

Hawaiian Islands – Mapping priorities for the period Sept 8 – Nov 15, 2009

References:

- A. NGDC Background ETOPO data; Sandwell and Smith global data compilation at 1 minute arc resolution.
- B. HRMG Hawaiian Island multibeam synthesis (HRMG Website) at 50 m resolution.
- C. Personal communication with local Hawaii scientists including Joyce Miller, Margo Edwards, Kayleen Keller, Scott Ferguson and Andy Collins.
- D. Submitted Cruise Instructions EX0909 Leg 1-4, August 2009.
- E. NOAA Nautical charts # 19007, 19010, 19004

Background

NOAA Ship Okeanos Explorer arrived in Honolulu, HI on 7 August, 2009. The ship is planning to stay and work in Hawaii till March / April 2009. In the schedule there were four cruises planned for FY 2009. A total of 77 days-at-sea (DAS) of mapping work has been dedicated to work in and around Hawaiian Islands during FY 2009. The first cruise (August 21-Sept 3, 2009) is being run currently. The purpose of this document is to synthesize the information available currently to OEAR to help decide the working grounds for next three cruises.

The primary objectives for these cruises are to test various ship's equipment and refine mapping sensors' operations and data processing protocols [D]. However, it was realized that as we test and refine mapping ops protocols, there is an opportunity to cover the areas that may be useful for later ROV testing, are critical to US ECS claim, and are priority areas for NOAA and other research / academic organizations.

On 20 August, 2009 EX mapping team met with Joyce Miller (soest.hawaii.edu/jimar/), Margo Edwards (soest.hawaii.edu/hmrg/index.php), John Rooney (soest.hawaii.edu/pibhmc/), Kayleen Keller and Andy Collins (<http://papahanaumokuakea.gov/>). These discussions brought to our attention additional data sets that are present around our intended working grounds [D] and also provided the information about the areas that are of interest to these local Hawaii scientists. Also local NOAA nautical charts [E] were studied carefully to select any interesting areas that can be used for mapping tests / ROV tests etc.

Mapping priorities proposed by local HI scientists (Note: Not all information is available as currently there is no internet available onboard)

1. Filling in holidays of HRMG multibeam data synthesis around Hawaiian Islands.
2. Four priority areas outside the monument boundary.
3. Three wreck sites where wrecks have not been located as yet.

4. Several sites inside Papahānaumokuākea Marine National Monument (PMM), which are not being considered here (FY 2009) for mapping as EX does not have permit to work inside PMM boundary, but provided as appendix A for future reference.

Mapping priorities proposed by OEAR staff

1. Targets suitable for ROV testing around Mauna Kea in protected waters.
2. Various seamounts around the Hawaii Island (Mauna Kea) including Wini, Hohono, Loihi, Apuupuu seamount (Except Wini all have existing multibeam data coverage), which can be suitable for repeat surveys and data comparison purposes.
3. Western Necker Ridge.

Ship priorities:

1. Small boat work including coxswain training, breaking in of small boat
2. CTD training for the deck and survey department
3. DP training

Changes in the cruise plan

In light of the new data sets and information about areas of interest and priorities for OEAR and local Hawaii scientists, the following updated schedule for the cruises is proposed. Please refer to figure 1 for any reference to mapping areas. All other sections including the cruise objectives in the submitted cruise plan remain unchanged. Major changes in the cruise implementation plan include:

- a. Switching Necker Ridge (Leg 3) and Mauna Kea (Leg 2) cruise to provide more time for discussion with local Hawaii scientists and synthesize additional information to help identify ROV targets. Now Necker ridge is proposed to be mapped in Leg 2 and Mauna Kea areas in Leg 3.
- b. Deletion of mapping areas 1 and 2 [D] from Mauna Kea cruise (Leg 3) as these areas have already been mapped with multibeam systems [C, B].
- c. Inclusion of mapping over HRMG synthesis holidays, ROV target area on the west coast of Hawaii Island, and one of the PMM provided priority area during Mauna Kea cruise (Leg 3).
- d. Inclusion of PMM provided priority area as the focus mapping area for Leg 4.
- e. Addition of CTD training, small boat break in and DP testing during Leg 2 and 3 in conjunction with mapping in protected water off Oahu. CTD training will include conducting one shallow water CTD cast (~ 750 m ~ 20 minutes) daily.

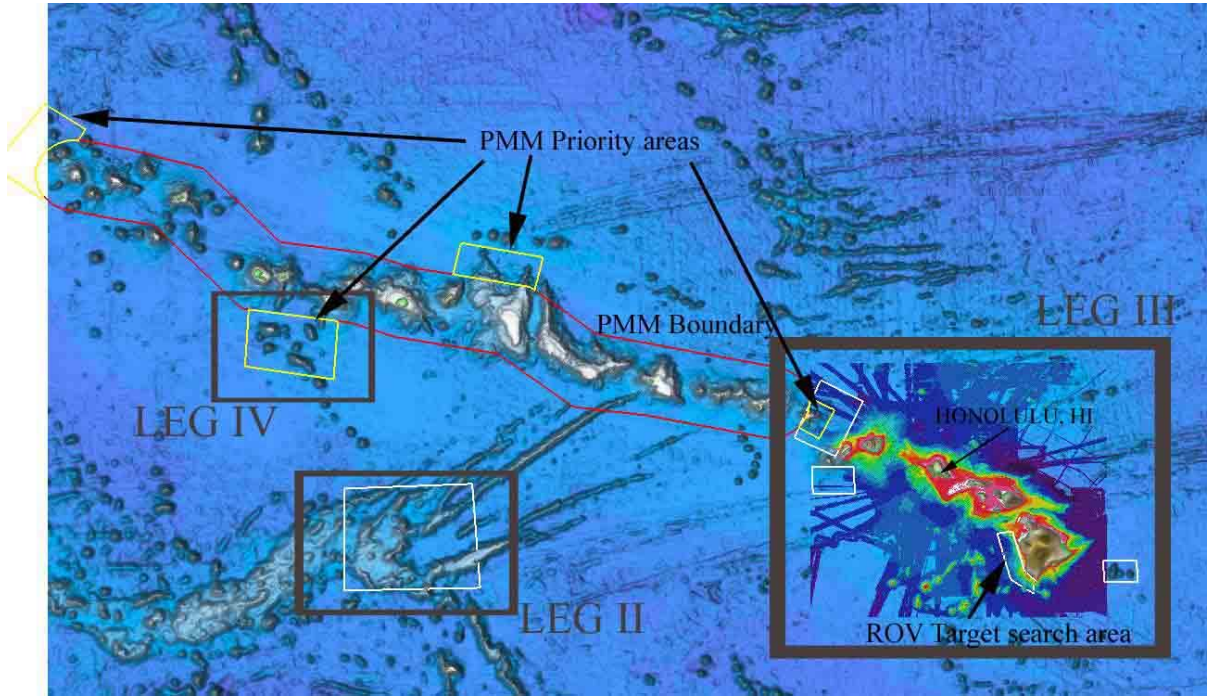


Figure 1: Overview of the mapping areas for EX0909 Leg 2-3.

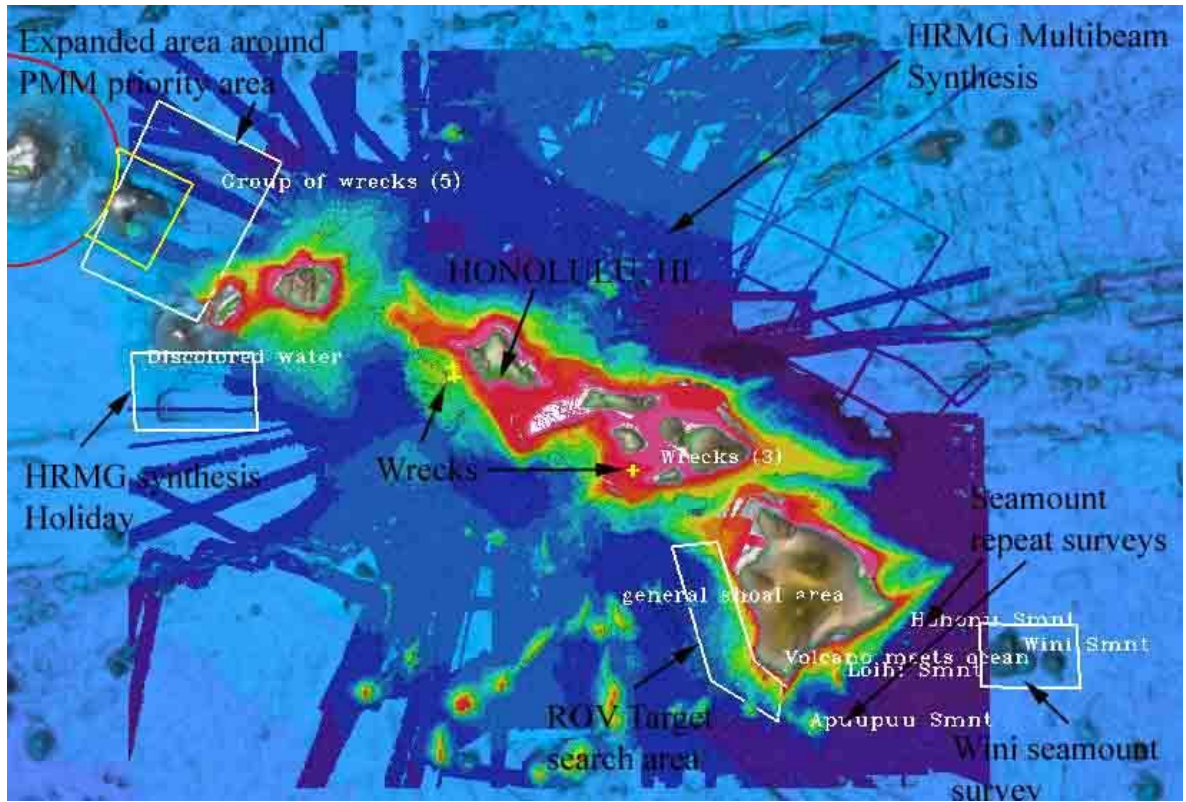


Figure 2: Detailed view of proposed mapping areas during EX0909 Leg 3.

Table 1: List of projected major operations associated with EX0909 Legs 2-4 cruises.

	Dates (mm/dd)	Location	Operations	Time (Days) Approx.	Distance (nm) Approximate
EX 0909 Leg 2	09/08	Depart Honolulu	Departure		
	09/8-09/11	Transit to Necker Ridge	Transit	2.5	450
	09/11-09/20	Map over Necker Ridge	Mapping	9	1800
	09/20-09/22	Transit to wreck sites	Mapping	2.5	450
	09/22-09/26	Investigation of potential wreck sites	Mapping Small boat operations	3.5	600
	09/26	Transit to Honolulu		0.5	
	09/26	Arrive Honolulu			
Total				18	3300
EX 0909 Leg 3	10/01	Depart Honolulu			
	10/01-10/03	Transit to Wini Seamount	Mapping in Transit over HRMG small holidays	1.5	250
	10/03 - 10/05	Map around Wini seamount	Mapping	2	400
	10/05-10/07	Map other seamounts in vicinity	Mapping Possible CTD cast	2	200
	10/07-10/10	ROV target search area	Mapping	4	800
	10/10-10/11	Transit to south of Kauai Island	Transit Mapping	1	200
	10/11-10/14	Mapping in HRMG holiday box	Mapping	3	600
	10/14	Transit to PMM priority area	Transit Mapping	0.5	100
	10/14-10/19	Expanded area around PMM priority area	Mapping	5	1000
	10/19-10/21	Transit to Honolulu	Transit	1.5	300
	10/21	Arrive Honolulu	Arrival		
Total				21	3850
EX 0909 Leg 4	10/26	Depart Honolulu			
	10/26-10/30	Transit to PMM priority area	Transit	4	800
	10/30-11/11	Map PMM priority area	Mapping	13	2600
	11/11-11/15	Transit to Honolulu	Transit	4	800
		Arrive Honolulu			
Total				21	4200

Detailed coordinates for these mapping areas are included in the following table:

		Approx Depths (m)	Bounding box location (Not to be used for Navigation) Long (-W) Lat (+N)	
EX 0909 Leg II	Western Necker Ridge	2000 – 4500	-171.96464488 -168.94662882 -168.78208211 -171.96391042	21.00831197 21.14565023 18.68873291 18.63887736
	Three Wreck Sites	300-800	-158.34537842 -158.32810107 -156.91204419	21.42534302 21.30705933 20.59394409
EX 0909 Leg III	HRMG small holidays while transiting from Honolulu to Wini Seamount (Expected to be covered by single line)	300-2500	-157.84453345 -162.28582560 -157.05138957 -156.36012370 -156.19301554 -156.07921753 -155.83106283 -155.73145345 -155.26350708	21.03302783 23.57158610 20.43353984 20.24634298 20.23301799 20.29848531 20.39270121 20.36032104 20.08205465
	Mapping area around Wini Seamount	< 4500	-154.08083203 -154.06649805 -153.27361043 -153.29230754	19.33948413 18.82745905 18.81396993 19.32653707
	Several seamounts in the vicinity	500 – 4000	-160.0 27.0 Sibelius seamount -154.7 19.3 Hohnonu seamount -155.5 18.5 Apuupu seamount -155.2 18.9 Loihi seamount	
	ROV target search	500- 4500	-156.59051921 -156.23213704 -155.92926636 -155.69806722 -155.73866781 -156.27424113 -156.58455404	19.97705282 20.02078044 19.05185954 18.86832275 18.55351563 18.87302958 19.95364176
	HRMG holiday area south of Kauai island	< 4500	-160.96135864 -159.98548177 -159.94773153 -160.92960815	21.52200114 21.54313863 20.90511068 2.89226888
	Expanded area around PMM priority area	100-2000	-161.37304688 -160.75572197 -159.75797986 -160.40018018	22.23185832 23.57557129 23.08341309 21.78639941
EX 0909 Leg IV	PMM priority area	< 5000	-174.24900360 -172.12246297 -172.23412679 -174.33103943	25.24633993 24.97829997 23.59051005 23.90895793

Appendix A: Email and document provided to OEAR by Scott Ferguson

Scott Ferguson wrote:

> I'm sorry we weren't able to get together the day you visited with our
> Hawaii mapping team. I just recalled that at Felipe's request last
> winter we assembled several potential projects that might be of
> interest to your team. In case you didn't receive them I'm passing
> them along directly to you.
>
> regards,
> Scott
>
> ----- Original Message -----
> Subject: Potential projects for Okeanos Explorer in Hawaii
> Date: Mon, 12 Jan 2009 17:44:31 -1000
> From: Scott Ferguson <scott.ferguson@noaa.gov>
> To: Felipe Arzayus <Felipe.Arzayus@noaa.gov>
> CC: Rusty Brainard <Rusty.Brainard@noaa.gov>, Peter Vroom
> <Peter.Vroom@noaa.gov>, John Rooney <John.Rooney@noaa.gov>, Randall
> Kosaki <Randall.Kosaki@noaa.gov>
> References: <49468F69.8080404@noaa.gov> <49469F99.7010106@noaa.gov>
> <4967A861.6030003@noaa.gov>
>
>
>
> Aloha Felipe,
>
> Attached is a brief description of three projects that might be of
> interest to you if the Okeanos Explorer is conducting operations in
> Hawaii later this year. These projects all are located in the
> Papahanaumokuakea Marine National Monument and include searching for
> tropical kelp communities with an ROV, looking for signs of submarine
> volcanism using the ship's multibeam and a program-provided AUV and
> developing multibeam base maps of number of poorly mapped seamounts
> within the Monument. These summaries consist of information I was able
> to pull together based on available information. If you have an
> interest in pursuing any of these projects let me know and we can work
> up something more substantive. Because we aren't current on the
> status of the ship's scientific equipment we purposely tried to keep
> these projects simple but meaningful. We would also look forward to
> collaborating with any researchers that may have similar interests.
>
> There is a fourth project that may also be of interest but we weren't
> able to get any information on this together today. We have begun using
> Autonomous Reef Monitoring Structures (ARMS) to establish measures of
> biodiversity of cryptic invertebrates. Though most of the work to date
> has been in tropical reef communities the technique is applicable in
> many other ecosystems. ARMS are diver-deployable structures that mimic
> the structural complexity of coral reef habitats and attract colonizing
> non-coral invertebrates. These structures would need to be deployed by
> an ROV or other mechanism and then left for recovery in a year or so

- > after they have been colonized. Because both the deployment and
- > recovery (perhaps with the KoK's submersible) may be complicated we
- > assume this is probably not of interest at this time. However, the
- > resulting data would be very important for monitoring the biodiversity
- > of the area under investigation and potentially for measuring the
- > effects of ocean acidification on the inhabitants. If this project is
- > of interest we can provide more detailed information.
- >
- > Thanks very much for the opportunity to provide some ideas!
- >
- > Regards,
- > Scott

Potential exploration opportunities for Okeanos Explorer in Hawaii

Searching for tropical kelp communities in Hawaii

Kelp forests have classically been viewed as being resident of temperate oceans because tropical surface waters are too warm and depleted in nutrients to support such communities. Recent investigations (Graham, et. al., Deep-water kelp refugia as potential hotspots of tropical marine diversity and productivity, PNAS:104:42, 2007) propose that kelp may inhabit deeper tropical waters where bathymetry and upwelling result in mixed layer shoaling above the depth of minimum annual irradiance necessary for kelp survival. Using model predictions the authors discovered extensive new deep-water *Eisenia galapagensis* populations in the Galapagos that increased in abundance with increasing depth to >60 m.

Recently authors Michael Graham and Brian Kinlan extended their model to the Northwestern Hawaiian Islands (NWHI) and found that several sites in the area may be suitable for kelp communities at depths between 70 and 200 m. They contacted Hawaiian Island phycologists Peter Vroom and Heather Spalding to learn more about the area. Vroom noted that Abbott and Huisman (Marine Green and Brown Algae of the Hawaiian Islands, 2004.) recorded the discovery of a brown kelp (*Desmarestia ligulata*) at Necker Island in 2000. The sample was recovered from a lobster trap set for research purposes in 30 to 50 m of water and was recorded to be "as fresh as if it had been picked up on Carmel Beach in California." Abbott noted that it is not possible for a sample drifting across the ocean to be recovered in this state of preservation and that of all the surprises working with brown algae in the Hawaiian Islands, perhaps the greatest is learning that *Desmarestia* may be living around tropical Necker Island.

The *Okeanos Explorer* would be an excellent vessel to look for kelp communities in the NWHI. The basic equipment necessary for this investigation would be an ROV and dynamic positioning. If for some reason the *Okeanos Explorer's* ROV is not available for this mission, NOAA has another ROV (a Phantom DHD2+2 with a 330 m tether) available in Hawaii.

Investigation of reported submarine volcanic activity within the Papahānaumokuākea Marine National Monument

“On August 20, [1955], persons aboard a plane bound from Tokyo to Honolulu sighted what appeared to be a column of smoke rising from the ocean about 55 miles N 85° E of Necker Island. On close approach they saw an oval patch of steaming turbulent water about a mile across, surrounded by a thin line of yellowish surf, with yellowish water drifting away from it. Near one end of the oval was an area of several thousand square yards of what looked like dry land. This probably was a raft of floating pumice which soon became waterlogged and sank. By the next day, when other planes visited the area, there were no further signs of disturbance other than a slick appearance of the water surface in the formerly turbulent area...” This short account recorded by Macdonald and Abbott in *Volcanoes in the Sea* (p 408, 1970.) describes the only evidence of volcanic activity in the Northwestern Hawaiian Islands in historic time.

The observation of submarine volcanism in this area is quite surprising because it is 550 nautical miles from current volcanic activity on Hawaii Island and 450 miles from the western most eruptions recorded in historic times. However, Brian Taylor (personal communication) says that he has observed submarine volcanic activity from the air and that this is an accurate description of such phenomena. The seabed at the location of the reported activity is on the flanks of a seamount in approximately 4000 m of water. However the summit of that seamount (at 23° 18N 163° 37'W) is only about 20 miles south of the reported sighting and is probably well within the bounds of the navigation error of 50's-era aircraft. Curiously, that seamount has a morphology that is distinct from most other seamounts in the NWHI. While most seamounts in this area are flat-topped seamounts, or guyots, that may have originated as coral atolls, this seamount has a gently rounded top. Preliminary maps based on data collected by the Kilo Moana in 2002 show the summit to be about 950 m deep.

An expedition to this seamount would include more detailed mapping of the summit using the Okeanos Explorer's 30 kHz multibeam as well as optical observations collected using a SeaBed AUV which has recently been built as the result of a collaboration between the Woods Hole Oceanographic Institution's Deep Submergence Lab and NOAA Fisheries. The AUV has a 2000 m depth rating and is designed to travel at speeds up to 2 kts while maintaining a precise distance off the seafloor. This design allows the vehicle to collect high-resolution photographs while maintaining a precise geometry between the cameras, the strobe lights and the seabed. The ship's underwater navigation system would be needed to track the AUV while deployed.

Bathymetric characterization of unmapped seamounts within the Papahānaumokuākea Marine National Monument

NOAA has undertaken a program of updating the charts and maps of the Northwestern Hawaiian Islands beginning in 2002 with the maiden scientific voyage of the R/V *Kilo Moana* which was supported by Ocean Exploration and mapped in excess of 38,000 km² of seabed. This effort has continued with seven additional cruises aboard the *Hi'ialakai* and the survey launch R/V *AHI* (Acoustic Habitat Investigator). A summary of the data collected during those cruises is available at the Pacific Islands Benthic Habitat Mapping Web site <http://www.soest.hawaii.edu/pibhmc/pibhmc_nwhi.htm>.

However, despite this substantial effort there are still a number of large bathymetric features within the Papahānaumokuākea Marine National Monument that are yet to be mapped. The best descriptions of those features are found in the *Fishery Atlas of the Northwestern Hawaiian Islands* (Uchida and Uchiyama, NOAA Technical Report NMFS 38, 1986). Ladd and Nero seamounts, each within 60 miles of Midway, have depths as shallow as 65 m. (Nearby Gambia Shoal is charted but not believed to exist.) Several very poorly characterized seamounts are located northwest of Kure Atoll at the extreme western limits of the Monument. The nautical chart shows depths as shallow as 68 fathoms (124 m) but the Fishery Atlas indicates the shallowest depth is 329 m. The banks surrounding Pearl and Hermes Atoll have been recently mapped but there is an extensive unmapped complex of deeper submarine features to the east. About 60 miles south of Pearl and Hermes Atoll is another seamount that rises to within 60 m of the surface.

Closer to Honolulu there are a complex of seamounts that extend from Brook Bank east to Necker Island. Most of these features have been mapped by the *Hi'ialakai* but some work still remains to complete that work. In particular, Larry Mayer and Jim Gardner have indicated that there is some potential for a claim to extend of the U.S. EEZ in the area southeast of Necker Island. Such a claim would rest on the bathymetric details of Necker Ridge which extends southwest of Necker. A very limited survey in this area was undertaken by the *Hi'ialakai* in 2008 but additional work is required to better characterize that area.

It should be noted that much of the Monument waters are probably too deep to be effectively mapped by a 30 kHz multibeam sonar such as the *Okeanos Explorer's*. The waters are also open ocean and dominated by tradewinds, resulting in 6 to 8 foot seas routinely being observed from the northeast. The *Hi'ialakai's* multibeam operates at that frequency and has been challenged by survey conditions in the NWHI. Some of those problems may be installation related and the *Okeanos Explorer* may be able to work more effectively. In fact, the NWHI may be a good location to determine the operational characteristics of the ship's sonar systems. However, one would be well advised to be cautious in dedicating a high-profile cruise to this mission.