

CRUISE REPORT¹

- VESSEL:** *Hi`ialakai*, Cruise 06-09
- CRUISE PERIOD:** 23 June–20 July 2006
- AREAS OF OPERATION:** Kure and Pearl and Hermes Atolls, Northwestern Hawaiian Islands Marine National Monument and Hanalei Bay, Kauai
- TYPE OF OPERATION:** Personnel from NOAA's Pacific Islands Fisheries Science Center (PIFSC), Coral Reef Ecosystem Division (CRED), and one person from the U.S. Fish and Wildlife Service (USFWS) conducted a research cruise supported by the mapping component of the NOAA Coral Reef Conservation Program's Coral Reef Ecosystem Integrated Observing System (CREIOS). Multibeam mapping at Kure and Pearl and Hermes Atolls, Northwestern Hawaiian Islands and Hanalei Bay, Kauai. The National Marine Sanctuaries Program (NMSP) had two piggyback missions on the cruise as well. Their marine archaeological investigations of shipwreck sites at both Kure and Pearl and Hermes Atolls were conducted to meet needs of the Pacific Islands Regional Office, Maritime Heritage Program (MHP). Education and Outreach (E&O) activities were conducted on behalf of the Northwestern Hawaiian Islands Marine National Monument (NWHIMNM). Supplies, mail, and equipment were also delivered to PIFSC, USFWS, and Hawaii Department of Land and Natural Resources (DLNR) personnel at French Frigate Shoals and Kure and Pearl and Hermes Atolls during the transit up the archipelago.
- ITINERARY:**
- 23 June Start of cruise. Embarked John Rooney (CRED), Emily Lundblad (CRED), Jonathan Weiss (CRED), Akel Sterling (CRED), Francis Lichowski (CRED), Joe Chojnacki (CRED), Louise Giuseffi (CRED), Kyle Holgreffe (CRED), Ron Salz (USFWS), Hans Van Tilberg (NMSP), Kelley Gleason (NMSP), Tane Casserley (NMSP), Lindsey Thomas (NMSP), Brenda Altmeier (NMSP), Robert Schwemmer (NMSP), Claire Johnson (NMSP), Ellyn Tong (Hawaii Audubon Society), Patricia Greene (NOAA Teacher-at-

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Sea), Dena Deck (NOAA Senior Teacher-at-Sea), Paulo Maurin (Univ. Hawaii). Scientists were briefed by NMSPMNM personnel on the cultural and biological sensitivity of the Northwestern Hawaiian Islands (NWHI). Departed Honolulu at 1000.

- 23–25 June Commenced transit to French Frigate Shoals to deliver equipment and supplies to National Marine Fisheries Service (NMFS) and USFWS personnel, enroute to Kure Atoll. Emergency egress and abandon ship drills were held during the first day of the transit, as well as an all scientists meeting, and a shipboard briefing for the science party given by the Executive Officer. Additional activities during the the transit included meetings and work preparations by each of the three science teams, a diver/snorkler briefing and injured diver drills, and other medical training for divers.
- 25 June Rendezvoused with a small boat from Tern Island, French Frigate Shoals to pass off eight boxes of frozen food, mail, and equipment. Mapping personnel processed data from earlier cruises. In the evening, one representative each from the mapping, maritime archaeology, and education and outreach teams gave a short presentation in the forward mess to anyone interested about the science their team had planned for the cruise.
- 25–27 June Continued transit to the northwest to Kure Atoll. Scientists prepared for data collection at Kure and processed previously collected data. The Education and Outreach team interviewed some of the scientists.
- 28 June Arrived at Kure. Held dive and small boat operations briefing. Launched boats on the south side of the atoll. After radio communications with the DLNR field team at Kure, the ship's 10-m launch was dispatched to pick up one of the volunteers on the island, Brad Vanderlip. He had been suffering for a month from an ear infection and came aboard to be examined by the medical officer, who recommended that Brad catch the next available flight from Midway to Honolulu for further medical treatment. The maritime archaeologists commenced work on the USS Saginaw wreck site, while the E&O team conducted snorkeling surveys of reef fish. The mapping team commenced operations with the R/V Acoustic Habitat Investigator (*AHI*) after getting the freon in the air conditioning unit recharged, and the ship commenced multibeam mapping as well. After recovering boats in the afternoon, the *Hi'ialakai* had to run outside of the 50-mile NWHIMNM to pump sewage.

29 June

Returned to Kure from transit offshore to dump sewage at approx. 0415. Conducted a conductivity-temperature-depth (CTD) cast and commenced multibeam surveying. The data output from the Position and Orientation System (POS-MV), which is a critical part of the multibeam system, degraded after a few minutes and it failed to restore. The electronics technician (ET) was called out at ca. 0530 and he and the survey tech replaced the POS. The ET believes that part of the problem with the POS was that a booby was perched on both the primary and secondary antennas. Held fire and abandon ship drills in afternoon. Ran outside 50 mi. to pump sewage after recovering boats. Engineers made the final connections to enable them to divert graywater to an empty ballast tank.

30 June–4 July

Continued operations at Kure Atoll. Spent 5 days engaged in shipboard mapping when not otherwise engaged in launching or recovering small boats. Had 3 nights of shipboard mapping, with 1 night primarily spent transiting 50 miles offshore to pump out the Chemical Holding Tank (CHT) in which the raw sewage produced onboard is stored until it can be properly disposed of. Completed 1-1/2 days of mapping with the R/V *AHI* when her A/C compressor seized, precluding further mapping until another means of keeping the electronics cool was established.

The maritime archaeology team spent this period deploying most of their people on most days to take full advantage of the relatively favorable weather and sea conditions to investigate wrecks on the usually unworkable reef crest. On July 5, archaeologist Robert Schwemmer was snorkeling on a wreck site when he was thrown by a swell onto the seafloor bruising his ribs. The medical officer onboard found no injuries that would preclude his diving but Robert elected to work onboard for several days until his ribs were less tender. On July 4, the ship's 10-m launch HI-1 developed engine problems and had to be towed back to the ship. Subsequent investigation by the engineering department indicated that HI-1's engine was not repairable by the ship's force and would require an extensive overhaul.

The Education and Outreach team spent 2 days and 1 night on Kure Atoll working with Hawaii DLNR personnel on a wide range of management activities. Most of the team spent the next 3 days conducting reef fish surveys at a range of sites in and outside the atoll. At 1700 on July 4, we left Kure en route to Pearl and Hermes Atoll.

- 5 July Arrived at Pearl and Hermes Atoll at approximately 0830. The R/V *AHI* was launched with a coxswain from the mapping team and two maritime archaeologists and their Seabotix ROV to look for deeper wreckage off a site on the south side of the atoll. The E&O team went out in one zodiac to conduct fish surveys. Spent the day completing a swath of shipboard mapping as close to the atoll as permitted by the ship's standing orders. Continued mapping further offshore at night.
- 6 July Continued mapping until 0930, at which time the ship departed for Midway Atoll. Arrived at Midway Atoll and transported three persons to shore to catch a scheduled flight to Honolulu. Persons disembarking included LtJG Kelly Stroud, scientist Ron Salz, and DLNR volunteer from Kure, Brad Vanderlip. The ship filled gaps in existing multibeam coverage for a few hours until the flight arrived and we could pick up a new A/C compressor for the R/V *AHI*. Departed Midway Atoll at approximately midnight.
- 7 July Arrived at Pearl and Hermes Atoll at approximately 0830. Both zodiacs were launched with the maritime archaeology team. Because of a lack of small boat support, the E&O team remained onboard. A NMFS zodiac came out to the ship to pick up a VHF antenna and supplies. Conducted shipboard multibeam mapping on the west side of the atoll. With the direction and assistance of the Chief Engineer, *AHI* coxswains Kyle Hogrefe and Joe Chojnacki installed, charged, and tested the new A/C compressor for the *AHI* and then surveyed for the last couple of hours of the afternoon. After recovering boats the ship departed for Kure, heading out to 50 miles offshore to pump sewage on the way.
- 8 July Arrived back at Kure at 0830. Launched R/V *AHI* to finish bank top mapping. The zodiacs were launched with archaeologists in one and the E&O team in the other. The ship filled in a few gaps in multibeam coverage prior to recovering small boats, and then collected a swath of deeper data along the eastern side of the atoll and out over Nero Seamount as we commenced transiting back to Pearl and Hermes Atoll.
- 9–13 July Spent these 5 days and 4 of the nights mapping the bank top and sides of Pearl and Hermes Atoll with shipboard multibeam systems. One night the ship had to transit to 50 mi. offshore to pump out the CHT tank. The maritime archaeology team spent 5 days in the field surveying wreck sites on the north, south, and eastern sides of the atoll. The E&O team spent 1 day conducting reef fish surveys and 1 day on shore helping NMFS Protected Species Division personnel with research and management

activities. They also deployed an Autonomous Underwater Listening Station (AULS) on the forereef to record sounds made by fish and other organisms over the course of a day. On July 11, HI-6 developed problems that precluded operating her safely for the remainder of the cruise. As a result, the E&O team was unable to go out in a boat for the next 2 days.

- 14 July The *AHI* and one zodiac were launched for a half day of mapping and fish surveys respectively, while the archaeology team remained on the ship mapping out artifacts they found at the different wreck sites at Pearl and Hermes. The ship mapped gaps in existing multibeam coverage and then recovered the boats before noon and started the transit to Kauai, collecting multibeam coverage of deeper parts of the atoll on the way.
- 15–18 July Transited to Hanalei Bay, Kauai. Conducted fire and abandon ship drills on the July 15. Data collected at the atolls were processed.
- 19 July Arrived off Kauai at approximately 0200. Conducted CTD cast and commenced multibeam surveying for a few hours to fill gaps in offshore coverage off northeastern Kauai. Transited to Hanalei Bay and launched the R/V *AHI* to fill gaps in existing nearshore bathymetric coverage of the greater Hanalei Bay area. The Trackpoint II Ultrashort Baseline Underwater Navigation System on the ship was tested in preparation for a laser line scan survey scheduled for October 2006. Recovered the *AHI* and resumed filling gaps in offshore bathymetric coverage. Commenced transit to Honolulu at 2200.
- 20 July Arrived off Honolulu at 0830. Proceeded into Snug Harbor and docked by 0930. End of cruise. Disembarked science party.

CRUISE STATISTICS FOR HI-06-09:

TABLE 1: MAPPING TEAM

	Kure	Pearl and Hermes	Hanalei Bay	Totals
CTDs (ship & launch)	27	27	4	58
Multibeam mapping (sq. km)	426	402	5	833
R/V <i>AHI</i> Deployments	6	7	1	14

TABLE 2: MARITIME ARCHAEOLOGY TEAM

	KA north side	KA east side	KA south west channel	PHA south side	PHA north side	Totals
Survey dives/person	40	35	16	21	18	130
in situ artifacts photo inventoried (estimated)	85	100	100	65	50	400
associated artifact areas recorded with digital still/video	0	11	5	5	4	25
resource sites discovered	2	6	1	0	2	11
lanes surveyed by photo/GPS ops	5	20	3	15	15	58
initial site surveys/phase 1 completed		1	1			2
site plans/phase 2 surveys completed	1			1	1	3

TABLE 3: EDUCATION AND OUTREACH TEAM

	Kure Atoll	Pearl and Hermes	Hanalei Bay	Totals
Snorkel Sites	13	3	0	16
REEF Fish Surveys	47	13	0	60
Logs and In-depth Articles	20	5	0	25
Activities	2	1	0	3
Lesson Plans (proposed)	7	3	0	10
Movies	4	0	0	4
AULS Deployment	0	2	0	2

MISSIONS AND RESULTS:

Benthic Habitat Mapping

1. Completed ship- and launch-based multibeam surveying of waters between a depth of 16 m and in excess of 500 m at Kure Atoll (See Appendix A, Figs. A-1 and A-2). In conjunction with existing pseudobathymetry derived from Ikonos satellite imagery, this combined dataset represents the first atoll in the NWHI to be completely mapped with high-resolution bathymetry.
2. Processed multibeam data from Kure Atoll. Swath and area-based editing of multibeam soundings collected at Kure was completed. Grids of the bank top only (5 m pixel size) and entire atoll (20 m pixel size) were completed and integrated into final maps.
3. A segment of high spur and groove morphology on the west side of Kure Atoll was also surveyed. Data were processed and a high-resolution (0.5 m pixel size) grid of the bathymetry was produced (See Appendix A, Fig. A-3). These data will be useful for comparing Ikonos satellite-derived pseudobathymetry and multibeam-derived bathymetry. This figure suggests that there is a systematic and depth-dependant difference between these two data sets that may enable the less accurate pseudobathymetry values to be modified to better reflect true depth values and mesh with the multibeam bathymetry.
4. Completed surveying a substantial portion of the bank top and sides of Pearl and Hermes Atoll with ship- and launch-based multibeam systems (See Appendix A, Fig. A-4). Essentially, the entire atoll that can safely be surveyed by a ship has been completed. A significant portion of the seafloor between depths of 16 m (the depth at which Ikonos-derived pseudobathymetry was clipped) and the inside edge of ship-based multibeam coverage remains unsurveyed. This work will require the use of the survey launch R/V *AHI* or a similar platform.
5. Process bathymetric data from Pearl and Hermes Atoll. Swath editing was 100% completed. Area-based editing of multibeam soundings collected at Pearl and Hermes was approximately 50% completed.
6. Completed multibeam surveying of portions of Hanalei Bay, Kauai in support of Coral Reef Conservation Program Local Action Strategies, the Hanalei Bay Watershed Hui and other NGOs and resource management agency partners, and a PIFSC-CRED research project.
7. Conducted shipboard and launch-based CTDs to support multibeam mapping requirements as needed.

8. Conducted multibeam data acquisition familiarization and training for a full day with one person from the education and outreach team and the sea cadet embarked aboard *Hi'ialakai* for the cruise.
9. Provided the R/V *AHI* and a coxswain to provide a platform and electrical power from which the maritime archaeology team conducted a day of ROV operations searching for deeper artifacts from a wreck site at Pearl and Hermes.
10. Deployed and recovered the AULS to record ambient noise on the forereef at Pearl and Hermes Atoll in support of the E&O team.

Maritime Archaeology

1. Phase 2 site survey of American whaler *Parker* wreck (lost 1842 Kure Atoll) using photo, video, CTD, Global Positioning System (GPS) and baseline trilateration survey techniques completed (see Appendix B-1). Site plan map completed.
2. Initial phase 1 site survey of navy side wheel steamer USS *Saginaw* wreck (lost 1870 Kure Atoll) using photo, video and GPS survey techniques completed (see Appendix B-2).
3. Initial phase 1 opportunistic survey (at request of refuge manager) of iron hulled sailing ship *Dunnottar Castle* (lost 1886 Kure Atoll) in southwest channel, using photo, video and GPS survey techniques, completed (see Appendix B-3).
4. Phase 2 site survey of British whaler *Pearl* (lost 1822 Pearl and Hermes Atoll) using photo, video, GPS and baseline trilateration completed (see Appendix B-4). Site plan map completed.
5. Phase 2 site survey of British whaler *Hermes* wreck (lost 1822 Pearl and Hermes Atoll) not completed. No work on site because of deteriorating sea state.
6. Phase 2 site survey of unidentified motor vessel wreck (date unknown Pearl and Hermes Atoll) using photo, baseline trilateration and GPS survey techniques. Site plan map completed (see Appendix B-5).
7. Initial phase 1 survey of seaward portion of freighter *Quartette ex-James Swan* (lost 1957 Pearl and Hermes Atoll) not completed. No work on site because of deteriorating sea state.
8. On-site maritime heritage education and outreach work in collaboration with education and outreach group conducted. Education team briefed on heritage resources and surveying techniques and guided interpretation to several of the maritime archaeology work sites.

9. National program education and outreach work conducted during cruise, via NOAA Sanctuary Program web site updates (text and images).

Education and Outreach

1. Since it would be too great an impact to bring a large number of educators to this amazing ocean wilderness for a first-hand experience, a five-member education and outreach team was selected to gain an experiential educational experience in which they would share their experiences with a broad audience. While on the NOAA ship *Hi'ialakai*, the education and outreach team wrote 25 logs and in-depth articles about the coral reef mapping, maritime heritage archaeology research and their personal experiences, as well as created four short video vignettes. They also documented their own personal experiences on Green Island in Kure Atoll, State Wildlife Refuge and Southeast Island in Pearl and Hermes Atoll, Hawaiian Islands Wildlife Refuge, as well as conducting REEF fish counts while snorkeling. These logs and articles were posted with compelling public domain imagery on the expedition website found at the following two web addresses: <http://sanctuaries.noaa.gov/missions/2006nwhi> and <http://hawaiianatolls.org>. The logs, articles, and short movies were also linked as additional reference materials to “A Teacher’s Guide to Navigating Change” to be used in a formal education setting.
2. The education and outreach team completed a total of 60 REEF fish surveys at 13 locations in Kure Atoll and 3 locations in Pearl and Hermes Atoll. The data collected will contribute to the Reef Environmental Education Foundation (REEF) database found at <http://reef.org>. More details and initial survey results are available in Appendix C.
3. Reaching a broad audience with these experiences aim to motivate people to change their attitudes and behaviors to better care for coral reefs and related marine environments. People need to understand a place in order to care about it and obtain a desire to conserve it for future generations. This information will make people aware of this special ocean area and possibly inspire them to be better ocean stewards. Various mechanisms, such as the posting of mission logs, images, and video vignettes on the expedition website are assisting the teachers to share and distribute materials that are developed for the cruise. Other mechanisms will include presenting a summary of the expedition at local, regional, and national conferences, such as the National Marine Educators Association, National Science Teacher’s Association, California Science Teacher’s Association, The Oceanography Society, and North American Association for Environmental Education. The two NOAA Teacher-at-Sea educators will also be developing activities and lesson plans to use in their classrooms and to share with educators in Hawai`i and around the country.

4. The education and outreach team successfully deployed the Autonomous Underwater Listening Station (AULS) from the research vessel *AHI* at Pearl and Hermes Atoll. The AULS passively collected natural and manmade underwater acoustics for 6 hours. The AULS pod was also hand deployed at a shallow reef off Southeast Island for 1.5 hours. Acoustic audio recordings from the AULS will be made available within 6 months of the cruise.
5. Materials developed after the expedition will aid in enhancing the general understanding of the unique Northwestern Hawaiian Islands. These materials will be developed post-cruise by the two NOAA Teacher-at-Sea educators and will be made available to all educational partners. All images collected by the education and outreach team are public domain and have been burned onto CDs, and copies will be provided to the Marine National Monument, State of Hawai'i DLNR, and U.S. Fish and Wildlife Service for use in publications and printed material with proper photo credit.

SCIENTIFIC PERSONNEL:

John Rooney, Co-Chief Scientist, Joint Institute for Marine and Atmospheric Research (JIMAR), University of Hawaii (UH)-Pacific Islands Fisheries Science Center (PIFSC)

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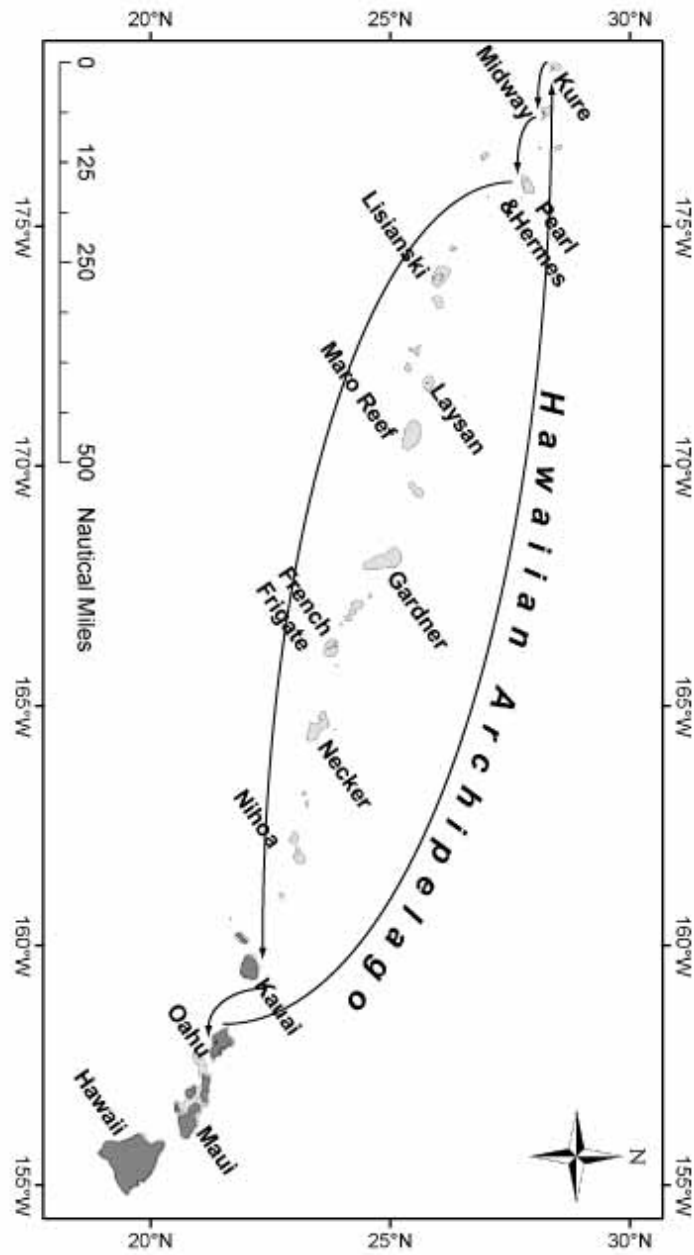


Fig 1. Cruise track for HI-06-09.

APPENDIX A: HI-06-09 Multibeam Mapping Results

Multibeam mapping priority areas for the Pacific Islands were delineated in the *Pacific Islands Mapping Implementation Plan* (Miller and Rohmann, 2003) based on discussions between a number of management and stakeholder agencies including: the NOAA Coral Reef Conservation Program (CRCP), the Coral Reef Ecosystem Division (CRED) of the Pacific Islands Fisheries Science Center (PIFSC), and National Marine Sanctuaries Program (NMSP) and Northwestern Hawaiian Islands Marine National Monument (NWHIMNM), the NOAA Pacific Regional Office (PIRO), as well as the Hawaii Department of Land and Natural Resources/ Division of Aquatic Resources (DLNR/DAR), and the U.S. Fish and Wildlife Service (USFWS). Priorities are reviewed regularly and for cruise HI-06-09, mapping of as much of the seafloor as possible between the 20-m and 200-m isobaths at Kure Atoll and Pearl and Hermes Atoll was completed. Since this is a multi-mission cruise, the final schedule was established in consultation with the NOAA National Marine Sanctuary Program. A piggyback mission to do a day of mapping at Hanalei Bay, Kauai was also added to the end of the cruise schedule.

Kure Atoll

Kure Atoll is located at the northwestern end of the newly designated Northwestern Hawaiian Islands Marine National Monument. It is the northernmost atoll not only in the Hawaiian Archipelago but in the entire world as well. The underlying basaltic structure is estimated to be 28 million years old. This classically shaped atoll encloses 0.86 sq. km of land including Green Island which was home to a Coast Guard-operated long range navigation (LORAN) station for decades starting in the mid-1900s. Kure is the only atoll managed by the State of Hawaii. The

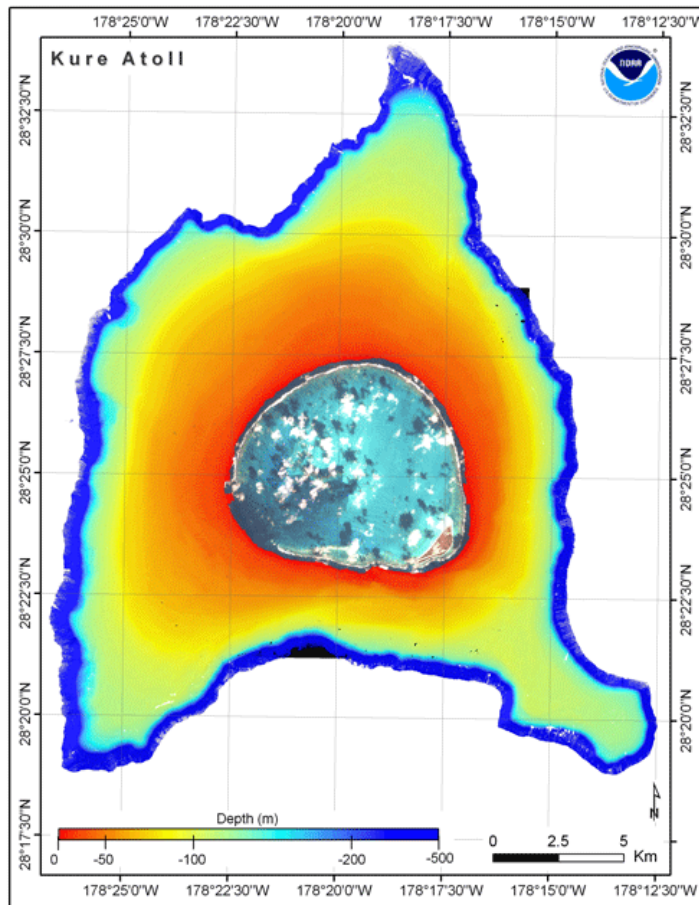


Figure A-1: Multibeam Coverage of Kure Atoll, and Ikonos Imagery of the lagoon

coral reef environment includes 167 sq. km of banks with depths less than 100 m. The top of the bank surrounding Kure Atoll slopes gently away from the base of the forereef to the outer edge of the bank top, spanning depths from

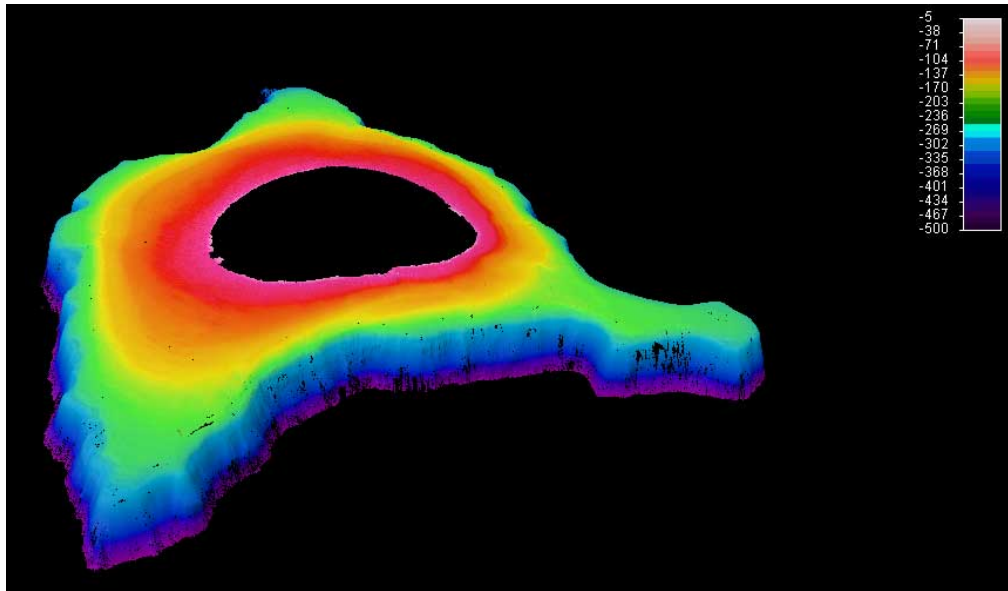


Figure A-2. A 3-dimensional view of Kure Atoll looking at the atoll from a south-southwesterly direction.

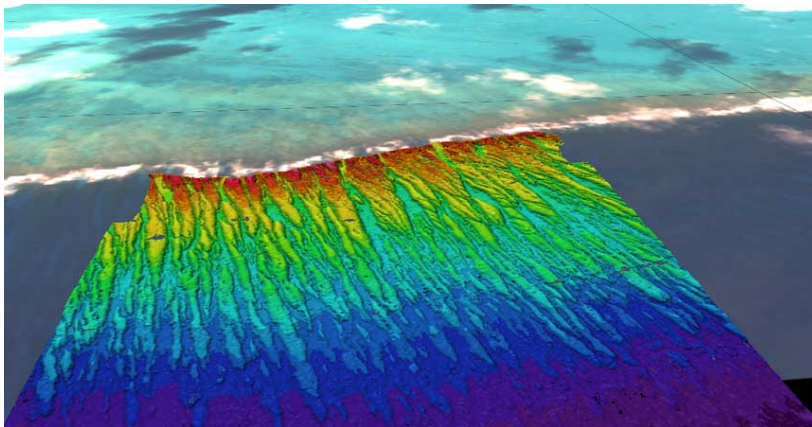


Figure A-3. An example of the spur and groove morphology characteristic of the Kure Atoll fore reef.

approximately 20 m to 130 m (Fig. A-2). The fore reef features well developed spur and groove morphology (Fig. A-3) around most of its perimeter.

Swath and area-based editing of multibeam data collected at Kure was completely processed during HI0609. Final bathymetric grids were generated including a one with a 5 m pixel size covering the bank top

down to a depth of 500 m. A second grid with a 20-m resolution was generated that includes all multibeam coverage of the atoll.

Pearl and Hermes Atoll

Pearl and Hermes Reef, located at 27.8N, 175.8W, is an extensive atoll area containing numerous small islets totaling 0.36 sq. km in area. The underlying basaltic structure is estimated to be 22 million years old. The coral reef environment includes 1,166 sq. km of banks shallower than 100 m. The rim of the atoll is somewhat oval-shaped with the long axis oriented northeast to southwest (Fig. A-4). Pearl and Hermes is classified as an

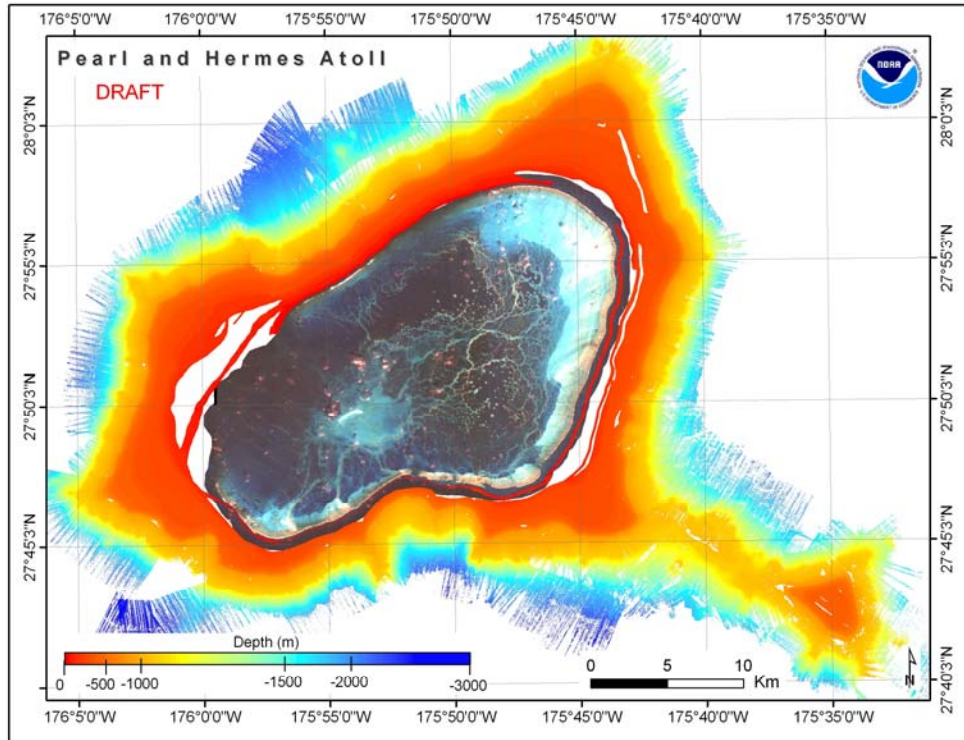


Figure A-4: Multibeam Coverage of Pearl and Hermes Atoll

open atoll, with its southwestern side mostly submerged allowing the free exchange of water, coral reef organisms, and small boats. The Pacific Islands Fisheries Science Center, Protected Species Division, maintains a field camp at North Island in the summer months to perform research and management tasks on the endangered Hawaiian monk seal populations there.

Primary processing, referred to as swath editing, of all multibeam data collected at Pearl and Hermes Atoll in 2006 has been completed. Secondary processing or area-based editing has been approximately 50% completed.

Hanalei Bay, Kauai

Mapping at Hanalei Bay was requested by Dr. Carl Berg on behalf of the Hanalei Bay Watershed Hui, a nongovernmental organization of which he is the director, and their numerous partner agencies. The Hui is investigating the water circulation, residence time, and flushing of Hanalei Bay, as primary factors controlling sedimentation, pollution levels, larval dispersal, nutrient availability, and episodic storm damage that collectively shape the coral reef communities there. Their work is consistent with the NOAA Coral Program's Local Action Strategies for Kauai and the other main Hawaiian Islands.

Additionally, a scientist from the Pacific Islands Fisheries Science Center is working with the Hui and U.S. Geological Survey on modeling of circulation and benthic shear stress from incident surface gravity waves. To complete this effort, they require high-resolution bathymetric information for a number of gaps in the existing multibeam and bathymetric LIDAR coverage for the greater Hanalei Bay area. Accordingly, the last day of the cruise was spent using the R/V *AHI* to survey these gaps.

APPENDIX B: HI-06-09 Maritime Archaeology Results

Maritime heritage resource target areas for cruise HI-06-09 were determined by the Maritime Heritage Program (MHP) staff at both the Pacific Islands Regional Office and MHP headquarters and on work begun at Kure Atoll and Pearl and Hermes Atoll during the 2003 and 2005 research expeditions. The team experienced excellent weather conditions at Kure Atoll, allowing for the completion of a phase 2 survey at the *Parker* site and a complete initial phase 1 survey of the USS *Saginaw* site, normally impossible to access due to surf conditions over the site. In addition, at the request of the refuge manager at Kure Atoll (who discovered the site the previous day), the team had the opportunity to confirm the identity and conduct an initial phase 1 survey of the collier *Dunnottar Castle*. At Pearl and Hermes Atoll the team completed the phase 2 survey of the British whaler *Pearl*, lost in 1822. Additionally, the team completed a phase 2 survey of an unidentified motor vessel, known as the "Oshima" wreck after the style of its anchors. All of these heritage resources, *Parker*, USS *Saginaw*, *Dunnottar Castle*, *Pearl*, and Oshima wreck are examples of the unique heritage resources and potential for historical and archaeological discovery in the Northwestern Hawaiian Islands (NWHI). Survey data for these sites contribute to the appreciation of maritime heritage resources and serves preservation management needs by completing site assessments and artifact inventories.

1. American whaler *Parker*

The New Bedford whaler *Parker* (Captain Prince Sherman) was lost on September 24, 1842 at Kure Atoll during a fierce storm. The ship struck on the north side of the reef and became a complete wreck in under an hour, very few provisions being salvaged by the unlucky survivors. The Captain and a few others were picked up from Ocean (Green) Island on April 16, 1843 by the ship *James Stewart*. The rest of the crew remained on island until May 2, when they were rescued by the *Nassau* and taken to Honolulu.

Written records of this event are scarce, but the physical remains tell the story. At Kure Atoll the maritime team completed the phase 1 survey of the site, documenting anchors, anchor chain, hull sheathing, copper fasteners, hawse pipes, windlass, rigging hardware, wire rope, ship's bell, bricks, and other material in linear distribution over 100 meters in length. Artifacts are representative of early 19th century whaling and nautical technology. The team also discovered a trail of bricks and broken try pot shards (cauldrons used to render the whale oil from the blubber) in a small pass through the reef crest. Survey outside the reef found almost no artifacts at all. Apparently, the extremely violent storm and seas brought the vessel entirely into the shallow backreef area, hundreds of meters from the reef pass, where she grounded at a heading of 135° magnetic. Deck features like the tryworks and pots were washed over the side as the ship entered the reef.

Site data includes: (1) site map completed from measured sketches and baseline trilateration showing all visible artifacts and topographic features; (2) descriptive artifact

inventory with photos; (3) feature photos and site photo mosaics; (4) conductivity, salinity, dissolved oxygen, temperature measurements (modeling corrosion rate); (5) (Geographic Information Systems (GIS) product showing initial impact zone at pass, transit path into lagoon, and final distribution of artifacts (pending). Heritage resources at this site are protected from damage or illegal removal by the Abandoned Shipwreck Act (1987), the Antiquities Act (1906), and other cultural preservation legislation.

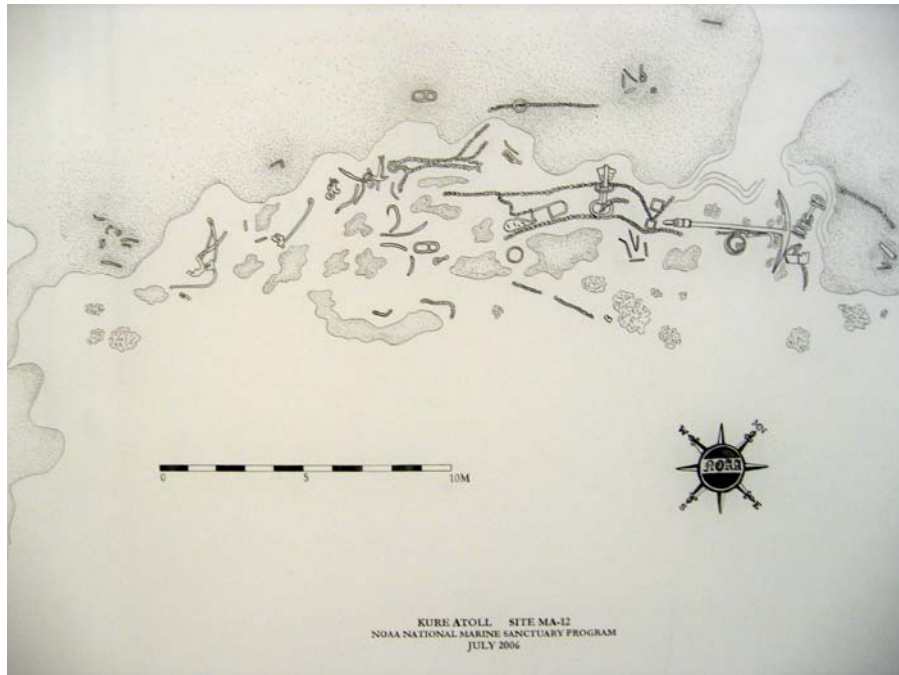


Figure A: portion of the 100-meter MA-12 site map created during Cruise HI-06-09.

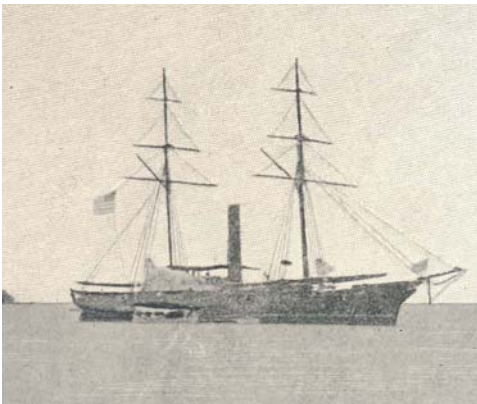
2. Navy side-wheel steamer USS *Saginaw*

The American side-wheel steamer USS *Saginaw* captures a critical period of American involvement in the Pacific, a rare example of the transitional steam and sail period, and the early use of inclined oscillating steam engines. The side-wheel steamer served in the East Indian squadron protecting American citizens in China and Japan during the Opium Wars. In 1862, she joined the Pacific squadron and operated on the West Coast to prevent Confederate activity. Her cruises took her to many ports in Mexico and Central America during the French Intervention. Her final cruise involved supporting an attempt to open a channel into Midway, which had been claimed by the U.S. in 1867. She wrecked at Kure Atoll on October 29, 1870. Survivors spent 2 months on Ocean (Green) Island, while five volunteers made a perilous open boat voyage to the Main Hawaiian Islands for rescue. Four died in the surf on Kauai. The fifth, coxswain William Halford, made his way to Honolulu and the Hawaiian steamer *Kilauea* soon brought the crew back from the distant atoll.

Documentation of this site adds to our understanding of this historic event, the heritage of the U.S. Navy and Hawaiian history in the 19th century. In extremely difficult conditions

under the surf zone adjacent to the seaward reef crest, the team discovered and photographed all of the major elements of the navy steamer, including bow and stern Parrott rifled pivot guns, 24-pdr broadside howitzers, steam oscillating engine, port and starboard paddlewheel shafts, rim of paddlewheel, anchors, brass steam machinery, boiler tubes, boiler face, rigging components, ship's bell, fasteners, rudder hardware, davits, sounding lead, and other material remains. The artifacts are scattered on top, adjacent to, and underneath the exposed eastern reef crest at Kure Atoll. Distribution of artifacts attest to the bow breaking off at the initial reef impact zone, and midships machinery falling into the reef just south, with the stern itself being pushed farther south and eventually lighter components falling into the backreef zone. Conditions on site prohibited in situ artifact inventory, baseline trilateration mapping, measured sketches of main features, and even most handheld Global Positioning System (GPS) shots.

Site data includes: (1) some GPS positions on artifact areas at reef crest; (2) photographs and video of all artifacts discovered; (3) backreef GPS/photo survey of artifact scatter area; (4) GIS product showing rough positions of major features (pending). Heritage resources at this site are protected from damage or illegal removal by the Abandoned Shipwreck Act (1987), the Sunken Military Craft Act (2004), the Antiquities Act (1906), and other cultural preservation legislation.



Figures B and C: the USS *Saginaw*, built at Mare Island Naval Yard 1859: one of her two Parrott 30-pdr pivot guns lies in a surge channel at Kure Atoll.

3. British collier *Dunnottar Castle*

The 258-foot British iron hulled ship *Dunnottar Castle* was lost at Kure Atoll on July 15, 1886, while bound for Wilmington, California from Sydney, Australia hauling coal. The chief officer and six seamen took one of the boats and made a 52-day passage to Kauai. The *Waialeale* was chartered by the British commissioner in Honolulu and sent on the rescue mission. Hawaiian officials, fearing that the British might use the occasion to annex the island, took formal possession of Kure Island on September 20.

Opportunistic documentation of this site at the request of the Kure Island wildlife refuge manager revealed the near complete remains of a late 19th-century tall sailing ship, with iron hull and steel yards and masts. The site lies in 14 to 25 feet of water in the

southwest area of the atoll. Large sections of iron hull plate, iron frames, rigging, masts, auxiliary steam boiler, keelson, anchors, windlasses, winches, capstans, davits, port holes, rudder and steering gear, cargo hatches, bow sprit, hawse pipes, chain locker, ballast stone, deadeyes, chains, stringers, bitts, ladders, etc. are scattered over the sea bottom. No movable artifacts were seen.

Site data includes: (1) digital video coverage; (2) digital still photos of area and major features; (3) rough site sketch with GPS positions for major features; overall dimensions of site. Heritage resources at this site are protected from damage or illegal removal by the Abandoned Shipwreck Act (1987), the Antiquities Act (1906), and other cultural preservation legislation.



Figure D: Diver recording admiralty anchor on *Dunnottar Castle* site.

4. British whaler *Pearl*

Preliminary work on the history of the British whaler *Pearl* indicates that the vessel was originally built as an American ship in Philadelphia in 1805. At some time after that, the ship was captured by the French during the aftermath of the Quasi-war and named (renamed?) *La Perla*; subsequently taken by the British privateer *Mayflower* and from there put into service in the British South Seas whaling industry out of London. The *Pearl* (Captain Clark), sailing with the sister ship *Hermes* in pursuit of whales, struck an unknown reef on the night of April 24, 1822. The combined crews made it safely to one of the small islands, salvaging provisions and timbers for the eventual construction of the 30-ton schooner *Deliverance*. Before launching the rescue vessel, the ship *Earl of Morby* was sighted. The entire complement, excluding 12 who elected to sail the beach-built schooner back to Honolulu, were rescued. James Robinson, survivor and chief carpenter, started the first shipyard at Honolulu in 1827.

Documentation of the *Pearl* site provides a glimpse of this wrecking event and the very early whaling technology in the Pacific. These sites were discovered by the National Marine Fisheries Service (NMFS) Coral Reef Ecosystem Division (CRED) marine debris divers in 2004 (team lead Jake Asher). The *Pearl* and the *Hermes* site to the west are the only known British South Sea whaling wreck sites in the world. Individual artifacts at this high energy site are quite deteriorated, but their distribution and superposition (vertical order) provide the wrecking interpretation. The oaken keel ground into the sand channel and distorted copper hull sheathing sections delineate the resting place of the ship. Iron try pots, fallen through the decks, now trap sections of hull sheathing. Anchors pinpoint the bow of the vessel towards the reef, gudgeon near what was the stern post to seaward. Inshore a large anchor was set, possibly to hold the stricken vessel in place after the wrecking. Two cannons lie on the main site; ballast and fasteners and bricks are strewn about the site.

Site data includes: (1) site map completed from measured sketches and baseline trilateration showing all visible artifacts and topographic features; (2) descriptive artifact inventory with photos; (3) feature photos and site photo mosaics. Heritage resources at this site are protected from damage or illegal removal by the Abandoned Shipwreck Act (1987), the Antiquities Act (1906), and other cultural preservation legislation.



Figure E: diver working on the site of the *Pearl*.

5. Unidentified motor vessel "Oshima" wreck

The site of this unidentified wreck was discovered by NMFS CRED marine debris divers in 2004. The vessel remains located in the northern atoll area of Pearl and Hermes Atoll (PHA) in the vicinity of the "engine block," a familiar landmark to NWHI researchers. The engine block is a 6-cylinder Atlas Imperial diesel and machinery scatter, propeller shaft and propeller, a marine propulsion plant popular in the early decades of the 20th

century. There is no written record of any vessel loss which corresponds to the "Oshima" wreck. Maritime work on the site focuses on dating and identifying the vessel.

The engine block site at the reef crest does not include major ship construction elements, nor does the vessel wreck site inside the lagoon include engine components. The two locations may be associated. Divers discovered a debris trail of riveted metal and straps, etc. stretching from the engine block into the lagoon. At the vessel wreck site there are three major artifact areas: (1) bow area with windlass, observation tower, ventilators and both hawse pipes and anchors (Japanese "Oshima" type dating to 1918); (2) cook stove area with remnants of battery boxes and insulators and electrical components and also marine head; and (3) engine skylight area, an intact deck skylight and main stack and ventilator component, along with scattered ventilator parts, pipes, and miscellaneous artifacts. Sedimentation rate at this site appears high, and there are indications of considerable material beneath the sediments of this low energy backreef site. Electrical components exhibit Chinese characters (translation pending), and insulators are marked with "H.K." (possibly "Hong Kong"). The findings suggest the following possible scenario: an East Asian fishing vessel (tuna tower?) of 70-foot plus strikes the northern reef crest at Pearl and Hermes under power (propeller blades all bent). The bottom is torn out of the vessel, leaving the Imperial Atlas engine, and the wreck is pushed farther into the lagoon where it sinks after striking two large coral heads (vicinity of site), sometime after 1918. Fate of the crew is unknown. Further research into the history of PHA wrecks is recommended.

Site data includes: artifact and area photographs, measured sketches of main features, completed site map, and GPS positions on reference baseline. Heritage resources at this site are protected from damage or illegal removal by the Abandoned Shipwreck Act (1987), the Antiquities Act (1906), and other cultural preservation legislation.



Figures F and G: Imperial Atlas engine on reef crest. Engine skylight and stack/ventilator component in lagoon.

APPENDIX C: HI-06-09 REEF Fish Survey Results (preliminary)

Species abundance and diversity were sampled using the Reef Environmental Education Foundation (REEF) survey method for reefs at Kure Atoll and Pearl and Hermes Atoll. These surveys involved snorkelers recording the relative abundance they observed of reef fish species while swimming in a random pattern, taking care to not swim over the same area twice. REEF fish surveys can also involve diving, but the educators did not have that option on this particular trip. For the most part, the survey sites were no deeper than 20 feet.

Thirteen sites were surveyed in and around Kure Atoll (see Fig. A-1) and three at Pearl and Hermes Atoll. The Kure sites were chosen so all corners of the atoll are represented with nine surveys on the inside reef and four on the outside reef. Differing habitats were targeted. The north shore outside the reef site, however, was not attainable to give a full representation of all areas on Kure Atoll. The three Pearl and Hermes Atoll sites were chosen to represent shallow reef and a deep-channel environment.

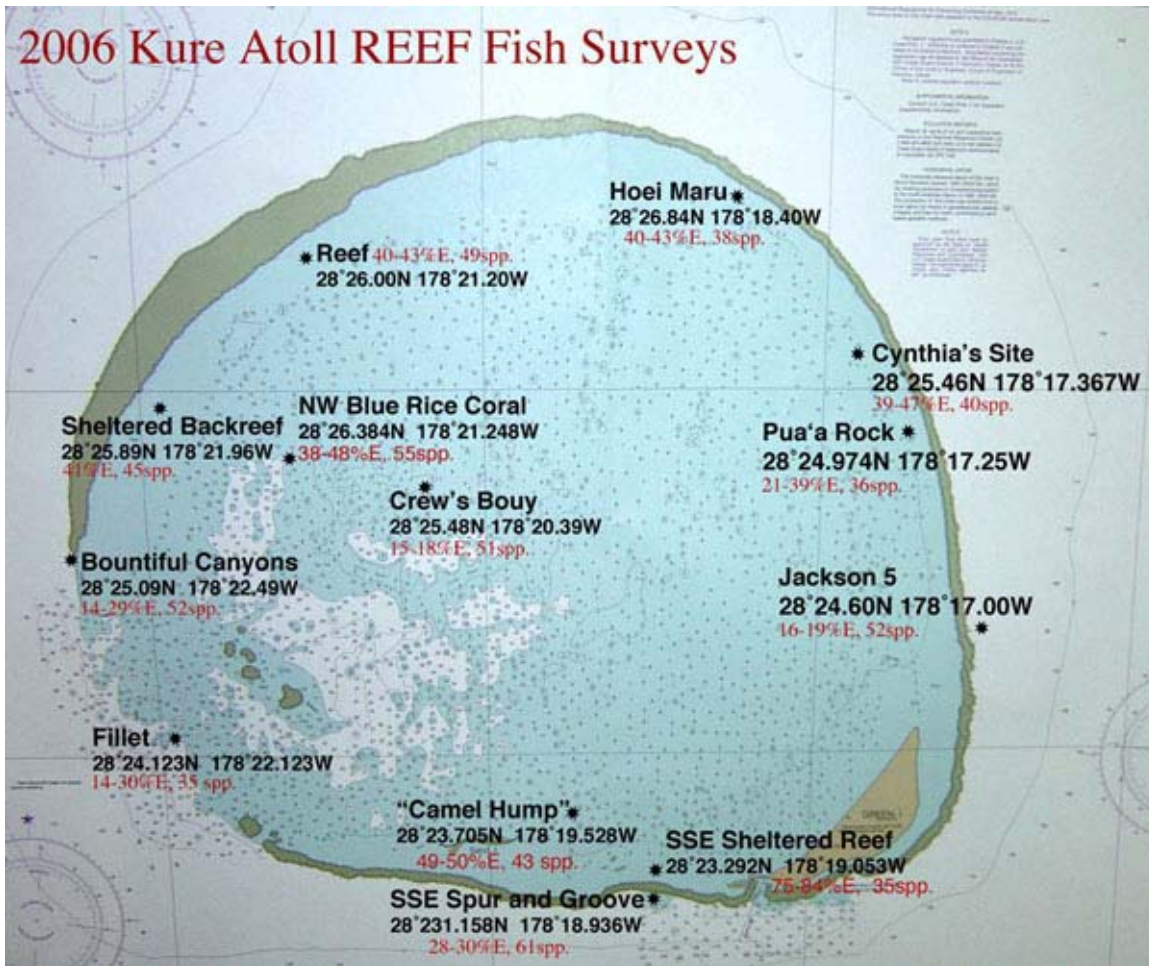


Figure A-1: REEF Fish Survey Sites at Kure Atoll, State Wildlife Refuge.

The numbers of different species at each site differed from between 35 to 65 species, representing 34 families of fish. The three sites with fewer than 40 species counted were shallow water, protected sites. The top 10 most common species were represented by 6 families and included the Pacific Gregory (*Stegastes fasciolatus*), threadfin butterflyfish (*Chaetodon auriga*), spectacled parrotfish (*Scarus perspicillatus*), convict tang (*Acanthurus triostegus*), whitebar surgeonfish (*Acanthurus leucopareius*), bluespine unicornfish (*Naso lituratus*), blacktail wrasse (*Thalassoma ballieui*), Hawaiian cleaner wrasse (*Labroides phthirophagus*), Hawaiian hogfish (*Bodianus bilunulatus*), saddle wrasse (*Thalassoma duperrey*), and sea chub sp. Half of the most common species are also endemic species, and the three species found at every site include Pacific gregory, blacktail wrasse, and the saddle wrasse. The two wrasses found at every site, the blacktail wrasse, and the saddle wrasse are endemic species.

The percent incidence of endemism was calculated for each site for number of fishes surveyed. Fish that are endemic are those species that are thought to have evolved in the Hawaiian Islands and are found for the most part in the Hawaiian Islands. Some of Hawaii's endemic species are also found at Johnston Atoll. Though 25% of the list of fish on our species list were endemic, seven of the sites showed 40% or higher rates of endemism by number of fishes counted. This means that the endemic species have proportionally more representatives than their non-endemic counterparts. Endemics may therefore be better suited, having evolved certain life history characteristics to more efficiently live on Hawaiian reefs. Typically island endemics are small bodied and have restricted geographic ranges.

Most of the sites with high levels of endemism occur on the inside reef that faces the north. These sites had close to or exceeded 40% endemism by number. An explanation of this endemism may be that these environments with coral heads interspersed with sandy bottoms provide suitable habitat for butterflyfishes and wrasses, two families of fishes that have higher numbers of endemic representatives than other families. For example, wrasses constitute over half of all endemics counted and need sandy bottoms to burrow in when they sleep at night. Butterflyfishes often sleep in holes and in spaces between many types of coral.

Recruitment may be an important factor favoring endemics, as endemic species may have evolved reproduction and dispersal patterns more attuned for the Northwestern Hawaiian Islands than non-endemics. Ocean currents and the timing of the availability of food for larvae may make the difference between which species witnesses more recruits and which does not. On average for most coral reef fish, only 1 out of 250,000 eggs reaches adulthood. Most of the mortality occurs during the larval stage, with half of the larvae succumbing to predators and the other half starving because of lack of suitable food (Leggett and Deblois, 1994).

Outside reef sites had lower rates of endemism, and this may be a result of those sites being more exposed to top carnivores and having fewer niches for recruitment of juveniles and typically smaller bodied endemic species. Some of these outside reef environments experience large wave events every year that may exceed over 20 feet. While the waves are this large, few species of fish would find this environment suitable. Transient species like smaller surgeonfishes and chub would be more suited to this environment than butterflyfishes and wrasses, which often develop territories that they keep and defend for many years. There are no endemic surgeonfish and chub in Hawaiian waters (Hoover, 1993).

The South/Southeast sheltered reef showed a high rate of endemism (75-84%), and this may be due to a somewhat strong surge current and lack of non-endemic schools of chub, convict tangs, whitebar surgeonfish, and goatfishes that might not have been able to swim effectively against the surge current. There were several species of wrasse, many of them tiny juveniles, which are typically small bodied and quick, able to swim against the current.

In a paper by Drs. Edward DeMartini and Alan Friedlander, *Spatial Patterns of endemism in shallow water reef fish populations of the Northwestern Hawaiian Islands*, they showed through scientific surveys an increasing incidence of endemism with increasing latitude. The four northernmost Hawaiian Islands were observed to have the highest rates of endemism that reached in some parts 52% by number. They surveyed 59 stations by snorkel and scuba. They were better trained and had the advantage of using scuba that may have resulted in higher reports of endemism than what we experienced. Most endemics are small bodied and a diver on scuba, rather than a snorkeler, is more likely to get an accurate count by carefully looking under ledges and in holes for the smaller fishes.

One Hawaiian endemic not seen in REEF fish surveys was the Hawaiian grouper, Hapuu (*Epinephelus quernus*). A larger species, reaching 32 inches or more, does not follow the general rule for small endemics. It is a member of the grouper family, a family whose members classically take many years to reach adulthood, spawn in aggregations and change their sex. Though it is part of the bottomfish fishery, unfortunately very little is known about the life history of this fish.

The Hawaiian Islands are the most remote island chain on earth. This isolation has supported the evolution of many marine fish species that exist nowhere else on earth. Through REEF fish surveys the education team were able to realize the unique abundance of these species on two atolls' remote reefs. Preservation of the Northwestern Hawaiian Islands as havens for endemics is important for their survival and contributes to our knowledge and appreciation of how special and unique the Hawaiian Island Archipelago truly is.

Acknowledgments

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