



Frequently Asked Questions

Palmyra Atoll and Kingman Reef Restoration/Shipwreck Removal

- What is a black reef?
- Some coral reef managers intentionally sink wrecks on reefs. Why is this different? How were the wrecks damaging reefs?
- What is corallimorph?
- What is filamentous algae?
- What is the long term plan for reef recovery at Palmyra and Kingman?
- What kinds of species live in the coral reef?
- What kinds of ships were removed?
- How were the ships removed?
- What will happen to the removed shipwreck debris?
- What was the general project timeframe?
- Where are Palmyra and Kingman?
- What is a National Wildlife Refuge? What is the difference between the Wildlife Refuge and the Marine National Monument? And, what are the roles of The Nature Conservancy and other partners at Palmyra and Kingman?

-
- What is a black reef?

Coral reefs can undergo relatively rapid changes in the dominant biota, a phenomenon referred to as a “phase shift.” During a phase shift, a beautiful, colorful reef with high coral diversity can transform into a reef dominated by a single species. These reefs become drab and dark in color and have been referred to as “black reefs” (see Kelly et al. 2011, <http://www.nature.com/ismej/journal/v6/n3/abs/ismej2011114a.html>; National Geographic 2011, <http://newswatch.nationalgeographic.com/2011/09/01/black-reefs-when-the-ship-hits-the-reef/>; Work et al. 2008, <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0002989>). Various reasons have been proposed to explain this phenomenon including increased human disturbance, pollution, or changes in coral reef biota. Phase shifts and black reefs can have long-term negative ramifications for coral reefs. Complete removal of organisms responsible for phase shifts in marine ecosystems can be difficult, particularly if such organisms cover a large area.

At Palmyra Atoll National Wildlife Refuge, a black reef was created by a phase shift away from diverse coral communities to a blanket of invasive corallimorph. At Kingman Reef National Wildlife Refuge, the black reef consists of a monoculture of invasive filamentous green algae. The proliferation of corallimorph and filamentous algae at Palmyra Atoll and Kingman Reef has been linked to iron leaching from shipwrecks at these Refuges.

- **Some coral reef managers intentionally sink wrecks on reefs. Why is this different? How were the wrecks damaging reefs?**

Some coral reef managers intentionally sink wrecks in order to create artificial reefs. Artificial reefs can serve as underwater structures for the accumulation of marine life and the promotion of fish habitat. The shipwrecks at Palmyra Atoll and Kingman Reef Refuges are not appropriate for the development of artificial reefs due to the unique marine environment at these remote coral atoll Refuges.

Palmyra Atoll and Kingman Reef Refuges contain some of the world's last remaining near-pristine coral reefs. These calcium carbonate coral reefs are located in iron-poor regions of the central Pacific, where natural terrestrial run-off of iron is non-existent and aerial deposition is extremely low. The shipwrecks introduced iron to an environment where it does not naturally exist. The increase in iron acted as a fertilizer to some benthic species, including the corallimorph at Palmyra Atoll and filamentous algae at Kingman Reef. These benthic species gained the upper hand and upset the natural balance of the coral reef ecosystems, leading to phase shifts and black reefs. Removing the shipwrecks eliminated the source of leaching iron.

- **What is corallimorph?**

Corallimorph is an anemone-like organism that is closely related to reef building corals. The species at Palmyra Atoll Refuge is *Rhodactis howesii*. It is native to Palmyra Atoll and tropical reefs, but is now growing out of control and smothering live coral and giant clams. At the Palmyra Atoll Refuge, leaching iron from *F/V Hui Feng No. 1* (Hui Feng), a sunken fishing vessel, has been linked to the proliferation of corallimorph. The corallimorph has been documented in extremely high densities near the ship, and has radiated out more than one mile from the wreck across the atoll's western terrace. Corallimorph is rare to absent in other parts of the atoll. The extensive corallimorph invasion and subsequent loss of coral reef habitat at Palmyra Atoll Refuge highlights the importance of natural resource monitoring and removal of shipwrecks on corals reefs. Monitoring ensures awareness of alarming changes such as the proliferation of corallimorph at Palmyra Atoll Refuge, allowing Refuge Managers to respond to the threat and mitigate the potential for reef overgrowth by invasive species.

- **What is filamentous algae?**

Filamentous algae are single algae cells that form long visible chains, threads, or filaments. These filaments intertwine forming a mat that resembles wet wool. Filamentous alga begin growing along the bottom in shallow water or attached to structures in the water. The species at Kingman Reef Refuge is the green alga *Derbesia tenuissima*, which has overgrown and killed sensitive hard corals and crustose coralline algae, as well as giant clams. Leaching iron from the shipwreck at Kingman Reef has been linked to the proliferation of the invasive filamentous algae.

- **What is the long term plan for reef recovery at Palmyra and Kingman?**

The removal of the three shipwrecks and their associated debris is just the first step of a larger coral reef restoration project at Palmyra Atoll and Kingman Reef Refuges. Prior to the wreck removal actions, scientists from the U.S. Fish and Wildlife Service, Scripps Institute of Oceanography, U.S. Geological Survey, the Coral Reef Ecosystem Division of the National Oceanic and Atmospheric Administration, and others surveyed the shipwreck areas to obtain a baseline status. These areas will continue to be monitored and surveyed for reef recovery and the recruitment of key species of coral and algae into the area.

In addition to monitoring reef recovery, the restoration project will involve the removal of invasive corallimorph across Palmyra Atoll's western terrace. The U.S. Fish and Wildlife Service will conduct corallimorph control and removal efforts for the next several years to stop the spread and decrease the population of corallimorph. Palmyra Atoll exhibits a very resilient ecosystem, and managers have confidence that by controlling corallimorph, the once-beautiful coral reefs of the western terrace will gain the opportunity to recover naturally once the corallimorph is removed. The damaged portion of the reef at the wreck site is surrounded by healthy diverse reef with many nearby corals which can help repopulate the newly available substrate in areas where the wrecks once lay and where corallimorph are removed. In these areas, corals, algae and other benthic organisms can settle and grow, creating a diverse colorful ecosystem, where there had previously been a black reef.

- **What kinds of species live in the coral reef?**

Palmyra Atoll Refuge is home to 176 species of corals, 147 species of algae, and roughly 418 species of reef fish. The atoll and its associated waters support a large population of threatened green turtles, as well as endangered hawksbill sea turtles. Palmyra Atoll Refuge has a healthy, intact, predator-dominated marine ecosystem with high abundance of sharks, jacks, and snappers. It is a known shark nursery. Several IUCN red-list species occur at Palmyra Atoll Refuge, including the bumphead parrot fish, humphead wrasse, and manta rays. Due to its close proximity to Palmyra Atoll, Kingman Reef Refuge shares many of the species found at Palmyra and also boasts large populations of top predators.

- **What kinds of ships were removed?**

Three ships were removed in total: 2 at Palmyra Atoll Refuge, and 1 at Kingman Reef Refuge. (See also the "Just the Facts" shipwreck removal factsheet.)

Palmyra Atoll National Wildlife Refuge

At Palmyra Atoll Refuge, two shipwrecks were removed:

- The *F/V Hui Feng No. 1* (Hui Feng), a 121-foot steel-hulled longline fishing vessel, and
- *Rust Island*, a 1940s-era 64-foot by 28-foot steel pontoon barge.

The Hui Feng was identified as a Taiwanese fishing vessel. It was 121 feet long with a breadth of roughly 28 feet. In 1991, the Hui Feng was intentionally grounded on the western terrace of Palmyra Atoll by its crew. It is believed the crew was seeking political asylum, and after grounding they were brought from Palmyra Atoll back to Honolulu where they were sent home to their respective countries of origin. The vessel was composed of steel with concrete and wood reinforcements and foam-insulated fish holds. The vessel exhibited a unique construction; layers of foam, wood, and concrete surrounding steel reinforcements beams were sandwiched between an inner and outer steel skin. The vessel design substantially increased the complexity of the removal operation.

The pontoon barge, nicknamed "Rust Island" due to its highly degraded condition, was grounded near the western lagoon end of the entrance channel sometime between 1953 and 1957. It was believed to be a Defense Department transport barge made out of steel pontoon sections that linked together. Over the past several decades, Rust Island greatly deteriorated and sprouted vegetation, including even a small coconut tree. During removal operations it became evident that Rust Island was not just a pontoon barge with a mound of vegetation on it, but there were likely two small landing craft on top of the barge. By 2013, the landing craft were so degraded that only the engine components and propellers remained, surrounded by piles of metal scale.



“Rust Island” October 2013

Kingman Reef National Wildlife Refuge

At Kingman Reef Refuge, major components of the following shipwreck were removed:

- An 85-foot (estimated) teak fishing vessel of unknown origin.

In 2007, an 85-foot (estimated) teak fishing vessel was discovered grounded on the northeastern portion of Kingman Reef Refuge. The origin of the vessel is unconfirmed but is believed to be from Indonesia. Based on the amount of scorched wood present, it is speculated that the vessel caught fire many miles from the Refuge and was then abandoned before drifting to the northeastern side of the reef, where it grounded. An engine fire had burned much of the stern section down to the water line, destroying all identifying markings. Since its discovery at Kingman Reef, the vessel had broken down significantly and posed a major threat to the reef ecosystem. The ship was composed mainly of wood but had considerable amounts of fiberglass and metal piping in the fish holds and metal components in the engine room.

- **How were the ships removed?**

Hui Feng

The Hui Feng was grounded on Palmyra’s western terrace in roughly 20 feet of water and a half-mile from the Palmyra Atoll entrance channel. A jack-up barge served as the work platform and was set up adjacent to the wreck. The jack-up barge was equipped with a crane and hard hat diver support system. The platform consisted of a work deck that was supported by 4 legs. The platform was floated into place and the legs were lowered down to the sea floor. Divers, using surface-supplied air, worked to cut the wreck into pieces. The Hui Feng was cut into pieces with a variety of tools, including underwater exothermic torches for the metal portions, hydraulic and pneumatic chainsaws and skill saws for the foam and wooden portions, and chippers (similar to jack hammers) and crowbars for the concrete portions. Once a piece was cut free of the wreck it was termed “scrap” and was “harvested.” To harvest the scrap, each piece, some weighing as much as 30,000 pounds, was lifted out of the water by a crane secured to the jack-up platform. The crane then placed the scrap on a shallow draft transport vessel or “scow.” The scow transported the scrap back to a 185-foot materials barge waiting in Palmyra’s western lagoon.

The Hui Feng was initially estimated to weigh 400,000 pounds. After 56 days of cutting, lifting and scrap transport, a total of 618,350 pounds of steel, foam, wood and concrete had been harvested and the wreck removed. The Hui Feng wreck site was declared clean and free of debris on December 31, 2013.

Rust Island

The wreck site at Rust Island was shallow with approximately 4 to 5 feet of water at high tide. Because of the shallow depth, it was necessary to complete all removal operations during high tide. All vegetation was cleared from Rust Island, and the metal scale remains of the two landing craft were shoveled into buckets and totes. All debris was transported back to the 185-foot materials barge. Once Rust Island was cleared of all debris, the above-water portion of the pontoon sections were cut loose with an acetylene torch and loaded onto the transport scow. The intact below-water sections were lifted out of the water with a small crane affixed to the scow. Once the large metal portions were removed, the crew worked to gather metal scale remains of the decaying vessel on the ocean floor with shovels and buckets. Over half of the weight harvested from this wreck was removed by shoveling metal scale into five gallon buckets while snorkeling. The original estimated weight of Rust Island was 100,000 pounds, but with the additional landing craft remains, the final weight removed from the reef was over 277,800 pounds. On January 7, 2014 the site was declared clean.

Unknown Fishing Vessel at Kingman Reef

The wreck at Kingman Reef Refuge had broken down considerably since the vessel's grounding in 2007. It was discovered by scientists on a routine monitoring expedition. After 6 years of pounding surf, only 20 feet of the bow section remained intact as it sat on the small rubble island on the northeast end of Kingman, with the rest of the wreck and debris scattered over the nearby reef flat, back reef, and lagoon.

The work site on the reef flat was very shallow with water depths of 1 to 7 feet at high tide, and just a few inches of water at low tide. The two small rubble islands that comprise the only land masses at Kingman Reef lie merely 3 feet above sea level. They are frequently awash by waves and offered no shelter during removal operations. The severe sea state and environmental conditions at Kingman Reef are unpredictable, and forecasts are relatively unreliable at the isolated central Pacific reef. Such uncertainty constrained safe operations, and the team determined that mobilizing the full shipwreck removal team and all floating assets, including the 185-foot barge and large crane, from Palmyra to be staged at the Kingman removal site, presented an unacceptable risk to crew and resources. Instead, a subset of the crew traveled to Kingman Reef from Palmyra Atoll on the tugboat *Sarah C* with a transport scow in tow.

One reconnaissance and three separate removal trips were made to Kingman to assess and remove wreck debris from the lagoon, reef flat, and back reef areas. The crew twice attempted removal of the 5,000-pound engine block on the seaward side of the reef, but had to leave it due to the breaking waves and violent surge at the site. The crew instead set about removing everything else found and retrievable, including 25-foot long 10-inch wide timbers and planks, metal piping, large metal compressors, small engines, and fiberglass debris from the reef crest and reef flat. Thousands of pounds of debris were hand-carried more than 300 feet to the shallow water rubble spit, cut into manageable pieces with plasma cutters and chainsaws, and moved to specially fabricated wood rafts that transported debris to the scow. The material was then offloaded from the scow onto the tugboat *Sarah C*, which was standing by in the deep waters of the Kingman Reef lagoon. The debris on the lagoon side was found in water depths of 5 to 60 feet and was located and removed by commercial divers on SCUBA. The larger pieces of debris were rigged and lifted out of the water onto the scow with a small crane that was affixed to the scow.

- **What will happen to the removed shipwreck debris?**

All of the scrap and materials from the three wrecks were piled onto the 185-foot materials barge and prepared for transport from Palmyra Atoll to Honolulu, and eventually to Long Beach California, where

the scrap metal will be recycled and made into rebar, or disposed of according to California environmental standards.

- **What was the general project timeframe?**

The mobilization phase, which involved the environmental assessment of the project, the fabrication of equipment, and the mobilization of all personnel and gear to the remote shipwreck locations, began in the spring of 2013. The tug *Sarah C* and barges departed Honolulu for Palmyra on October 20, 2013. Onsite preparation and salvage operations began upon the arrival of the tug and barges at Palmyra Atoll Refuge on October 30, 2013 and ended on January 16, 2014. The demobilization phase is currently underway.

- **Where are Palmyra Atoll and Kingman Reef Refuges?**

Palmyra Atoll National Wildlife Refuge is located approximately 1,000 miles south of Honolulu. Palmyra is the northernmost of the Line Islands and is one of the minor outlying territories of the United States. Kingman Reef National Wildlife Refuge is located about 30 miles northwest of Palmyra Atoll, 970 miles south of Honolulu, and is a territory of the U.S. as well.

- **What is a National Wildlife Refuge? What is the difference between the Wildlife Refuge and the Marine National Monument? And, what are the roles of The Nature Conservancy and other partners at Palmyra and Kingman?**

The National Wildlife Refuge System, <http://www.fws.gov/Refuges/>, is the system of public lands and waters set aside to conserve America's fish, wildlife and plants. The Refuge System is comprised of over 560 national wildlife Refuges plus 38 wetland management districts, in total encompassing more than 150,000,000 acres (three times the size of the National Park Service). Refuges are found in every U.S. state and territory. The Refuges at Palmyra Atoll and Kingman Reef include uplands and submerged lands, and extend out to 12 nautical miles. National Wildlife Refuges are protected areas of the United States, as identified by the National Wildlife Refuge Administration Act, and managed primarily for wildlife conservation. They are, by law, managed by the U.S. Fish and Wildlife Service (Service), an agency within the Department of the Interior.

Palmyra Atoll is made up of 25 small islands, three lagoons and surrounding reefs. The largest island, Cooper Island, is owned by The Nature Conservancy (TNC) (<http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/hawaii/palmyraatoll/>).

The Service and TNC work together to manage and conserve the atoll and its wildlife. The Palmyra Atoll Research Consortium (www.palmyraresearch.org/), a blue-ribbon association of scientific institutions, have come together and work with the Service and TNC to better understand the natural systems at this unique atoll as a model for the world. A number of PARC scientists, as well as the NGO Marine Conservation Institute (<http://www.marine-conservation.org/what-we-do/program-areas/mpas/pacific-islands-conservation/central-pacific-monuments/>), have advocated for removal of the shipwrecks to restore ecosystem health to these Refuges' reefs.

Both Palmyra and Kingman National Wildlife Refuges were established in 2001, under the Clinton Administration. In 2009, President George W. Bush also included them as a part of the Pacific Remote Marine National Monument, <http://www.fws.gov/pacificremoteislandsmarinemonument/>. The Monument status adds stature and protection for these areas and extends the conservation area out to 50 nautical miles. The Monument is managed and administered by the Service, in consultation with NOAA, except that NOAA has primary responsibility, in consultation with the Service, for managing fishery-related activities in the area from 12 to 50 nautical miles from land

(http://www.fpir.noaa.gov/MNM/mnm_prias.html). Both agencies work closely with the U.S. Coast Guard (<http://www.uscg.mil/d14/>) for monitoring, surveillance, and law enforcement; as well as search and recovery and safety at sea.