Pacific Reef Assessment and Monitoring Program

Fish monitoring brief: Jarvis Island time trends 2008-2017

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Background

The Coral Reef Ecosystem Program (CREP) of the NOAA Pacific Islands Fisheries Science Center conducts a long-term monitoring program, the Pacific Reef Assessment and Monitoring Program (Pacific RAMP). In recent years, we have conducted surveys, auxiliary to Pacific RAMP and funded by the NOAA Ocean Acidification Program to assess the impacts of the 2014-2015 global bleaching event. This summary brief provides a rapid preliminary overview of the most recent data relative to previous years at Jarvis. More detailed survey results will be available in a forthcoming status report (see web-links at end of brief).

Jarvis Island

Jarvis 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 Equatorial Undercurrent, a deep subsurface current that flows east (Figure 1). Because of it's position right on the equator and the strong currents hitting the island, Jarvis sits in the middle of a major upwelling zone, where cold nutrient rich water is drawn up from the deep. 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 extremely remote, it provides an important reference point and opportunity to understand the natural structure, function and variation in coral reef ecosystems. It also offers a natural laboratory in which the effects of ocean warming can be assessed in the absence of 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 Equatorial Pacific upwelling at Jarvis alternates between warm El Niño years, when upwelling is weak and oceanic productivity low and cold La Niña years where upwelling is strong and productivity is high (Gove et al. 2006). The anomalously warm sea surface temperatures and strong El Niño of 2014-2015 triggered 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 also impacted upwelling at Jarvis, as evidenced by a decrease in the primary productivity around the island.

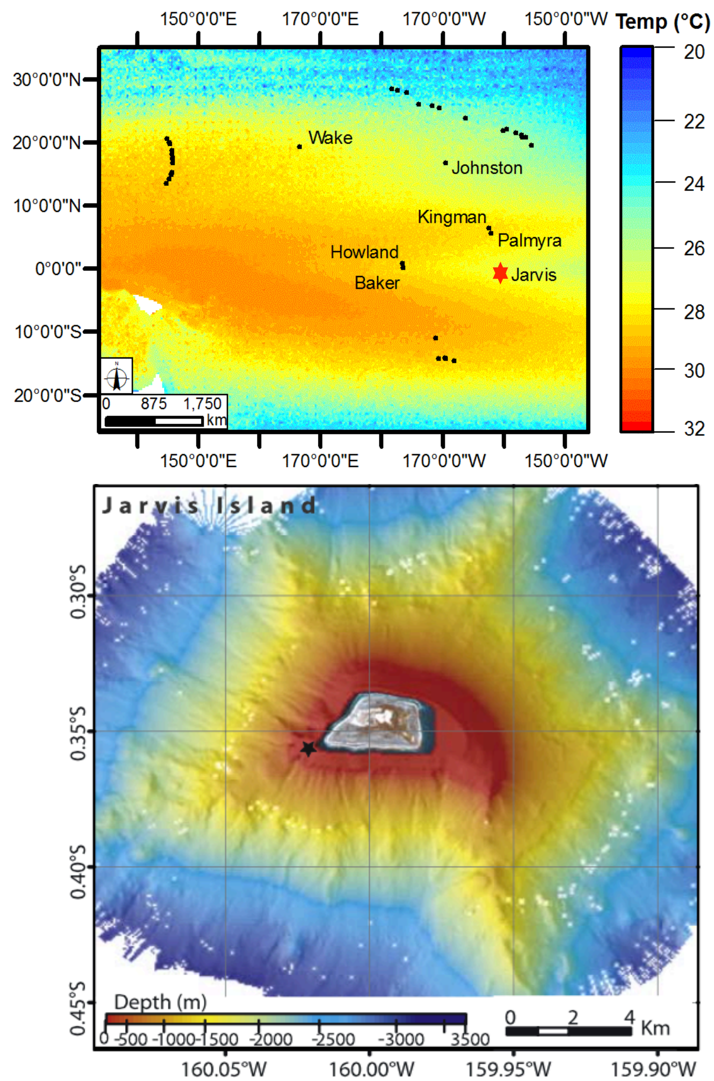

Figure 1. The temperature profile (top) and bathymetry (bottom) around Jarvis.

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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 this year, 30 in 2016, 62 in 2015, 42 in 2012, and 30 in 2010.
- At each site, divers surveyed the fish assemblage was and visually assessed benthic cover (Figure 2).

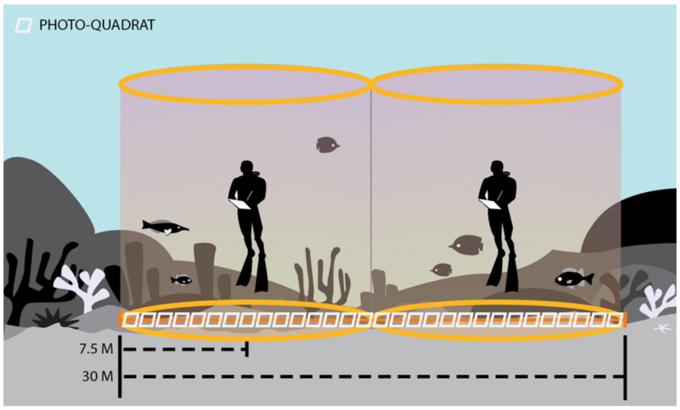

Figure 2. The stationary point count method is used to monitor the fish assemblage and benthic communities at the Rapid Ecological Assessment (REA) sites.

Overview of the data

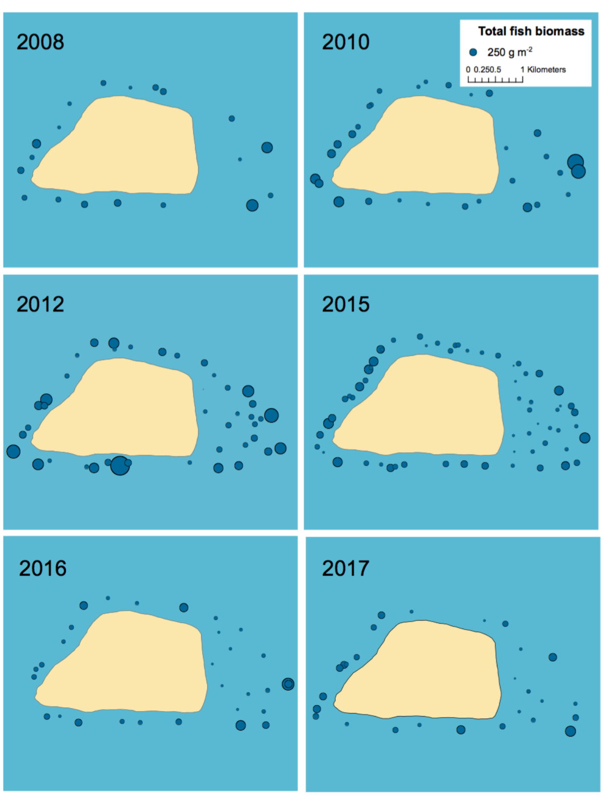

Figure 3. Total fish biomass at sites surveyed per year.

Main observations

- Fish biomass tends to be highest on the western side of the island where equatorial upwelling occurs (Figure 3).
- In 2016 we observed somewhat reduced total fish and planktivore biomass (Figure 4). This reduction was within the normal range of variability we have seen in previous years.
- 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 (Figure 5).

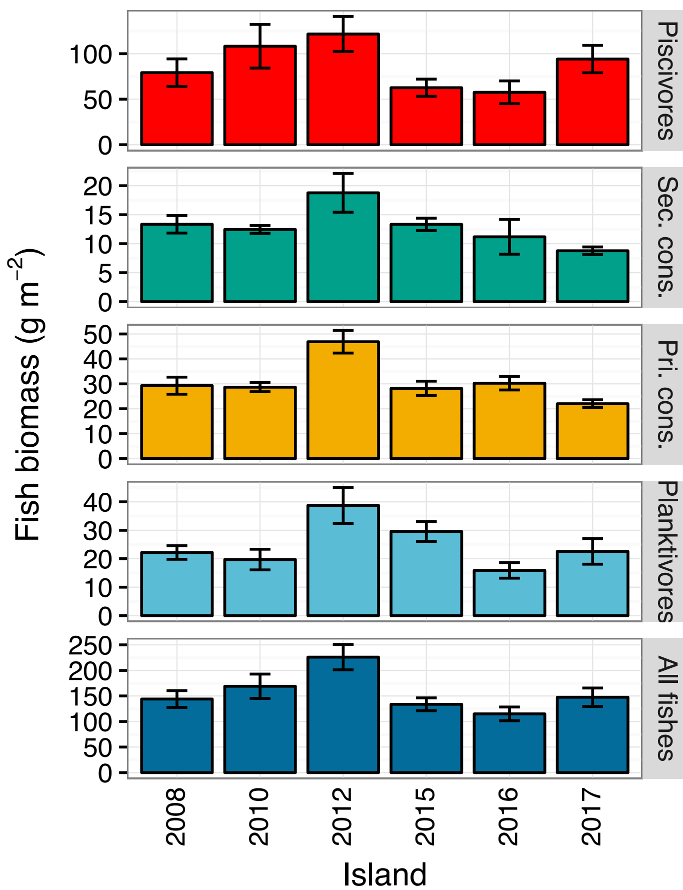

Figure 4. Primary consumers include herbivores (which eat plants) and detritivores (which bottom feed on detritus), and secondary consumers are largely omnivores (which mostly eat a variety of fish and invertebrates) and invertivores (which eat invertebrates).

- Very high levels of coral mortality were evident in 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 (Figure 6).

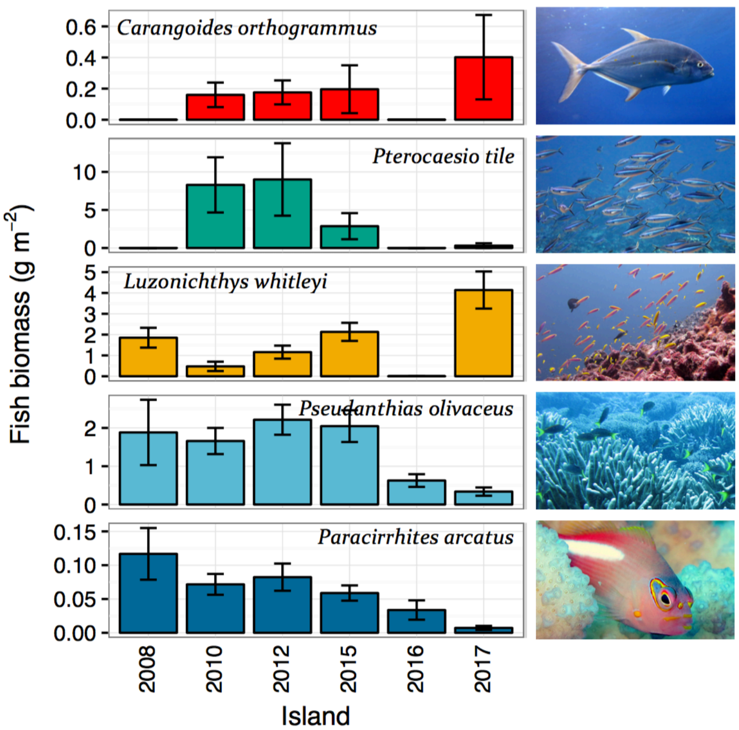

Figure 5. Mean species biomass (± standard error) per survey year at Jarvis.

Whether this reduction in specific planktivore, piscivore and live coral dwelling fish species is a widespread and long-standing 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 (Figure 7) and changes to preferred habitat due to the anomalous warm sea conditions in 2014-15.

Methods

Sampling design

Survey site locations are 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 are then randomly drawn from a map of the area of target habitat (hard-bottom reef) per study area (typically an island or atoll, or in the case of larger islands, sectors per island), within the depth strata of shallow (0-6 m), mid (6-18 m), and deep (18-30 m).

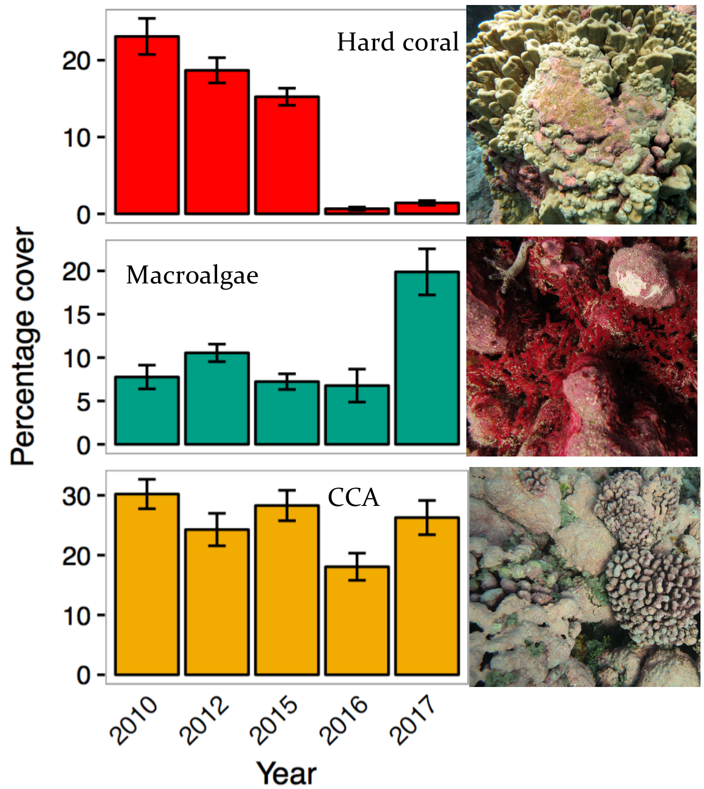

Figure 6. Mean percentage cover estimates (± standard error) of benthic habitat per survey year at Jarvis. CCA: crustose coralline algae. Note: no benthic data are available for 2008 as we began collected rapid visual estimates of these benthic functional groups in 2010.

Survey method

A pair of divers surveys the fish assemblage at each site using a stationary-point-count method (Fig. 2). Each diver identifies, enumerates, and estimates the total length of fishes within a visually estimated 15-m-diameter cylinder with the diver stationed in the center. These data are used to calculate fish biomass per unit area (g m^{-2}) for each species. Mean biomass estimates per island are calculated by weighting averages by the area per strata. Island-scale estimates presented here represent the areas surveyed during each survey period. Each diver also conducts 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 estimate the complexity of the reef structure, and take photos along a transect at each site that are archived to allow for future analysis.

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

About the monitoring program

Pacific RAMP is 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 (Figure 8). CRCP monitoring efforts have these aims:

- 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

For more information

Coral Reef Conservation Program:
http://coralreef.noaa.gov
NMFS Pacific Islands Fisheries Science Center:
http://www.pifsc.noaa.gov/
CREP publications:
http://www.pifsc.noaa.gov/pubs/credpub.php
CREP fish team:
http://www.pifsc.noaa.gov/cred/fish.php
Survey methodology standard operating procedures:
https://www.pifsc.noaa.gov/library/pubs/admin/PIFSC_Admin_Rep_15-07.pdf
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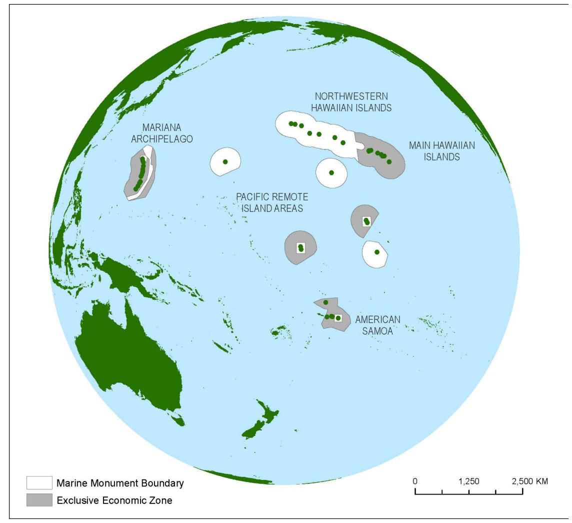

Figure 8. NOAA-CREP monitors the status and trends of coral reef ecosystems of ~40 islands, atolls, and shallow banks spanning the waters of American Samoa, the Hawaiian Archipelago, the Mariana Archipelago, and the Pacific Remote Islands Marine National Monument. Gray areas represent the U.S. Exclusive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

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