



Baseline

Mapping elemental contamination on Palmyra Atoll National Wildlife Refuge



Matthew A. Struckhoff^{a,*}, Carl E. Orazio^a, Donald E. Tillitt^a, David K. Shaver^{b,1},
Diana M. Papoulias^{a,1}

^a US Geological Survey, Columbia Environmental Research Center, 4200 New Haven Rd., Columbia, MO 65203, USA

^b US Geological Survey, Mid-Continent Mapping Center, 1400 Independence Rd., Rolla, MO 65401, USA

ARTICLE INFO

Keywords:

Palmyra Atoll
Elemental contaminants
WWII Pacific bases
Line Islands
Geospatial data
Hand-held X-ray fluorescence spectrometry

ABSTRACT

Palmyra Atoll, once a WWII U.S. Navy air station, is now a U.S. National Wildlife Refuge with nearly 50 km² of coral reef and 275 ha of emergent lands with forests of *Pisonia grandis* trees and colonies of several bird species. Due to the known elemental and organic contamination from chemicals associated with aviation, power generation and transmission, waste management, and other air station activities, a screening survey to map elemental concentrations was conducted. A map of 1944 Navy facilities was georeferenced and identifiable features were digitized. These data informed a targeted survey of 25 elements in soils and sediment at locations known or suspected to be contaminated, using a hand-held X-ray fluorescence spectrometer. At dozens of locations, concentrations of elements exceeded established soil and marine sediment thresholds for adverse ecological effects. Results were compiled into a publically available geospatial dataset to inform potential remediation and habitat restoration activities.

Numerous Pacific islands served as U.S. Navy facilities during World War II (WWII) and are threatened by legacy contamination in the form of trace metals, persistent organic pollutants, petroleum-derived hydrocarbons, and radioactive materials (Nautilus Institute, 2017). Conservation of fish and wildlife species and protecting human health on lands formerly used for military purposes requires preventing and minimizing adverse effects from exposure to legacy contaminants. In recognition of this fact, contaminated materials have been and continue to be removed from a number of islands where military operations have historically occurred, including Johnston Atoll, Wake Island, Midway, and American Samoa (Smith, 2014). There is a continuing need for geospatial data to support these clean-up efforts, as well as to reduce the risks of exposure to fish, wildlife, and humans (Dell, 2014).

Palmyra Atoll is part of the Pacific Remote Islands Marine National Monument, 1773 km (1056 miles) south-southwest of Hawaii at 5° 53' N latitude and 162° 5' W longitude, toward the northwest end of the Line Islands (Fig. 1). Maximum natural elevation is approximately 2 m above mean sea level, and in most places the water table lies only 1 m below the surface. Average monthly air temperatures range from 23 to 30° C and average annual rainfall is 4060 mm (www.weatherbase.com). Dominant vegetation types include coconut palm forest (*Cocos nucifera*), *Scaveola* – *Tournefortia* scrub forest, *Pandanus* forest, and *Pisonia*

grandis beach forest.

The atoll was once comprised of numerous islets in a horseshoe shape open to the west and totaling about 120 ha in total land area. It has been uninhabited throughout most of its known history, but during WWII, the atoll was greatly modified to create a U.S. Naval Air Station. Areas of the reef were dredged, and the materials were used to increase land area for operational facilities and to create a landing strip for aircraft (Fig. 2).

An overview of ownership of the atoll islands and waters is important to consider in order to address a range of resource management goals relating to contaminant remediation and habitat restoration (Fig. 2). Between WWII and 2000, the entire atoll was privately owned, and Home Island remains so today (The Nature Conservancy, 2017). In 2000, The Nature Conservancy (TNC) acquired the rest of the atoll to protect its quality reef, and currently owns nearly all of Cooper Island and Menge Island (97 ha). Areas owned and managed by TNC include headquarters for all management and research activities on the atoll, including the operational runway originally built by the Federal Aviation Administration prior to WWII (Platt, personal communication). In 2001, several islets and small portions of Cooper Island (totaling 141 ha) were purchased by the Department of Interior (DOI) U.S. Fish and Wildlife Service (USFWS) to form the Palmyra Atoll National

* Corresponding author.

E-mail addresses: mstruckhoff@usgs.gov (M.A. Struckhoff), corazio@usgs.gov (C.E. Orazio), dtillitt@usgs.gov (D.E. Tillitt).

¹ Retired.



Fig. 1. Location of Palmyra Atoll National Wildlife Refuge. Image credit: Palmyra Atoll Research Consortium (Suchanek, 2012).

Wildlife Refuge, which also includes the lagoons and open ocean out to 12 nautical miles from the atoll. The DOI Office of Insular Affairs (OIA) retained 8 near-shore “exclusion areas” because of known or suspected contamination. An additional large exclusion area (652 km²) surrounding a Navy explosives dumping area west-southwest of the atoll partially intersects the 12 mile ownership buffer of the refuge.

Dredging during WWII affected only a relatively small area, and

most of the Palmyra coral reef system was not disturbed. The reef is considered pristine because it is not subject to overfishing and coastal runoff that affect many reefs throughout the world. The reef system supports 125 coral species and a predator-dominated food web with numerous species of sharks (Stevenson et al., 2007; The Nature Conservancy, 2017). Much of the terrestrial management at Palmyra is intended to support sea bird breeding and resting grounds, and to protect and restore stands of *Pisonia grandis*, a species in decline throughout its range (Batianoff et al., 2010; Handler et al., 2007). The islands provide nesting habitat for more than one million marine birds, including sooty terns (*Onychoprion fuscatus*), fairy terns (*Sterna nereis*), boobies (*Sula* spp.), bristled-thigh curlews (*Numenius tahitiensis*), and red-tailed tropic birds (*Phaethon rubricauda*). Other notable natural resources at Palmyra include the world’s largest terrestrial arthropod, the endangered coconut crab (*Birgus latro*). The atoll is also a nesting site for green sea turtles (*Chelonia mydas*) (Kropidlowksi, personal communication).

Chemical contaminants and debris remaining at Palmyra Atoll may threaten the integrity of both terrestrial and marine ecosystems. At the conclusion of WWII, the Navy abandoned many potential sources of contamination in-situ, including electrical transformers, unexploded ordnance, vehicles, fuel tanks, and mechanical and industrial facilities that supported the naval air station. Some buildings were left in place; others were disassembled or bulldozed. Large debris piles were either burned or allowed to deteriorate in both terrestrial and near-shore locations. Although the locations of these piles and buffers around them are in the OIA exclusion areas and not under USFWS ownership, they nonetheless threaten atoll resources based on the exposure potential from the migration of contaminants.

There have been attempts both to document and clean up contaminated sites on the Palmyra Atoll. A Defense Environmental Restoration Program review in 1987 identified the presence of legacy contaminants from use by the Navy during WWII (U.S. Army Corps of

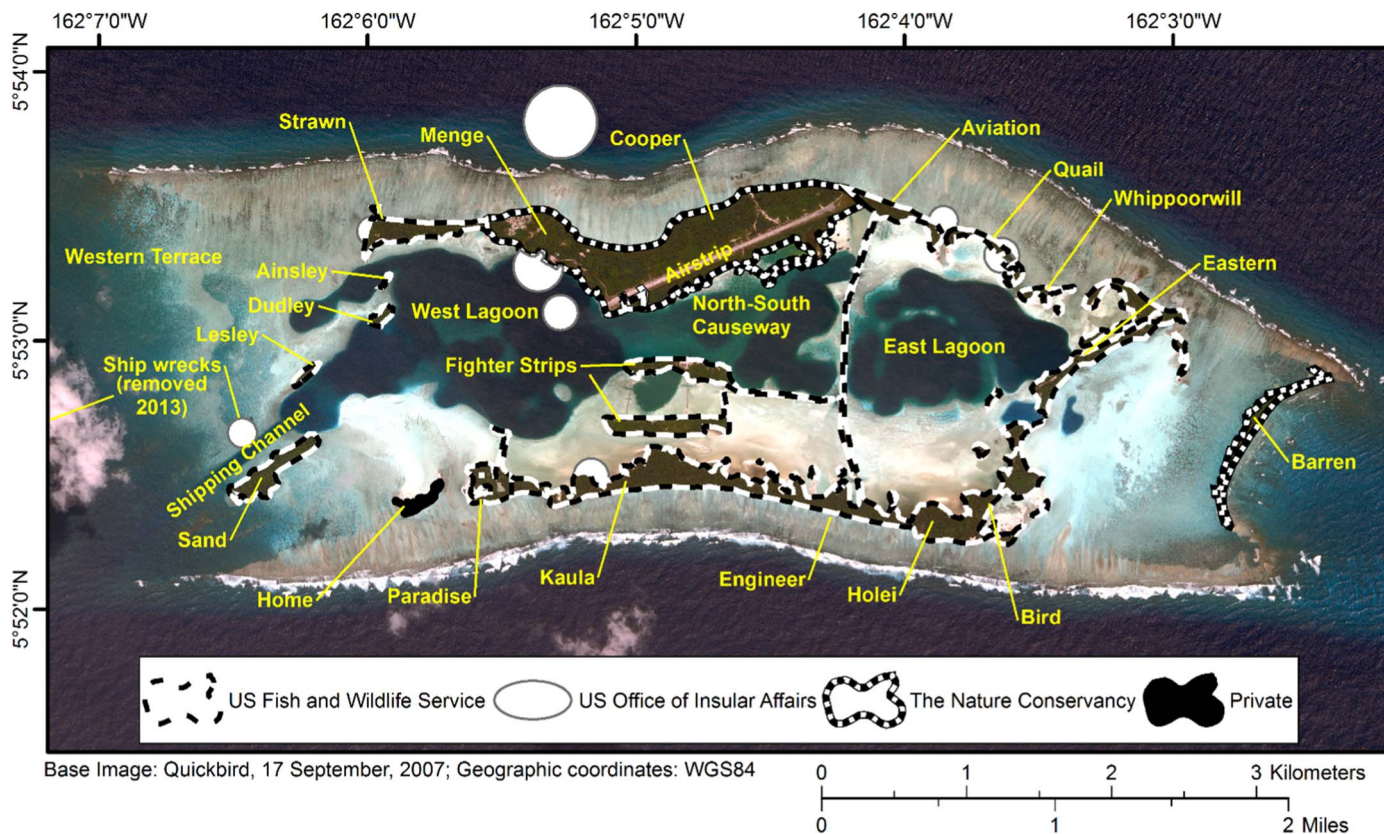


Fig. 2. Satellite image of Palmyra Atoll in 2007 showing current ownership.

Download English Version:

<https://daneshyari.com/en/article/8871882>

Download Persian Version:

<https://daneshyari.com/article/8871882>

[Daneshyari.com](https://daneshyari.com)