Quantifying the Accumulation of Marine Debris Near Coral Reefs Using Aerial Imagery and GIS Analysis

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INTRODUCTION & PURPOSE

Marine debris poses serious risks to Hawai'i's fragile reef environment:

- Introduction of aquatic invasive species
- Ingestion by reef wildlife
- Physical breakage
- Entanglement

Given the vast extent and remoteness of coastlines in the Hawaiian Islands, large scale surveillance efforts are necessary to identify and describe accumulations of shoreline marine debris.

Capture and analysis of high-resolution aerial imagery allows for rapid qualitative and quantitative assessments at this scale, providing data that can be used to plan further management actions and establish a baseline of debris accumulations to evaluate patterns over time.

METHODS: AERIAL IMAGERY ANALYSIS

Aerial ortho-imagery was collected from a Cessna 206 between August and November 2015 with a spatial resolution of 2 cm in swaths of 200-300 m (Figure 1).

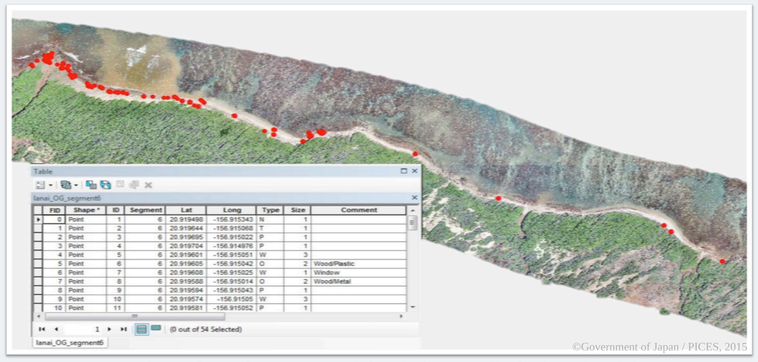


Figure 1. GIS analysis of aerial imagery. Red dots indicate individual marine debris items.

Individually detected points of debris were then categorized by type and size class(Figure 2).

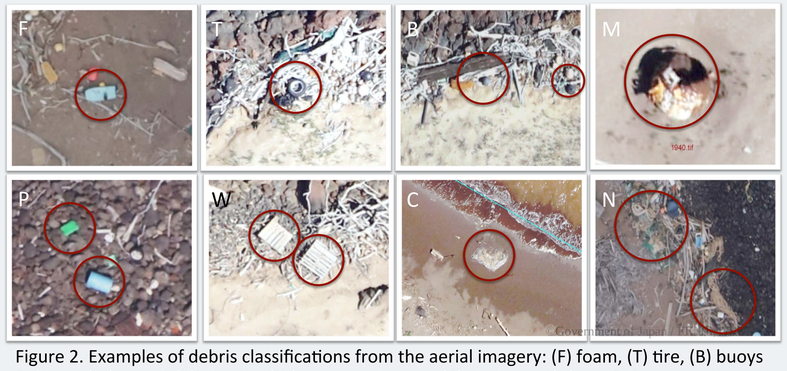


Figure 2. Examples of debris classifications from the aerial imagery: (F) foam, (T) tire, (B) buoys & floats, (M) metal, (P) plastics, (W) processed wood, (C) cloth, and (N) net & line. Not pictured: (V) vessels, (O) other or (U) unknown.

Once compiled, debris densities were analyzed by quantity, location, category and size (Figure 3). Additional ground truth surveys were conducted to evaluate vessels identified from the aerial imagery.

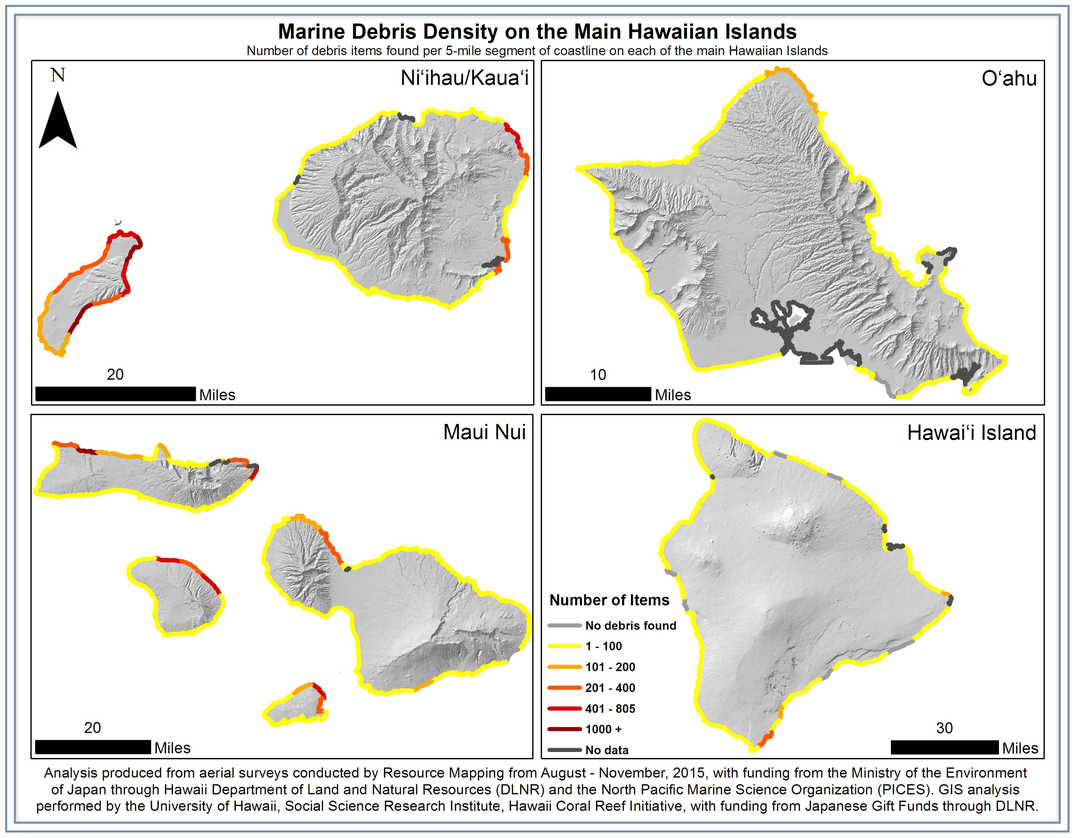


Figure 3. Statewide map of marine debris densities from the aerial imagery analysis.

METHODS: VESSEL GROUND TRUTHING

The aerial survey analysis detected 50 separate vessels (Figure 4), evaluated for:

- Boat identification information
- Condition
- Risk of washing out in high storm surge
- Biofouling – presence of alien species
- JTMD status – possibility of the boat coming from the Tohoku Earthquake in Japan in 2011.

An estimated 1.5 million tons of **JTMD**, or **Japanese Tsunami Marine Debris**, has been drifting across the North Pacific since March 2011. JTMD began arriving in North America in March 2012 and in Hawai'i in September 2012. 8 vessels were identified as JTMD from the analysis.

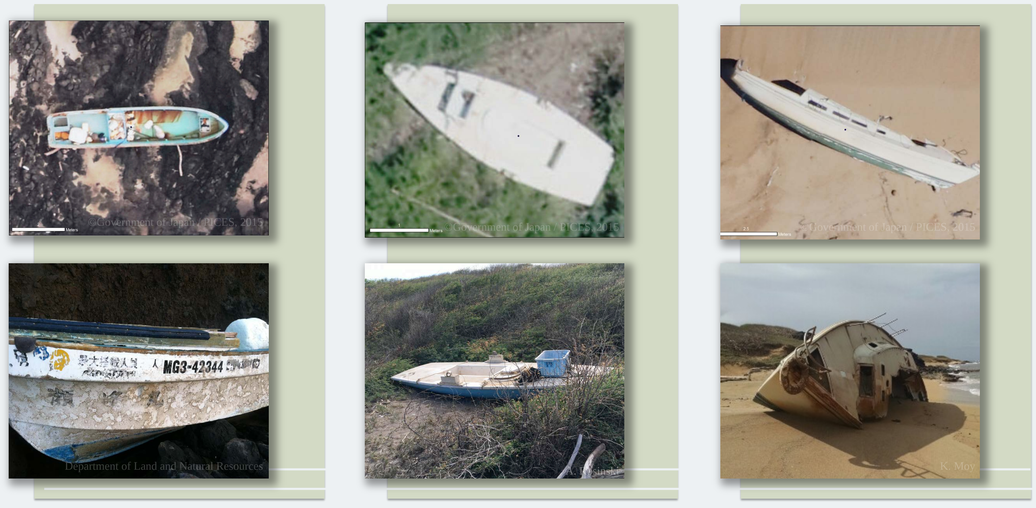
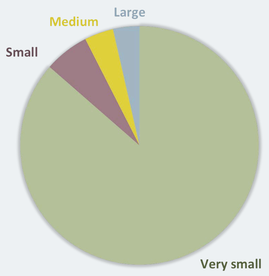


Figure 4. Imagery from the aerial survey (top) and the corresponding photos from ground truth observations (bottom). JTMD vessels were detected and identified through boat ID numbers (left). Other vessels were suspected marine debris that were privately owned and in use (center). Ground truthing also revealed some vessels predated the tsunami (right).

KEY FINDINGS



- 86% of debris identified was very small (<0.5 m^2). Small (0.5 – 1 m^2), medium (1 – 2 m^2), and large (>2 m^2) debris made up only 6% to 4%.
- Marine debris "**hotspots**" identified in the analysis (Figure 3) provide guidance to local cleanup organizations and managerial agencies.
- **Plastics** were the most common debris type, making up about 50% of the total detected debris on every island (Figure 5).

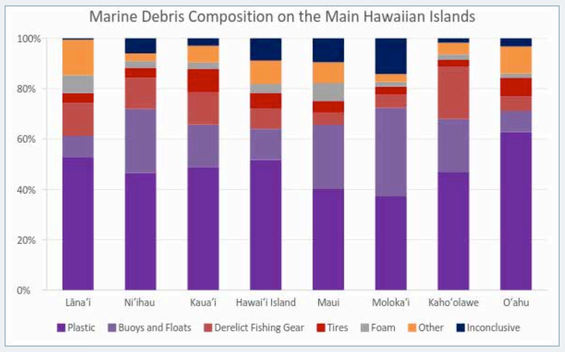


Figure 5. Categorical composition of marine debris in the MHIs. Combined categories include derelict fishing gear (nets and line) and other (processed wood, metal, cloth, and vessels).

- Having the data in a GIS format improves the study's usefulness to inform site prioritization, accessibility, and resource needs.
- Ortho-imagery offers a consistent, structured method of monitoring for purposes other than marine debris such as coral bleaching, wildlife and fisheries monitoring, shoreline erosion, and sea level rise (Figure 6).

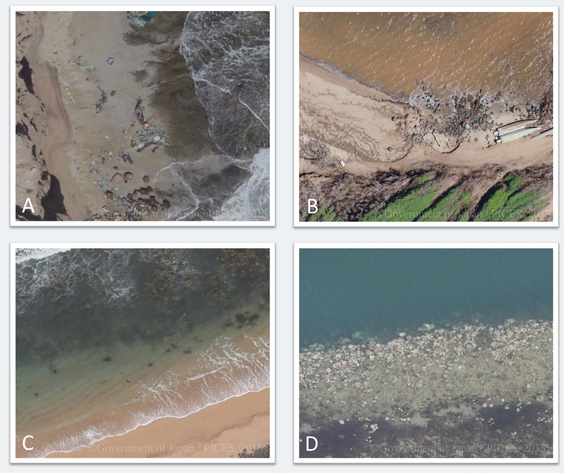


Figure 6. Aerial imagery depicting (A) Hawaiian monk seals, (B) shoreline sedimentation, (C) sea turtles in water, and (D) coral bleaching.

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