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# Pacific Reef Assessment and Monitoring Program

## Fish Monitoring Brief: Jarvis Island Time Trends, 2008 – 2017[1]

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## Background

The NOAA Pacific Islands Fisheries Science Center conducts the long-term Pacific Reef Assessment and Monitoring Program (Pacific RAMP) to track the status and trends of coral reef ecosystems of the U.S. Pacific Islands. This summary brief provides an overview of a subset of the data from surveys conducted at Jarvis Island in April 2017 relative to previous survey years. More detailed survey results will be available in a forthcoming status report (see web-links at end of brief).

## Jarvis Island

Jarvis Island is located in the central equatorial Pacific (0°22.5'S, 160° 1.0'W). It is a small island (4.5 km$^2$) that lies in the direct path of the surface westward-flowing South Equatorial Current and the eastward-flowing subsurface Equatorial Undercurrent. The coral reefs of Jarvis are bathed in cool, nutrient-rich waters (Fig. 1) driven by both equatorial upwelling and topographic upwelling of the EUC. This water fertilizes the whole area, elevating nutrient levels and productivity in the reef ecosystem (Gove et al., 2006). As a result, Jarvis supports an especially high biomass of planktivores and piscivorous fishes (Williams et al., 2015). Because Jarvis is unpopulated and remote, it provides an important reference point and opportunity to understand the natural structure, function, and variability of a natural coral reef ecosystem in the absence of direct stressors that impact coral reefs where humans are present (e.g. fishing or land-based sources of pollution).

## El Niño, La Niña and the Global Coral Bleaching Event of 2014-2015

The central Equatorial Pacific alternates between warm El Niño years, when upwelling is weak and oceanic productivity low, and cool La Niña years, when upwelling is strong and productivity is high (Gove et al., 2006). The anomalously warm sea surface temperatures and strong El Niño of 2015-2016 coincided with the third recorded global coral bleaching event. At Jarvis, these warmer waters led to widespread coral bleaching and mortality. High sea surface temperatures in 2015-2016 also impacted upwelling at Jarvis, as evidenced by a decrease in the primary productivity around the island.

## Sampling Effort

- The most recent ecological monitoring at Jarvis took place from April 2 2017, to April 5 2017.
- Data were collected at 28 sites in 2017, 30 in 2016, 62 in 2015, 42 in 2012, and 30 in 2010.
- At each site, divers visually surveyed the fish assemblage and estimated benthic cover (Fig. 2).

[1]PIFSC Data Report DR-18-003.
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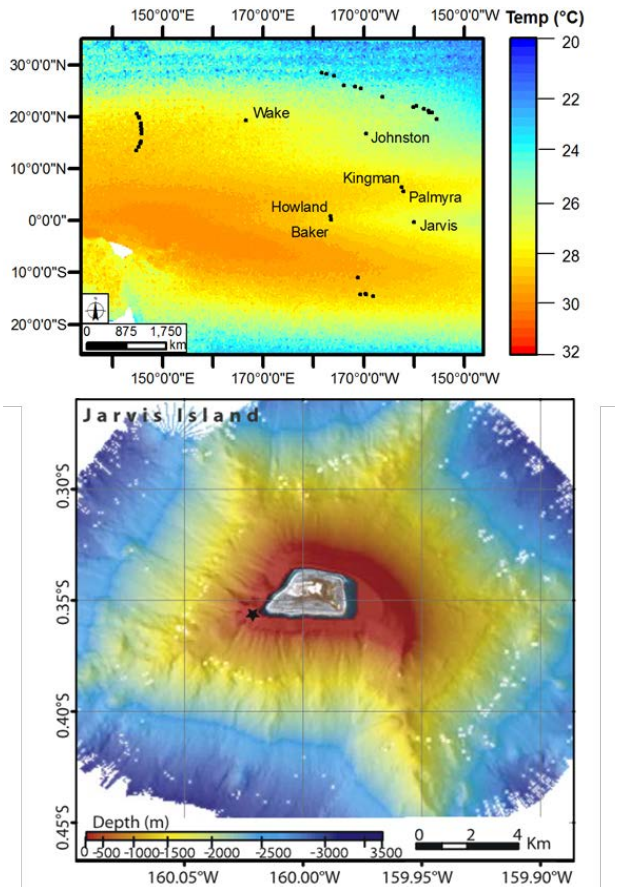


**Figure 1. The temperature map (top) and bathymetry (bottom) around Jarvis. The temperature map shows a long-term average sea surface temperature across the Pacific Ocean for 2003-2016, from satellite-derived data (NOAA POES AVHRR) for the geographic area 25°S–35°N, 135°E–145°W, White space indicates areas with no data while black areas are island midpoints.[1]**

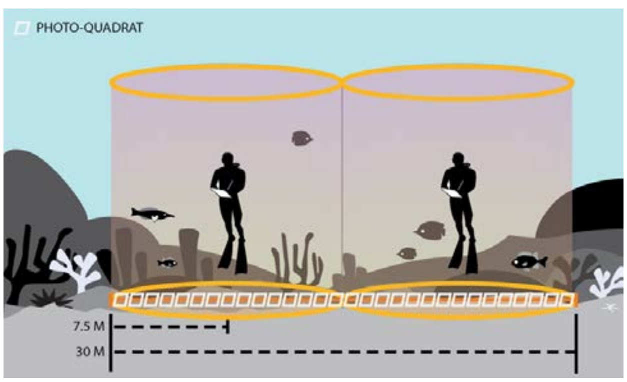


**Figure 2. Method used to monitor fish assemblage and benthic communities at the Rapid Ecological Assessment (REA) sites.**

## Main Observations

Fish biomass tends to be highest on the western side of the island where topographic upwelling of the EUC occurs (Fig. 3).

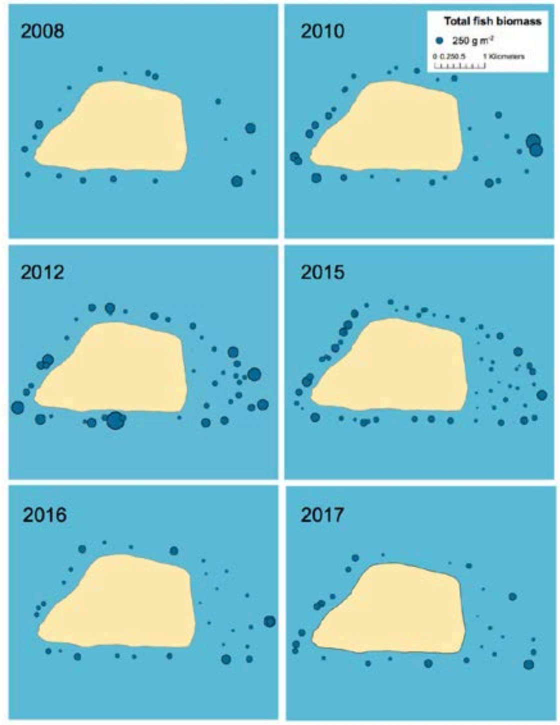


**Figure 3. Total fish biomass at sites surveyed per year.**

In 2016, immediately following the 2015-2016 El Nino, we observed reduced total fish and planktivore biomass (Fig. 4). This reduction was within the normal range of variability we have seen in previous years.

[1] http://gis.ncdc.noaa.gov/all-records/catalog/search/resource/details.page?id=gov.noaa.ncdc:C00284.

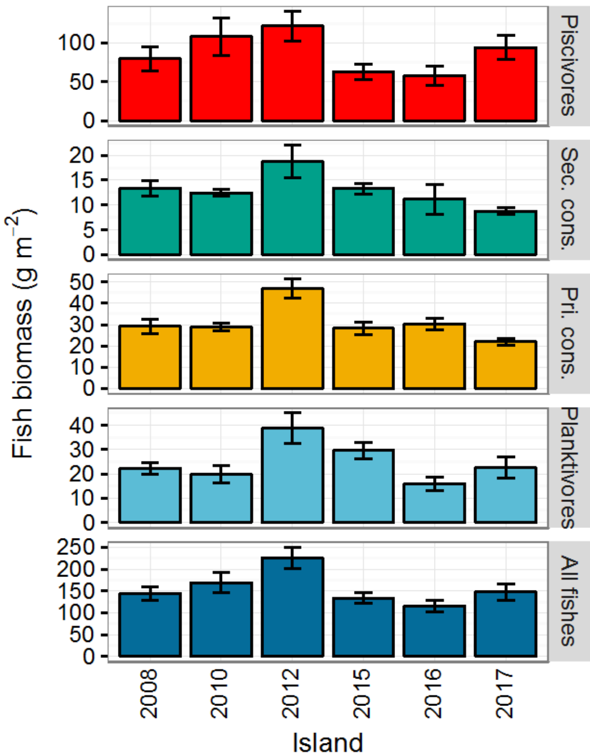


**Figure 4. Primary consumers include herbivores (which eat plants) and detritivores (which bottom feed on detritus), and secondary consumers are largely omnivores (which mostly eat a variety of fish and invertebrates) and invertivores (which eat invertebrates)**

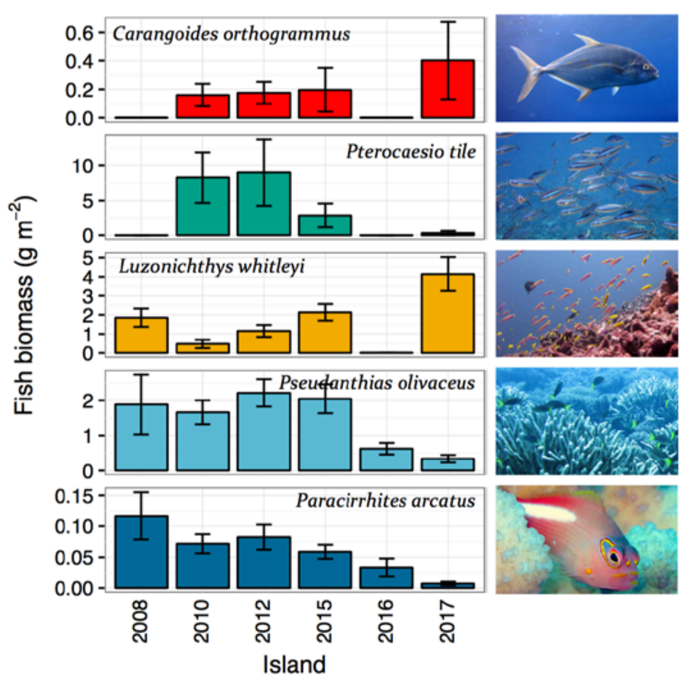


**Figure 5. Mean species biomass (± standard error) per survey year at Jarvis.**

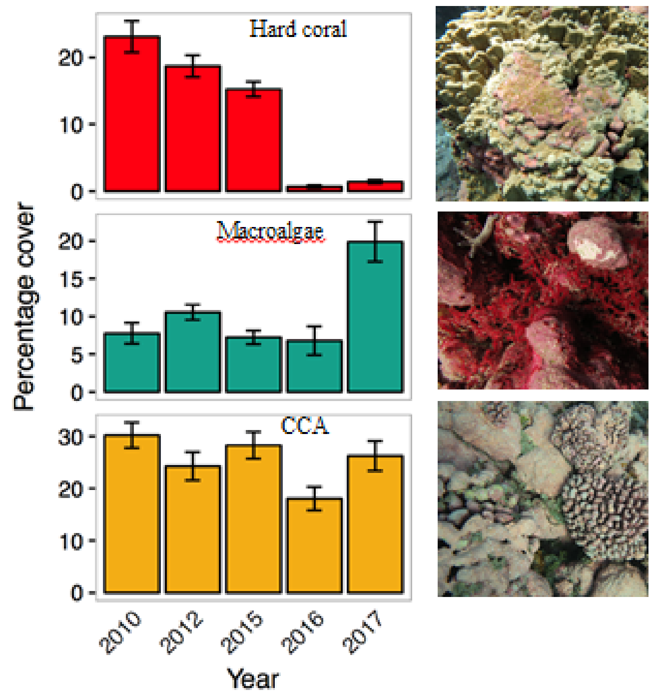


**Figure 6. Mean percentage cover estimates (± standard error) of benthic habitat per survey year at Jarvis. CCA: crustose coralline algae. Note: no benthic data are available for 2008 as we began collected rapid visual estimates of these benthic functional groups in 2010.**

Some species appeared significantly reduced in 2016. These reductions were noticeable across multiple trophic groups, for instance the planktivorous Whitley's fusilier *Luzonichthys whitleyi*, Olive anthias *Pseudanthias olivaceus*, dark banded fusilier *Pterocaesio tile*, the piscivorous Island trevally *Carangoides orthogrammus*, and the coral dwelling arc-eyed hawkfish *Paracirrhites arcatus* which is strongly associated with Pocillopora coral heads. Some of these species had returned to previous ranges by 2017, but others remain depleted (Fig. 5).

Exceptionally high levels of coral mortality were documented during the 2016 surveys, and, unsurprisingly cover remained low in 2017. Notably, macroalgal cover increased in 2017, approximately by the amount of coral cover lost in 2016 (Fig. 6).

Whether this reduction in specific planktivore, piscivore, and live coral-dwelling fish species was a long-standing and widespread shift in the fish assemblages at Jarvis will be the subject of forthcoming research. It seems plausible that they reflect impacts of a prolonged period of reduced food availability (Fig. 7) and changes to preferred habitat due to the anomalously warm sea conditions in 2015-2016.

**Figure 7. Figure 7. An emaciated grey reef shark Carcharhinus amblyrhynchus observed during a 2017 fish survey.**

Spatial Sample Design

Survey site locations were randomly selected using a depth-stratified design. Logistic and weather conditions factor into the allocation of monitoring effort around each island or atoll. The geographic coordinates of sample sites were randomly drawn from a map of the area of target habitat (hard-bottom reef) at Jarvis, within the depth strata of shallow (0-6 m), mid (6-18 m), and deep (18-30 m).

## Sampling Methods

A pair of divers surveyed the fish assemblage at each site using a stationary-point-count method (Fig. 5). Each diver identified, enumerated, and estimated the total length of fishes within a visually estimated 15-m-diameter cylinder with the diver stationed in the center. These data were used to calculate fish biomass per unit area (g $m^{-2}$) for each species. Mean biomass estimates per island were calculated by weighting averages by the area per stratum.

Each diver also conducted a rapid visual assessment of reef composition by estimating the percentage cover of encrusting algae, fleshy macroalgae, and hard corals in each cylinder. Divers also estimated the complexity of the reef structure, and collected photographs along a transect at each site that were archived to allow for future analysis.

## About the Monitoring Program

Pacific RAMP forms a key part of the National Coral Reef Monitoring Program of NOAA's Coral Reef Conservation Program (CRCP), providing integrated, consistent, and comparable data across U.S. Pacific islands and atolls (Fig. 8). The following aims are part of the CRCP monitoring efforts:

- Document the status of reef species of ecological and economic importance.
- Track and assess changes in reef communities in response to environmental stressors or human activities.
- Evaluate the effectiveness of specific management strategies and identify actions for future and adaptive responses.

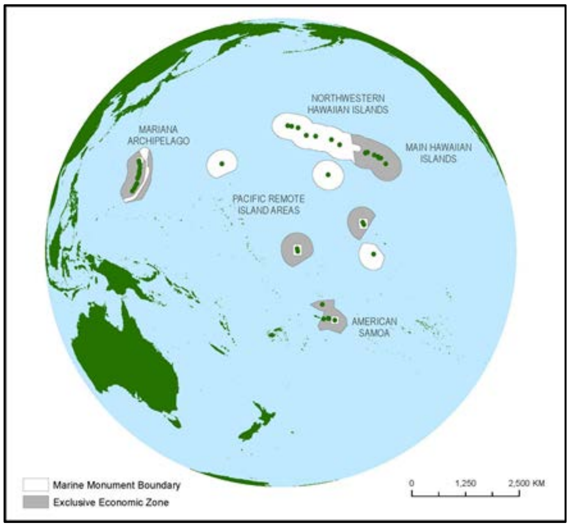


**Figure 8. NOAA-PIFSC monitors the status and trends of coral reef ecosystems of ~ 40 islands, atolls, and shallow banks spanning the waters of American Samoa, the Hawaiian Archipelago, the Mariana Archipelago, and the Pacific Remote Islands Marine National Monument. Gray areas represent the U.S. Exclusive Economic Zones and the white areas represent the four large Marine National Monuments in these areas.**

## For more information

Coral Reef Conservation Program:
http://coralreef.noaa.gov
NMFS Pacific Islands Fisheries Science Center:
http://www.pifsc.noaa.gov/
Related publications:
http://www.pifsc.noaa.gov/pubs/credpub.php
Additional information:
http://www.pifsc.noaa.gov/cred/fish.php
Fish team lead: ivor.williams@noaa.gov

## References

Gove J. et al. (2006) Temporal variability of current-driven upwelling at Jarvis Island. J Geo Res: Oceans 111, 1-10, doi: 10.1029/2005JC003161

Williams I. et al. (2015) Human, oceanographic and habitat drivers of central and western Pacific coral reef fish assemblages. PLoS 10: e0120516, doi: 10.1371/journal.pone.0120516