Marine ecosystem response to shipwreck removal at Palmyra Atoll National Wildlife Refuge

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Project Objectives

In the late fall of 2013, the U.S. Fish and Wildlife Service (Service) will remove a 121 ft. long-line fishing vessel grounded on the western terrace reef of the Palmyra Atoll National Wildlife Refuge (Palmyra). This is a high priority project and funding has been allocated by Washington and the Chief of the Refuge System to remove the wreck, but not to monitor and restore the affected coral reef. The eroding wreck is acting as a "time release fertilizer", fueling the growth of an invasive corallimorph by releasing limited elements, such as iron, into the water. The corallimorph is currently spreading over once pristine coral reefs, killing and smothering the corals and turning an area once rich in species diversity into a monotypic blanket of corallimorph.

The Sandin and Smith Labs at the Scrip Institution of Oceanography (SIO) are members of the Palmyra Atoll Research Consortium (PARC), and have been working at Palmyra since 2005, looking at fish and benthic communities in the area. These labs have been using permanent transects with photo quadrats, as well as photomosaic mapping of the benthos, for species surveys, and documentation of the invasive corallimorph. SIO in collaboration with Stanford University (another PARC member) are working together at Palmyra to understand the biotic and abiotic forcing within the coral reef ecosystems and how the Palmyra coral reefs are affected by climate change, global warming and specifically ocean acidification. Due to its protected status as a NWR Palmyra has few anthropogenic stressors and can be used as a model for resilience and restoration of coral reefs. The removal of the wreck and subsequent restoration efforts, gives the service an opportunity to collect a robust data set of biotic and abiotic factors for a Before-After-Control-Impact study design to determine the effects of wreck removal, and the subsequent succession of native species after invasive species removal.

A series of experimental plots have demonstrated that the corallimorph can be successfully removed from large spots, in areas of monotypic corallimorph cover, in situ by tarping them and inoculating the tarps with chlorine tablets. Small areas in coral rich areas can be controlled in situ by covering the polyps with calcium carbonate slurry.

The project objectives include; 1) Evaluating the effects of the shipwreck removal on the benthic and fish communities, by surveying the area pre-removal effort, to get a current understanding of the extent of the corallimorph spread, and its effects on the benthic and fish communities. Then repeating the surveys post removal and restoration efforts to 2) Determine succession patterns on corallimorph-cleared patches of the reef in high density areas and sites where smaller outbreaks of corallimorph are occurring. Succession in removal plots will provide valuable information for conservation and management efforts.

Methods

Evaluating the effects of the shipwreck removal on benthic and fish communities

- Benthic community Surveys; coral, alga, sessile and mobile invertebrates

    - Resample permanent transects and photo-quadrats previously sampled in 2007, 2009, and 2011
        - Percent cover of hard and soft coral, fleshy algae and crustose coralline algae (CCA)
        - Record species, presence, size, and mortality of any coral species within transects and quadrats
    - Photo mosaic
        - Establish mega-quadrats 50x50 meter, at all permanent transect sites
- The fish community surveys
        - Record species, size, and abundance on 25x2 meter belt transects and timed swims at benthic survey sites
- Corallimorph surveys
    - Resample towed diver and permanent transects surveyed for corallimorph abundance and colony density in 2007, 2009, and 2011.
        - Record abundance and polyp density along transects and at established permanent sites using photo-quadrats, line transects, quadrats, and percent cover.
        - Photo mosaic in area surrounding the wreck.

Rates of Recovery and Succession after removal of corallimorph

- Establish permanent plots in the area with in the densest concentration of corallimorph invasion, near the wreck site, as well as a number of other sites on the periphery of the invasion.
    - Create 5-10 permanent photo-quadrats at each of these sites in a highly infested corallimorph area. Take initial photographs of each plot in 2013 prior to wreck removal. Clear patches of corallimorph using tarping and scoring methods, and re-photograph.
        - Corallimorph removal will be evaluated on a site to site basis to ensure that no corals or other benthic organisms are damaged.
    - Record succession of benthic species with permanent photo-quadrats
        - Take succession photos over the course of 3-6 months to determine the recruitment of benthic organisms.

Project implementation timeline

Table 1. Implementation timeline for marine ecosystem monitoring post shipwreck removal at Palmyra

	Planning	**Field work**	**Data Analysis**	**Draft Report**	**Final Report**
Start date	March 2013	June 2013	October 2013	December 2013	January 2014
Finish date	June 2013	October 2013	November 2013	December 2013	January 2014

The wreck must be removed by December 31, 2013, posing a time urgency to collect up-to-date and current pre-removal data on the corallimorph spread and population densities, and the native species that will benefit from the removal project. Field work will take place for three weeks to a month during between June and October 2013.

Confluence with I&M Funding Priorities

- Priority: Inventory Project / Collection of Data priory to wreck removal
    - This project includes invasive species mapping, fish and benthic species surveys.
- Priority: Protocol Development
    - The methods developed for this control and monitoring project have, and will continue to, assist Service staff in monitoring and managing the natural resources at Palmyra. These methods could easily transfer to other refuges within Region 1. Corallimorph have been documented at several refuges within the Pacific Reefs NWRC; Kingman Reef, and Howland and Baker Islands.
- Priority: Evaluate effects of climate change or other stressors

- The results from this project coupled with the ocean acidification work being done concurrently by SIO and Stanford will inform Refuge managers about the impacts that invasive corallimorph have on native organisms, natural ecosystem processes, and the recovery and resilience of Palmyra's native marine organisms in a changing ocean climate free of many common anthropogenic stressors.

Project justification

The reefs of Palmyra are being threatened by the presence of ever increasing corallimorph populations, an invasive species that causes tissue necrosis in corals leading ultimately to death. Corallimorph, specifically *Rhodactis howesii*, were seen increasing in number around Palmyra Atoll after a long-line fishing vessel wrecked in the area in 1991 and began corroding in the water. In 2004, corallimorph was observed surrounding the ship wreck in low densities during a routine survey dive by the U.S. Geological Survey (USGS). By 2006, corallimorph had spread 100m down current of the vessel and permanent monitoring transects were established to monitor its spread and growth. Recent reports from USGS in 2011 state that corallimorph has spread over 2km from the wreck location and is present in large monotypic stands, carpeting the substrate in areas that were once dominated by reef building corals. The speed at which the corallimorph is spreading poses a serious threat to the health of the reefs surrounding Palmyra. Of the 66 species of reef building corals proposed by NOAA to be listed under the Endangered Species Act, 15 occur on Palmyra, and are presently being smothered or encroached upon by corallimorph. Bumphead parrotfish and Humphead wrasse are among the fish species that are dependent on the coral reefs of Palmyra for food and shelter, habitat which is being destroyed as a result of the shipwreck and corallimorph.

The Refuge is currently working on the draft CCP for Palmyra Atoll NWR wherein Objective 4.2 is to restore coral reefs impacted by the shipwreck and invasive species corallimorph by removing the shipwreck and prevent the further spread of corallimorph by removal or control of its leading edge into native coral habitats. Shipwreck removal became a high priority project for the refuge system, and recently the service has awarded funding to remove the shipwreck at Palmyra, with complete removal of the wreck and surround debris field by December 31, 2013. Along with the removal, the service will restore 150 acres of the western terrace and fringing reefs by reducing corallimorph invasion by 70 percent of the 2011 mapped distribution within 5 years.

Requested funding

The 2013 marine ecosystem response to shipwreck removal project will cost a total of $40,000. We anticipate that of this total amount, approximately $9,000 will be needed for travel expenses including transportation from the US mainland to Palmyra at $3,000 per round trip; $27,000 for lodging at Palmyra for 30 days, at $300 per person per day; $4,000 for field work, supplies, and other project expenses.