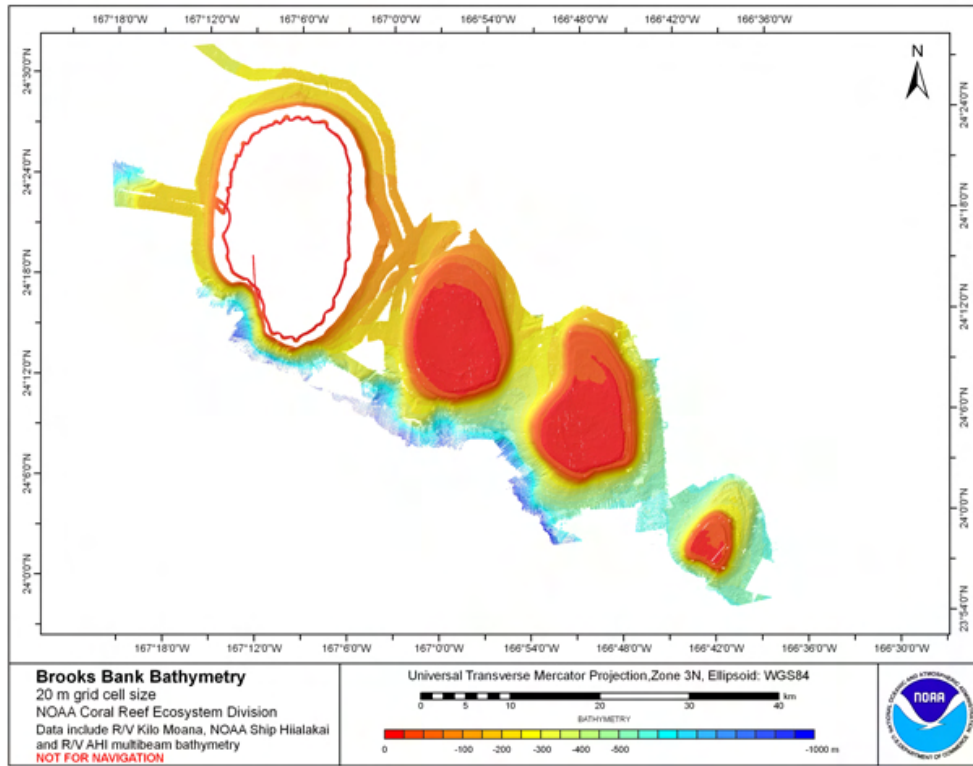


Figure 1: Bathymetry of Brooks Banks using data collected in October 2006 is now on PIBHMC website.

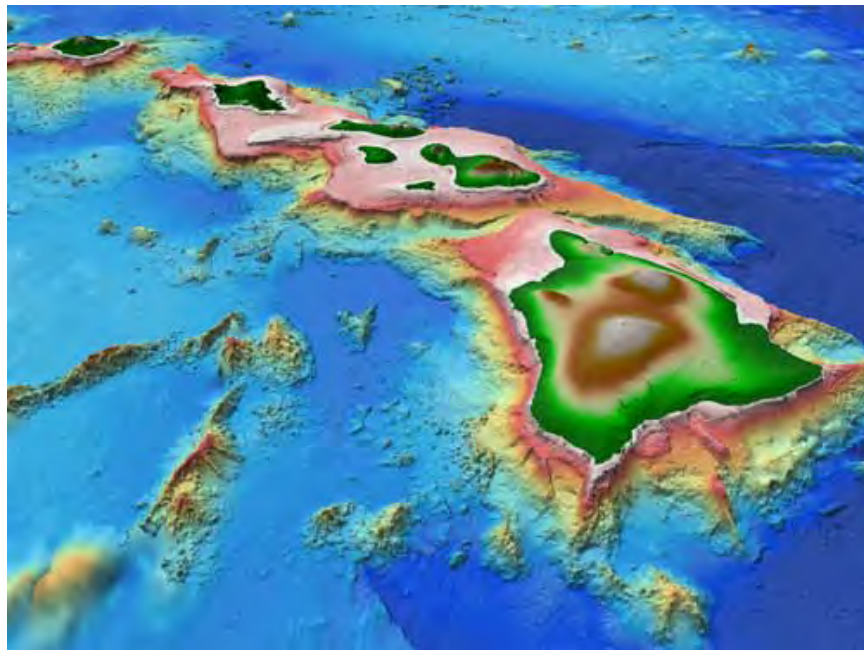


Figure 2. MHI multibeam data synthesis done by Hawaii Mapping Research Group in collaboration with PIBHMC and the Hawaii Undersea Research Laboratory (HURL)

Hawaii’s Department of Land and Natural Resources/Division of Aquatic Resources (DLNR/DAR) has agreed that multibeam data collected by PIBHMC in water depths less than 100 m can now be released. Data between 100 m and 500 m, which is the area of primary concern for bottom fish stocks, that is less than 2 years old are still under hold at the request of DLNR/DAR.

Subtask 1.3: Geographic Information System (GIS)

Maps of camera sled tow tracks for Ni’ihau (Figure 3), Kaua’I, O’ahu, and Moloka’i were prepared using ArcGIS. These maps also show the percentage of seafloor covered by scleractinian coral every 20 m along each track. Optical data were classified using the PIBHMC benthic habitat classification scheme (<ftp://ftp.soest.hawaii.edu/pibhmc/web/docs/Benth-Habitat-Class-Codes.htm>). In addition to the percentage of hard coral, all the other classifications are as embedded in ArcGIS shapefile attribute tables. These shapefiles and their associated metadata publicly available for download via the PIBHMC website.

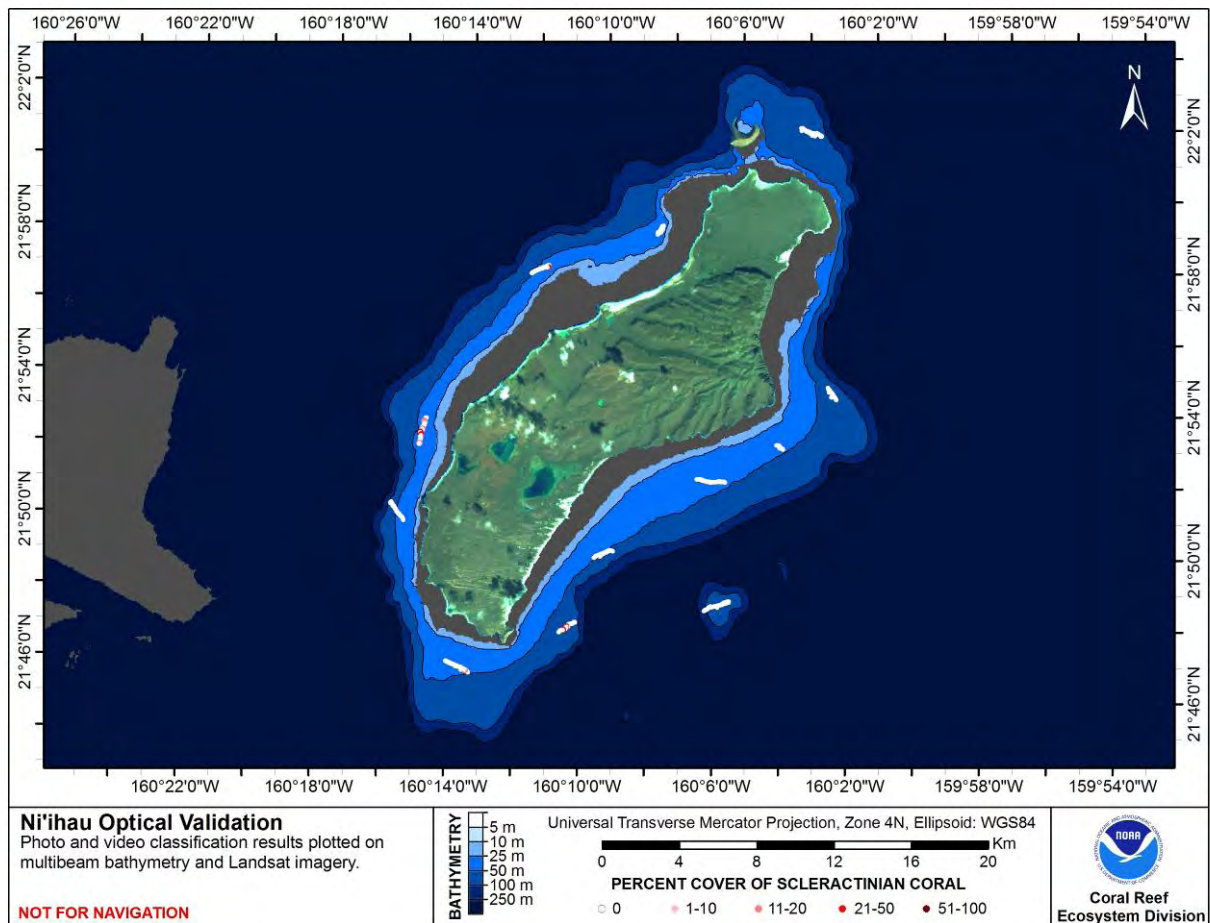


Figure 3. Percent cover of Scleractinian coral at Ni’ihau.

Task 2: Support Collection and Processing of Data in Hawaiian Waters

Subtask 2.1: Multibeam Bathymetry and Acoustic Imagery Data

No mapping cruises in the Hawaiian Archipelago are scheduled in 2007, but three cruises to Wake, Guam, and the Commonwealth of the Northern Mariana Islands were supported by PIBHMC staff from April 19 to June 9, 2007. Draft maps from these cruises are also posted on the website. It should be noted that three later cruises mentioned in the March 2007 CEROS report will not include any mapping component and have thus been removed from our operations list.

Table 1: 2007 Ship and Launch Operations

	Begin Date	End Date	Sea-Days
NOAA Ship <i>Hi'ialakai</i>			
HI0701 – Wake Island, transit to Saipan	4/19/07	5/9/07	20
HI0702 – S. Mariana Archipelago	5/12/07	5/22/07	11
HI0703 – N. Mariana Archipelago	5/25/07	6/09/07	16
R/V <i>AHI</i>			
AHI0701 – Wake Island	4/19/07	5/9/07	20
AHI0702 – S. Mariana Archipelago	5/12/07	5/22/07	11
AHI0703 – N. Mariana Archipelago	5/25/07	6/09/07	16

Subtask 2.2: Ground-Truth Data

Maps showing the location of optical validation data collected via underwater camera sled have been developed for Ni'ihau (Figure 3), Kaua'i, Moloka'i, and O'ahu. These maps, the attributed ArcGIS shapefiles used to generate them, and associated metadata are available to the public on the PIBHMC website. Data in the shapefile attribute tables include the full suite of classifications listed in the PIBHMC benthic habitat classification scheme. All of the available ground truth data for the Hawaiian Archipelago were classified according to the PIBHMC Benthic Habitat Classification Scheme by the end of December 2006. As discussed in the March 2007 CEROS report, PIBHMC analysts are now going back through PIBHMC's stock of optical validation videos to count motile fauna that can be seen.

Task 3: Develop Data Processing and Analysis Methods and Data Products

Table 2 (at the end of this document) presents a summary of PIBHMC milestones that were included in our original proposal to CEROS.

Subtask 3.1: Data Processing and Analysis Methods

Work continues on analyzing the applicability of various habitat analysis methods with particular emphasis this quarter on evaluating various measures of benthic complexity or rugosity and the occurrence of motile fauna.

In addition, French Frigate Shoals banktop data are now being analyzed to differentiate between hard and soft substrates, to quantify rugosity, and to identify areas of sand and pinnacles.

Subtask 3.2: Data Products

Data products resulting from the development of processing and analysis methods covered under this project include maps and ArcGIS layers characterizing the geomorphology of insular shelves. These have been discussed in previous section of this report, and samples of some of them are seen in Figures 1, 2, and 3 above.

Task 4: Establish Means for Data Dissemination

Subtask 4.1: Data Publication

A major effort is underway to upgrade and update the PIBHMC website with bathymetry, backscatter, optical and benthic habitat products and to ensure that all web pages are consistent and coherent. A new format for backscatter web pages is under development.

PIBHMC scientists were co-authors on the following publication during this past quarter:

J. Maragos¹, J. Miller², J. Gove³, E. DeMartini³, A. Friedlander⁴, S. Godwin⁵, C. Musburger⁶, M. Timmers³, R. Tsuda⁷, P. Vroom³, E. Flint², E. Lundblad³, J. Weiss³, P. Ayotte⁸, E. Sala⁹, S. Sandin¹⁰, S. McTee⁷, T. Wass³, R. Brainard¹⁰, D. Obura¹¹, S. Ferguson¹¹, and B. Mundy⁴ (submitted) U.S. atolls and low reef islands in the Line and Phoenix Islands, Central Pacific Ocean. In: Riegl B, Dodge RE (eds) Coral Reefs of the USA. Springer, Berlin.

¹ Pacific Remote Islands National Wildlife Refuge Complex, U.S. Fish and Wildlife Service, 300 Ala Moana Blvd., Rm. 5-231, Box 50167, Honolulu, HI 96850

² University of Hawai'i Joint Institute for Marine and Atmospheric Research, c/o Coral Reef Ecosystem Division NOAA Pacific Islands Fisheries Science Center, 1125 B. Ala Moana Blvd., Honolulu, HI 96814

³ NOAA Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, HI 96822-2396

⁴ NOAA/NOS/NCCOS/CCMA-Biogeography Branch and Oceanic Institute, Makapu'u Pt., 41-202 Kalaniana'ole Hwy. Waimanalo, HI 96795

⁵ Hawai'i Institute of Marine Biology, University of Hawai'i, P.O. Box 1346, Kaneohe, HI 96744-1346

⁶ Department of Zoology, University of Hawai'i, 2538 McCarthy Mall, Honolulu, HI, 96822

⁷ Natural Sciences, Bernice P. Bishop Museum, 1525 Bernice St., Honolulu, HI, 96817-2704

⁸ Marine Sciences Department, University of Hawai'i, 200 W. Kawili St., Hilo, HI, 96720

⁹ Center for Marine Biodiversity and Conservation, Scripps Institution of Oceanography, La Jolla, CA 92093

¹⁰ Coral Reef Ecosystem Division, NOAA Fisheries Service, Pacific Islands Fisheries Science Center, 1125 B. Ala Moana, Blvd., Honolulu, HI, 96814

¹¹ CORDIO East Africa, 8/9 Kibaki Flats, Kenyatta Public Beach, P.O. Box 10135, Mombasa 80101, Kenya

Subtask 4.2: Data Dissemination

As discussed previously, MHI bathymetry data collected by PIBHMC have been cleared for dissemination and are included in the HMRG website mentioned above. Swath bathymetry data are being prepared for submission to the National Geophysical Data Center.

Subtask 4.3: Outreach and Education

PIBHMC's primary venue for education and outreach during this period was the Center's website. We also routinely field telephone and email questions and requests for data.

After completion of cruises in CNMI and Guam, PIBHMC scientists visited management agencies on Saipan and Guam to present draft bathymetric maps to collaborating scientists. These draft maps can be downloaded from the PIBHMC website (see PIBHMC News – MARAMP 07 Draft Bathymetry Maps). A copy of these maps and posters was also presented to Mr. Pete Tenario, who is the CNMI Representative to the U.S. Congress.

Task 5: Develop Schedule of Fees for Support on Cruises of Opportunity

This task was completed in the 1st quarter of 2005. This schedule of fees is available on the website at http://www.soest.hawaii.edu/PIBHMC/pibhmc_price.htm.

Task 6: Coordinate NOAA's Mapping in the U.S. Pacific Islands

The PIBHMC/NMSP/Hawaii Institute of Marine Biology (HIMB) project to the Pacific Region Integrated Data Enterprise (PRIDE) to analyze and evaluate estimated depth algorithms for use in extracting depth information from IKONOS imagery is underway and the data are currently being analyzed.

Prior to the cruises in CNMI and Guam, Joyce Miller worked with representatives from multiple management agencies (the Environmental Protection Agency, NOAA's Pacific Islands Regional Office, the U.S. Fish and Wildlife Service, the National Park Service, Guam's Division of Aquatic and Wildlife Resources, as well as CNMI's Division of Fish and Wildlife, Division of Environmental Quality, Coastal Resources Management, and the Commonwealth Port Authority) to prioritize mapping targets in CNMI and Guam. Inputs were gathered from all agencies and, with the agreement of local managers, the limited mapping time was allocated to highest priority projects. With the exception of Apra Harbor, which by itself would have required more mapping time than was allocated for the R/V *AHI* mapping work, all requests by local and federal managers were fulfilled.

During the cruises, Joyce Miller and Scott Ferguson worked with personnel from the Office of Coast Survey (OCS) to perform nautical charting surveys in the harbors at Rota, Saipan, and Tinian. The R/V *AHI* was used to perform these surveys to nautical charting standards. In May two OCS scientists spent a week in Honolulu in order to certify that the survey system aboard

the vessel could produce data to OCS and International Hydrographic Organization (IHO) standards. Three OCS personnel met the *AHI* in Rota and worked with PIBHMC personnel to carry out surveys to IHO standards at Rota, Saipan, and Tinian harbors over the next two weeks. Meetings with the CNMI harbormaster and the U.S. Coast Guard were held to discuss progress and preliminary results. The Saipan harbor survey was OCS' top priority for completion this year and OCS has committed to production of updated charts within 90 days of survey completion.

Following this cruises series, Dr. Rusty Brainard and Scott Ferguson were contacted by representatives of the U.S. Navy to discuss the multibeam, biological, and oceanographic data collected by PIBHMC around Guam and CNMI. Because there is a major effort to expand Dept. of Defense facilities in Guam and CNMI, the Navy is interested in all data collected in the area since PIBHMC's mapping and monitoring cruises began in 2003. Discussions with the Navy are continuing with regards to the possibility of accelerating processing of data and preparation of a comprehensive ecosystem monitoring report.

Task 7: Reports and Program Reviews

Subtask 7.1 Quarterly Reports

This document is prepared to fulfill the requirement for the quarterly report for the quarter ending June 30, 2007.

Previous reports: DEC 2004 (for the period 16-31 Dec 2004)
 MAR 2005 (for the period Jan. 1-Mar. 31, 2005)
 JUN 2005 (for the period Apr. 1- Jun. 30, 2005)
 SEP 2005 (for the period Jul. 1 – Sept. 30, 2005)
 DEC 2005 (for the period Oct. 1– Dec, 2005)
 MAR 2006 (for the period Jan. 1-Mar. 31, 2006)
 JUN 2006 (for the period Apr. 1 – Jun. 30, 2006)
 SEP 2006 (for the period July 1 – Sept. 30, 2006)
 DEC 2006 (for the period Oct. 1– Dec, 2006)
 MAR 2007 (for the period Apr. 1 – Jun. 30, 2007)

Patents, Trademarks, Copyrights and Publications

No patents, trademarks, copyrights and publications have been developed as a result of the work in this quarter.

PART II: SCHEDULE

At this time, there are no anticipated scheduling problems.

PART III: PROBLEMS

One of the six primary PIBHMC staff members, Joe Chojnacki, accepted a job with the NWHI Marine National Monument. We are currently recruiting for two additional personnel. Because Joe was one of two PIBHMC personnel working with our optical data, some delay in production of optical data outputs is anticipated.

Processing of backscatter data from Kure and Pearl and Hermes will not be completed until approximately November 2007 for two reasons: 1) Extensive reprocessing of the bathymetry data, which must be finalized in order to process backscatter data, was required after the cruise; 2) The October 2007 cruise was moved forward by six months and required that the mapping personnel who would have been working on the Kure and Pearl and Hermes backscatter data were involved in this cruise.

PART IV: FINANCIAL STATUS

The UH Office of Research Services has invoiced CEROS for the initial payment that was due on contract execution, and for the quarterly periods ending DEC 2004, MAR 2005, JUN 2005, SEP 2005, DEC 2005, MAR2006, JUN2006, SEP2006, and DEC2006, MAR2007). An invoice for this quarter (JUN 2007) is being issued with this report.

Table 2: PIBHMC Milestones and Status

Orig. Date	Year	Milestone Description	Comp. Date	On Website?
10	2004	Multibeam acquisition: NWHI coral bleaching and mapping survey	6/7/05	Yes
7	2005	Multibeam acquisition: Ocean Exploration survey	7/7/05	Yes ¹
8	2005	Multibeam acquisition: MHI RAMP survey	8/13/05	Yes ²
8	2005	Multibeam acquisition: NWHI deep water multibeam survey	10/31/05	Yes
10	2005	Multibeam acquisition: Oahu shallow water multibeam system	7/7/05	No ³
12	2005	Complete inventory of data accessible via PIBHMC web site ??	12/31/05	Yes
12	2005	Develop and publish seafloor classification based on TPI	12/31/05	Yes
12	2005	Document all methods on PIBHMC website	12/31/05	Yes
12	2005	Update the existing NWHI bathy atlas to include data collected since the publication of the atlas	12/31/05	Yes
12	2005	Develop and publish bathymetry and backscatter imagery methods	12/31/05	Yes
12	2005	Develop and publish optical imagery (towed camera and video) methods	12/31/05	Yes
12	2005	Develop and publish gridding and charting methods	12/31/05	Yes
12	2005	Develop and publish diver observation methods	12/31/05	Yes
12	2005	Develop and publish methods for ingestion of layers into GIS	6/30/06	Yes
12	2005	Develop and publish a schedule of equipment and personnel costs for surveys of opportunity	12/31/05	Yes
12	2005	Expand the existing atlas to provide coverage of the main HI	Underway	Underway
12	2005	Develop and publish analytical methods for seafloor classification based on Fourier analysis	12/31/05	Yes
12	2005	Develop inventory of available bathymetry and ecological data from public sources	12/31/05	Yes ⁴
12	2005	Hawaiian Atlas: chart set of bathy, backscatter and seabed bottom characteristics	12/31/05	Yes ⁵

Notes:

¹ Gridded data published on HMRG, rather than PIBHMC website.

² Gridded data published on HMRG, rather than PIBHMC website.

³ Proprietary data from privately-funded mapping program

⁴ Initial development is done; synthesis will continue as new data sets become available

⁵ Initial development is done; synthesis will continue as new data sets become available

Figure 6: Task Timeline

	D e c	M a r	J u n	S e p	D e c	M a r	J u n	S e p	D e c	M a r	J u n	S e p
	2 0 0 4	2 0 0 5	2 0 0 5	2 0 0 5	2 0 0 5	2 0 0 6	2 0 0 6	2 0 0 6	2 0 0 6	2 0 0 7	2 0 0 7	2 0 0 7
Task 1: Create an Inventory of Benthic Habitat Maps and Data												
Task 2: Support Collection and Processing of Data in Hawaiian Waters												
Task 3: Develop Data Processing and Analysis Methods and Data Products												
Task 4: Establish Means for Data Dissemination												
Task 5: Develop Schedule of Fees for Support of Cruises of Opportunity												
Task 6: Coordinate NOAA's Mapping in the U.S Pacific Islands												
Task 7: Reports and Program Reviews												

Appendix B

**JIMAR Quarterly Report
For Period Ending 30 September 2007**

Quarterly and Final Report for Period Ending
September 30, 2007

Benthic Habitat Mapping Support for
National Oceanic and Atmospheric Administration
Activities in the Hawaiian Archipelago and
Other U.S. Pacific Island Areas

A Contract Between:

CEROS – National Defense Center of
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And

University of Hawaii’s Joint Institute
For Marine and Atmospheric Research

Dr. Bruce Appelgate, Principal Investigator



Quarterly and Final Report – September 30, 2007

Benthic Habitat Mapping Support for National Oceanic and Atmospheric Administration Activities in the Hawaiian Archipelago and Other U.S. Pacific Island Areas

This report is submitted in partial fulfillment of the requirements of the contract entitled “Benthic Habitat Mapping Support for National Oceanic and Atmospheric Administration Activities in the Hawaiian Archipelago and Other U.S. Pacific Island Areas” between the Natural Energy Laboratory of Hawaii National Defense Center of Excellence for Research in Ocean Sciences (CEROS) and the University of Hawaii under the direction of Dr. T. Bruce Appelgate, principal investigator for this project from the Joint Institute of Marine and Atmospheric Research. This report documents the following: (1) progress to date under each task listed under the contract’s Scope of Services, patents, trademarks, copyrights and publications; (2) schedule; (3) problems; and (4) financial status. This 12th quarter and final report documents the progress between June 30 and Sept. 30, 2007 and briefly reviews the entire project.

PART (I): PROGRESS UNDER EACH TASK

Task 1: Create an Inventory of Benthic Habitat Maps and Data

Subtask 1.1: Benthic Habitat Maps and Data

Primary efforts at PIBHMC over the past quarter have been focused on preparing previously collected backscatter and optical data for the website. Bathymetric grids have been updated for the NWHI to incorporate all data collected during cruises in 2006. Backscatter data for Maro Reef and Kure Atoll have been posted on our website using a new format for backscatter data display. A new product type with viewable images linked to data location was developed and posted on www.soest.hawaii.edu/pibhmc for the French Frigate Shoals optical data (Figure 1).

In the course of the CEROS contract, PIBHMC has developed a number of benthic habitat layers and products that are available for integration into a Geographic Information System (GIS).

These include:

- Multibeam bathymetry at all islands and banks in the NWHI
- Backscatter imagery products at FFS, Maro Reef, and Kure Atoll (Figure 2)
- Optical validation data at FFS, Maro Reef, Lisianski Island, Laysan Island, Pearl and Hermes
- Geomorphology layers at FFS, including slope, rugosity, and Bathymetric Position Index (BPI) structures and zones.

PIBHMC is currently developing a GIS template for FFS with all of the above-mentioned layers integrated into an ArcGIS project that can be downloaded from the web or from a CD/DVD.

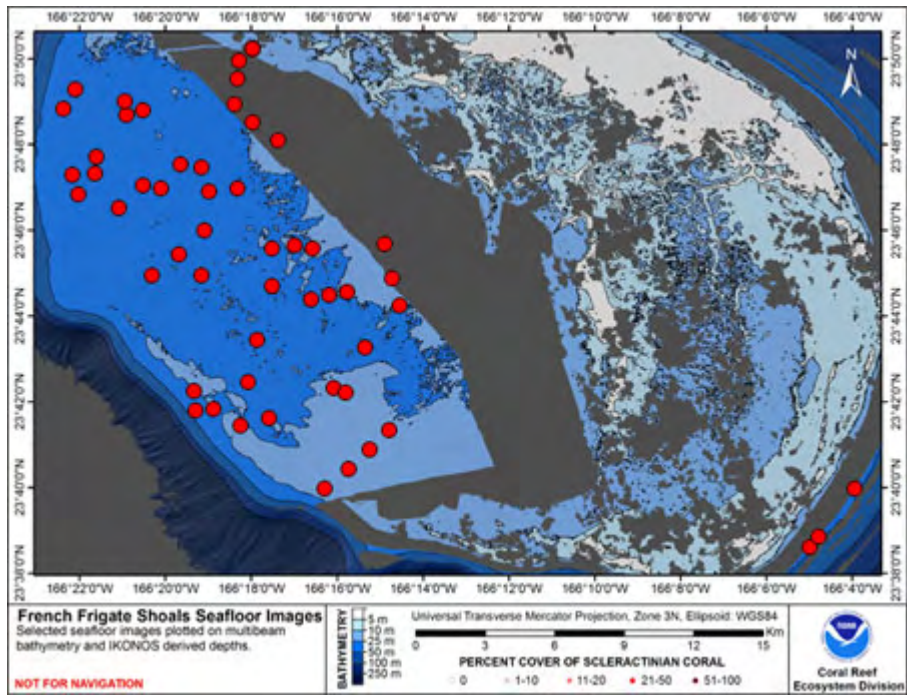


Figure 1: Locations of FFS photographs that can be viewed on PIBHMC web site.

Figure 2: Backscatter data for Kure Atoll

Subtask 1.2: Northwestern Hawaiian Island (NWHI) Bathymetric Atlas

The original NWHI bathymetric atlas was printed in 2002 using financial support from the NWHI Coral Reef Ecosystem Reserve. As part of the CEROS work over the past three years, a web interface for digital dissemination of additional NWHI bathymetric data has been developed and each year a major update of the NWHI synthesis has been posted. All data collected to date in the NWHI are available on the PIBHMC website in netCDF and ARC Ascii formats and have also been submitted to the National Geophysical Data Center (NGDC) in Generic Sensor Format (GSF). Metadata have been generated for all data submissions.

We have also prepared a “Hawaiian Archipelago Map Collection” that includes data collected by PIBHMC from both the NWHI and the Main Hawaiian Islands (MHI). The map collection is similar in format to “The American Samoa Map Collection” and the “Mariana Archipelago Map Collection”, both of which are available through the website. These documents are available for download in pdf format.

The directors of NOAA’s Pacific Islands Fisheries Science Center and Hawaii’s Department of Land and Natural Resources/Division of Aquatic Resources (DLNR/DAR) have agreed that all multibeam data collected by PIBHMC in the MHI can be released two years after data collection. 2005 MHI data have been submitted to NGDC. MHI data collected in 2006 will be submitted to NGDC in 2008. All released PIBHMC MHI data are available through the HMRG website at <http://www.soest.hawaii.edu/hmrg/multibeam/index.php>. Unreleased data are accessible to permitted users via a password-protected page on the same site.

Subtask 1.3: Geographic Information System (GIS)

As discussed in Section 1.1 all PIBHMC data are available in formats compatible with ArcGIS. An ArcGIS project using ArcReader is currently under development; this pilot benthic habitat project at FFS will include all data layers currently available from the PIBHMC website. The user or resource manager will be provided with an easy-to-use interface and the ability to look at a variety of map layers (e.g. backscatter, rugosity, slope, depth, optical properties) that can be combined in different ways to delineate the suite of habitat characteristics unique to the individual species or groups of species of interest.

Task 2: Support Collection and Processing of Data in Hawaiian Waters

Subtask 2.1: Multibeam Bathymetry and Acoustic Imagery Data

Under this CEROS contract, it was originally proposed that PIBHMC would support 150 mapping and/or processing days per year in the Hawaiian Archipelago for each of two years. Because of ship scheduling changes that were not under the control of the mapping center, it was necessary to extend the contract by one year in order to fulfill this operational obligation.

PIBHMC also supported a number of mapping operations in the Territory of American Samoa, the Mariana Archipelago, and the Pacific Remote Island Areas (PRIA). Table 1 presents a summary of multibeam cruises supported by PIBHMC during the CEROS project period, including cruises in areas other than the Hawaiian Archipelago. In addition to the operational days shown in Table 1, data were processed continuously over the three year period; thus the number of mapping and processing days far exceeded the original estimate of 300 days of mapping and processing efforts.

Table 1: Cruises supported by PIBHMC between FY2005 and FY2008. Numbers in parentheses indicate cruises outside of the Hawaiian Archipelago.

Year	Cruise	Areas	Ship Days	AHI Days
2005	Testing	San Francisco	5	
	Testing	Honolulu	1	
	HI0501	NWHI, FFS, Brooks Bank	20	10
	HI0503	NWHI, FFS, Maro, P&H, Midway, Kure	24	
	HI0504	MHI, Ni'ihau, Moloka'i, Penguin Bank	25	23
	HI0505	MHI, Maui, Kaua'i	21	
	HI0508	NWHI, Maro Reef	21	7
2006	HI0601	PRIA, Johnston, Howland, Baker	(23)	(9)
	HI0602	Am. Samoa, Tutuila, Rose, Swains, 2% Bank, Northeast Bank	(22)	(22)
	HI0604	PRIA, Palmyra, Jarvis, Kingman	(26)	(13)
	HI0605	MHI, Penguin Bank, Molokai, Lanai, Kohala	19	10
	HI0609	NWHI, Pearl and Hermes, Kure	27	19
	HI0612	NWHI, Brooks Banks, West Nihoa	21	5
	HI0613	MHI, West Maui	5	
2007	HI0701	Wake Island	(20)	(2)
	HI0702	Guam, Rota, Saipan, Tinian, Agrihan	(11)	(11)
	HI0703	N. Mariana Islands	(16)	(16)
		Mapping Days – Hawaiian Archipelago	189	74
		Mapping Days – PRIA, Am. Samoa, CNMI/Guam	(118)	(73)
		Total Mapping Days – Pacific-wide	307	147

Table 2 presents a summary of the amount of multibeam mapping that has been done by PIBHMC since the beginning of mapping efforts in 2002 and 2003.

Table 2: Summary of multibeam sonar data collected by PIBHMC throughout the Pacific.

Area	Years	Moderate Depth (15-200 m) (sq. km)	Moderate Depth Percent Covered	Deep Coverage >200 m (sq. km)
NWHI	2002-2006	3,338/12,167	28%	38,367
MHI	2005-2006	3,018/5,430	95%	n/a
CNMI/Guam	2003, 2007	400/464	86%	12,695
Am. Samoa	2004, 2006	410/410	100%	975
PRIAs	2006	100/121	82%	4,300
Totals		7,266/18,592	39%	56,337

Multibeam mapping, particularly in the NWHI, will continue in the future with support and cooperation from NOAA’s Coral Reef Conservation Program and the Papahānaumokuākea Marine National Monument. The primary determinant of expected productivity is that there are approximately 30 days/year of shiptime available on the NOAA ship *Hi’ialakai* to support mapping cruises, based upon current operational schedules. At this rate of effort, it is estimated that it will take approximately 10 more years to complete moderate depth mapping in the NWHI.

Subtask 2.2: Ground-Truth Data

A new interactive map that allows the user to view optical data has been developed for FFS (Figure 1). This map, the attributed ArcGIS shapefiles used to generate it, and associated metadata are available to the public on the PIBHMC website.

All of the available ground truth data for the Hawaiian Archipelago were classified according to the PIBHMC Benthic Habitat Classification Scheme by the end of December 2006 and have been posted on the website. As discussed in the March 2007 CEROS report, PIBHMC analysts are now going back through PIBHMC’s stock of optical validation videos to count motile fauna that can be seen.

Task 3: Develop Data Processing and Analysis Methods and Data Products

Subtask 3.1: Data Processing and Analysis Methods

In this quarter work has continued to analyze French Frigate Shoals banktop data and to differentiate between hard and soft substrates, to quantify rugosity, and to identify areas of sand and pinnacles.

Over the course of the CEROS contract, data processing and analysis methods have been developed to efficiently process bathymetry, backscatter, and optical data.

- Bathymetric data are processed using commercial and publicly-available software and are routinely posted on the PIBHMC website within 6 months of data collection.
- Backscatter data processing methods have been developed by PIBHMC and HMRG to process and integrate data from three different sonars: Reson 8101ER (*AHI*), Simrad EM300 and EM3002 (*Hi'ialakai*). In general, backscatter data are made available within one year of data collection.
- Optical data are processed using a classification scheme and methods developed by PIBHMC personnel. Data classifications are entered into spreadsheets that are then converted to ArcGIS shapefiles. In the course of the CEROS contract a significant backlog of optical data has been cleared; classifications of all optical data collected by PIBHMC to date are available on our website.
- Benthic habitat data include derived bathymetry layers including slope, rugosity, and Bathymetric Position Index. This suite of products has been developed for FFS in the NWHI and Tutuila in American Samoa. Future work will include production of these layers for all areas where high resolution bathymetric data exist.
- Benthic habitat data also include integrated data analysis products currently still under development using ENVI. Work is currently underway to integrate bathymetry data and derivatives, backscatter data and classified optical data and to produce interpretative maps showing hard/soft and/or sand/non-sand classifications.

Descriptions of all PIBHMC methods have been published on the website.

Subtask 3.2: Data Products

A variety of products are available for download on the PIBHMC website including:

- Bathymetry data gridded at 5, 20, and 60 m grid cell size with metadata and jpeg images.
- Backscatter data gridded at 1, 5, and 30 m grid cell size with metadata and jpeg images.
- Classified tracks of optical data with metadata and, in some instances, linked photo or video images.
- Derived bathymetry grids of slope, rugosity, and bathymetric position index with metadata and jpeg images.
- (Under development) ArcGIS Reader projects that integrate the above data products.

Task 4: Establish Means for Data Dissemination

Subtask 4.1: Data Publication

During this quarter, Joyce Miller gave a presentation, “The Geomorphology, Habitats, and Mapping of the Hawaiian Archipelago at the Hawaiian Archipelago Marine Ecosystem Research meeting on August 14, 2007. It is posted on the PIBHMC website.

Over the course of this project, PIBHMC scientists have presented, published or been co-authors on the following:

- Peer-reviewed literature:

- Rooney, J., Wessel, P., Hoeke, R., Weiss, J., Baker, J., Parrish, F., Fletcher, C. Chojnacki, J., Garcia, M.O., Vroom, P., (in review) Geology and geomorphology of coral reefs of the Northwestern Hawaiian Islands. In: Riegl B, Dodge RE (eds) Coral Reefs of the USA. Springer, Berlin
- J. Miller, S. Vogt, R. Hoeke, S. Ferguson, B. Appelgate, J.R. Smith, and M. Parke, “Bathymetric atlas and website for the Northwestern Hawaiian Islands” Northwestern Hawaiian Islands, Third Scientific Symposium, Nov. 2-4, 2004. Published by the National Museum of Natural History, Smithsonian, Atoll Research Bulletin no. 543, pp. 391-408.
- Lundblad et al., 2006, A benthic terrain classification scheme for American Samoa, Marine Geodesy, 29(2):89 - 111.
- J. Maragos, J. Miller, J. Gove, E. DeMartini, A. Friedlander, S. Godwin, C. Musburger, M. Timmers, R. Tsuda, P. Vroom, E. Flint, E. Lundblad, J. Weiss, P. Ayotte, E. Sala, S. Sandin, S. McTee, T. Wass, R. Brainard, D. Obura, S. Ferguson, and B. Mundy (submitted) U.S. atolls and low reef islands in the Line and Phoenix Islands, Central Pacific Ocean. In: Riegl B, Dodge RE (eds) Coral Reefs of the USA. Springer, Berlin.
- Fletcher, C.H., Conger, C.L., Engels, M., Field, M., Grossman, E.E., Harney, J.N., Murray-Wallace, C., Rooney, J.J., Rubin, K., (in review) Complex origin and structure of the Oahu carbonate shelf: Hawaiian Islands. In: Riegl B, Dodge RE (eds) Coral Reefs of the USA. Springer, Berlin
- Fletcher, C.F., Engels, M.E., Grossman, E.G., Harney, J.N., Rooney, J.J., Sherman, C.E., Glenn, C.R., Rubin, K., Murray-Wallace, C.V., Edwards, L., Simmons, K.S. (submitted) Reef system of Oahu, Hawaiian Islands: Origin, stratigraphy, and geologic processes. Quaternary Science Reviews.
- Conger, C.L., Fletcher, C.H., Hochberg, E.J., Frazer, N., Rooney, J.J., (accepted). Patterns of sand distribution across fringing reefs on Oahu, Hawaii. Marine Geology.
- Genz, A.S., Fletcher, C.H., Dunn, R.A., Frazer, L.N., and Rooney, J.J., 2007. The Predictive Accuracy of Shoreline Change Rate Methods and Alongshore Beach Variation on Maui, Hawaii. Journal of Coastal Research, 23:87-105
- J. Miller, contributing author, The State of Coral Reef Ecosystems of the Commonwealth of the Northern Mariana Islands, in the State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005.
- Contributing authors on seven chapters for the Hawaiian Archipelago, American Samoa, Mariana Archipelago, and the Pacific Remote Island Areas for upcoming publication of the State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2008.
- Contributing authors on all chapters of the American Samoa Monitoring Report, in preparation for publication Dec. 2008 (530 pp). Coral Reef Ecosystem Division, Pacific Islands Fisheries Science Center.
- Fletcher C.H., Engels M., Grossman, E.G., Rooney, J.J., Sherman, C.E. (2006) /Decoding the geologic record of Holocene sea-level change in the Hawaiian Islands/. Geological Society of America 2006 Fall Meeting. Philadelphia, Pennsylvania, October 22-26, 2006.

- Fifteen cruise reports, now available from the Pacific Islands Fisheries Science Center website at www.pifsc.noaa.gov.
- Seventeen presentations, given at various conferences and meetings available for download at the PIBHMC website.

Subtask 4.2: Data Dissemination

The major avenue for data dissemination is through our PIBHMC website, where bathymetry, backscatter, optical, and benthic habitat data are routinely posted. In addition, all multibeam swath data are regularly submitted to the National Geophysical Data Center, which is the U.S. entity that is tasked to provide a permanent archive for geophysical data. FGDC compliant metadata are submitted for all PIBHMC data products.

Subtask 4.3: Outreach and Education

PIBHMC personnel have participated in a variety of education and outreach activities between 2005 and 2008 including:

- Presentations in 2004, 2005, and 2006 at GIS Day functions, including an invited talk in Kona, Hawaii in 2006. In addition a presentation was given at the 2006 ESRI national meeting in California.
- Regular attendance at regional meetings such as the ESRI Hawaii Regional Group Users meetings and the Hawaii Integrated Geographic Information Systems Coordinating Council (HIGCC).
- Presentations in 2005 and 2006 at the Thursday night lecture series at Hanauma Bay.
- Three presentations and posters at Oceans 2006, Honolulu, Hawaii.
- Teaching an upper-division and graduate-level course at the University of Hawaii, GG710 Remote Sensing In Marine Environments.
- Frequent meetings with management and scientific personnel from the Hawaii Institute of Marine Biology, the Papahānaumokuākea Marine National Monument, and the Hawaii Dept. of Land and Natural Resources to discuss needs for benthic habitat maps.
- Providing at-sea multibeam training opportunities for personnel from the USFWS, NOAA's National Marine Sanctuaries Program, NOAA's Pacific Islands Regional Office.
- Organizing and participating in tours of research vessels for Pacific Islands students.

Task 5: Develop Schedule of Fees for Support on Cruises of Opportunity

This task was completed in the 1st quarter of 2005. This schedule of fees is available on the website at http://www.soest.hawaii.edu/PIBHMC/pibhmc_price.htm.

Task 6: Coordinate NOAA's Mapping in the U.S. Pacific Islands

During the course of this contract, PIBHMC personnel have taken an active role in coordinating NOAA's mapping efforts in the U.S. Pacific Islands. These activities include:

- Attendance and presentations at meetings held by NOAA's Integrated Ocean and Coastal Mapping group in New Hampshire, Silver Springs, Boulder and Seattle.
- Working with NOAA's Biogeography Program in 2007 to produce an update to the 2003 Pacific Moderate Depth Mapping Implementation Plan.
- Working with University of Hawaii personnel from the Hawaii Mapping Research Group and the Hawaii Undersea Research Laboratory to coordinate multibeam mapping in the MHI and the NWHI. Participation in HMRG/HURL cruise to finish mapping around the Big Island of Hawaii.
- Mapping of priority sites at Penguin Bank and Kohala, Hawaii, in collaboration with scientists from the Humpback Whale National Marine Sanctuary.
- Regular consultation with personnel from the Papahānaumokuākea Marine National Monument to prioritize mapping in the NWHI and to plan cruises.
- Regular communication with NOAA's Office of Coast Survey (OCS) regarding planned mapping activities. This collaboration resulted in joint PIBHMC/OCS surveys in Saipan, Tinian, and Rota Harbors in early 2007.
- Consultation with the U.S. Navy and the Military Sealift Command in 2005 to provide an assessment of the Saipan Garapan Anchorage area.
- Consultation with the U.S. Navy in 2007 regarding possible work in Apra Harbor in Guam to accelerate production of mapping and monitoring data.
- Consultation with representatives from the USFWS, EPA, NPS, and local agencies in Guam, CNMI, and American Samoa to establish mapping priorities throughout the region.
- Consultation from a variety of NOAA offices, including the Pacific Islands Fisheries Science Center, the Pacific Islands Regional Office, the Western Pacific Fisheries Management Council, the National Marine Sanctuaries Program, and the Coral Reef Conservation Program to establish mapping priorities throughout the region.

Task 7: Reports and Program Reviews

Subtask 7.1 Quarterly Reports

This document is prepared to fulfill the requirement for the quarterly report for the quarter ending June 30, 2007.

Previous reports: DEC 2004 (for the period 16-31 Dec 2004)
 MAR 2005 (for the period Jan. 1-Mar. 31, 2005)
 JUN 2005 (for the period Apr. 1- Jun. 30, 2005)
 SEP 2005 (for the period Jul. 1 – Sept. 30, 2005)
 DEC 2005 (for the period Oct. 1– Dec, 2005)
 MAR 2006 (for the period Jan. 1-Mar. 31, 2006)
 JUN 2006 (for the period Apr. 1 – Jun. 30, 2006)
 SEP 2006 (for the period July 1 – Sept. 30, 2006)
 DEC 2006 (for the period Oct. 1– Dec. 31, 2006)
 MAR 2007 (for the period Mar 1 – Mar. 31, 2007)
 JUN 2007 (for the period Apr 1 – Jun. 30, 2007)

Patents, Trademarks, Copyrights and Publications

No patents, trademarks, copyrights and publications have been developed as a result of the work

PART II: SCHEDULE

All milestones and obligations under this contract have been completed.

PART III: PROBLEMS

Processing of backscatter data from Pearl and Hermes is currently underway, but will not be completed until approximately December 2007 for two reasons: 1) Extensive reprocessing of the bathymetry data, which must be finalized in order to process backscatter data, was required after the cruise; 2) The October 2007 cruise was moved forward by six months and required that the mapping personnel who would have been working on the Kure and Pearl and Hermes backscatter data were involved in this cruise.

PART IV: FINANCIAL STATUS

The UH Office of Research Services has invoiced CEROS for the initial payment that was due on contract execution, and for the quarterly periods ending DEC 2004, MAR 2005, JUN 2005, SEP 2005, DEC 2005, MAR2006, JUN2006, SEP2006, and DEC2006, MAR2007, and JUN2007. A final invoice for this quarter (SEP 2007) is being issued with this report.

***Should we remove Table 3 and just use the summary table (Table 4) that Bruce and I created for the summary submission???

Table 3: PIBHMC Milestones and Status

Orig. Date	Year	Milestone Description	Comp. Date	On Website?
10	2004	Multibeam acquisition: NWHI coral bleaching and mapping survey	6/7/05	Yes
7	2005	Multibeam acquisition: Ocean Exploration survey	7/7/05	Yes ¹
8	2005	Multibeam acquisition: MHI RAMP survey	8/13/05	Yes ²
8	2005	Multibeam acquisition: NWHI deep water multibeam survey	10/31/05	Yes
10	2005	Multibeam acquisition: Oahu shallow water multibeam system	7/7/05	No ³
12	2005	Complete inventory of data accessible via PIBHMC web site ??	12/31/05	Yes
12	2005	Develop and publish seafloor classification based on TPI	12/31/05	Yes
12	2005	Document all methods on PIBHMC website	12/31/05	Yes
12	2005	Update the existing NWHI bathy atlas to include data collected since the publication of the atlas	12/31/05	Yes
12	2005	Develop and publish bathymetry and backscatter imagery methods	12/31/05	Yes
12	2005	Develop and publish optical imagery (towed camera and video) methods	12/31/05	Yes
12	2005	Develop and publish gridding and charting methods	12/31/05	Yes
12	2005	Develop and publish diver observation methods	12/31/05	Yes
12	2005	Develop and publish methods for ingestion of layers into GIS	6/30/06	Yes
12	2005	Develop and publish a schedule of equipment and personnel costs for surveys of opportunity	12/31/05	Yes
12	2005	Expand the existing atlas to provide coverage of the main HI	9/30/07	Yes ¹
12	2005	Develop and publish analytical methods for seafloor classification based on Fourier analysis	12/31/05	Yes
12	2005	Develop inventory of available bathymetry and ecological data from public sources	12/31/05	Yes ⁴
12	2005	Hawaiian Atlas: chart set of bathy, backscatter and seabed bottom characteristics	12/31/05	Yes ⁵

Notes:

- ¹ Gridded data published on HMRG, rather than PIBHMC website.
- ² Gridded data published on HMRG, rather than PIBHMC website.
- ³ Proprietary data from privately-funded mapping program
- ⁴ Initial development is done; synthesis will continue as new data sets become available
- ⁵ Initial development is done; synthesis will continue as new data sets become available

Table 4: CEROS/PIBHMC Tasks Milestones and Outcomes

Description	Milestone Description	% Complete	Description of Activities
Task 1: Create an inventory of benthic habitat maps and data	Complete inventory of data accessible via PIBHMC web site	100%	The NWHI and MHI multibeam synthesis has been routinely updated as new data have been collected.
Task 2: Support collection and processing of data in Hawaiian waters	Multibeam acquisition: NWHI coral bleaching and mapping survey	100%	In 2005 we completed surveys at FFS, Necker, Nihoa, Maro Reef, Pearl and Hermes, Kure, and Little Brooks Bank; in 2006, we surveyed at Kure, Pearl and Hermes, Brooks Banks, St. Rogatien, and W. Nihoa Bank. All bathymetry data have been published on PIBHMC and backscatter data from FFS and Maro Reef are also available.
Task 2	Multibeam acquisition: Ocean Exploration survey	100%	Joint Ocean Exploration surveys were conducted around Kauai, Niihau, Oahu, and Molokai during HI0504. Data are being published on HMRG and PIBHMC websites.
Task 2	Multibeam acquisition: MHI RAMP survey	100%	In 2005 we collected multibeam data near Hawaii, Maui and Kauai during the MHI RAMP cruise, HI0508. In addition we collected multibeam data at Penguin Bank, N. Molokai, Lanai, and Hawaii during 2006. MHI bathymetry data are currently available through HMRG website.
Task 2	Multibeam acquisition: NWHI deep water multibeam survey	100%	Deep water multibeam data were collected in the NWHI during HI0501, HI0503, HI0507, and HI0508 in 2005. Additional deep data were collected in 2006 on HI0609 and HI0612. All NWHI bathymetry data are published on web site and Data were collected for a commercial survey operation at two sites around Oahu. These data have not been published because they were commercial and proprietary.
Task 3: Develop data processing and analysis data methods and data products	Develop and publish seafloor classification based on TPI	100%	A TPI classification for the FFS multibeam data was prepared and published on PIBHMC web site. A web-based Habitat Mapping GIS module is currently under development and will be published as well.
Task 3:	Document all methods on PIBHMC website	100%	All methods are currently documented on PIBHMC website.
Task 4: Establish means for data dissemination	Update the existing NWHI bathy atlas to include data collected since the publication of the atlas	100%	Yearly updates are made as additional data are collected.
Tasks 3 & 4:	Develop and publish bathymetry and backscatter imagery methods	100%	All methods are currently documented on PIBHMC website.
Tasks 3 & 4:	Develop and publish optical imagery (towed camera and video) methods	100%	Optical imagery results are currently posted for Kure, Midway, Pearl and Hermes, French Frigate Shoals, Laysan, Lisianski, and Maro Reef. Linked photos are published at FFS. In the MHI optical imagery is posted for Niihau, Kauai, Oahu, and Molokai.
Tasks 3 & 4	Develop and publish gridding and charting methods	100%	All methods are currently documented on PIBHMC website.
Tasks 3 & 4	Develop and publish diver observation methods	100%	All methods are currently documented on PIBHMC website.
Tasks 3 & 4	Develop and publish methods for ingestion of layers into GIS	100%	All methods are currently documented on PIBHMC website.
Task 5: Develop schedule of fees for support of cruises of opportunity	Develop and publish a schedule of equipment and personnel costs for surveys of opportunity	100%	Equipment and personnel costs were published on the HMRG website.

Tasks 3 & 4	Expand the existing atlas to provide coverage of the main HI	100%	MHI data between 100 and 500 m depths are currently available from a password protected website at www.soest.hawaii.edu/hmrg .
Tasks 3 & 4	Develop and publish analytical methods for seafloor classification based on Fourier analysis	100%	All methods are currently documented on PIBHMC website. Various analytic techniques, including Fourier analysis, have been investigated for seafloor classification. The Dartnell technique for classification and recently released ENVI tools are currently being investigated.
Tasks 3 & 4	Develop inventory of available bathymetry and ecological data from public sources	100%	Inventory of bathymetric data is part of data synthesis. Ecological data sharing agreements are in place between NOAA, the State of Hawaii, the University of Hawaii, USFWS and other agencies.
Tasks 1, 3 & 4	Hawaiian Atlas: chart set of bathy, backscatter and seabed bottom characteristics	100%	Bathymetric and backscatter data are published for download on web.
Task 6: Coordinate NOAA's Mapping in the U.S. Pacific Islands	No specific milestones were associated with this task.	100%	PIBHMC participated in NOAA's Integrated Ocean and Coastal Mapping Group for the duration of this contract. Collaborative mapping was conducted with NOAA National Marine Sanctuaries, Ocean Exploration, Pacific Islands Regional Office, and Office of Coast Survey, and NURP; USFWS; NPS; USGS; State of Hawaii DLNR, University of Hawaii; and several local agencies in Guam, CNMI, and American Samoa.
Task 7: Reports and Program Reviews	Quarterly reports and reviews	100%	All required documents have been submitted to CEROS in the time frame required by the contract and bi-yearly reviews have been conducted.