

Coral Reefs of Guam: Results from Intensive Surveys by NOAA PIFSC CRED May-June 2011



Coral reef fish and benthos were surveyed at 133 coral reef sites around Guam in May and June 2011 during a CNMI Reef Assessment and Monitoring Program (RAMP) cruise and a supplemental shore-based survey effort. Both projects were conducted by NOAA Pacific Islands Fisheries Science Center's Coral Reef Ecosystem Division (CRED). More detailed results and all survey data are available on request (email: nmfs.pic.credinfo@noaa.gov; web: www.pifsc.noaa.gov/cred).

Project Goals, Survey Sites, Methods

The goals of the combined survey effort were: (i) to generate a more spatially comprehensive data set on the coral reefs around Guam than has been possible based on 4-5 survey-days (which has been the standard for the Guam portion of biennial cruises conducted since 2003); and (ii) to generate data to assess the status of reef fish assemblages in Guam's marine preserves (MPs) and to compare those with assemblages in areas around Guam that were open to fishing.

Sites were randomly located in hardbottom habitats < 30 m deep and surveyed using a visual survey method, in which SCUBA divers recorded the species, number, and size of all fishes observed within visually-estimated 15-m diameter cylinders. At the end of the fish counts, divers estimated benthic cover within their cylinder in broad functional categories: coral, turf, macroalgae, crustose coralline algae [CCA].

Eighty-five sites were surveyed in areas open to fishing and another 48 within Pati Point, Tumon Bay, Piti Bomb Holes, and Achang Reef Flat MPs (Fig. 1). No surveys were conducted in Sasa Bay MP or elsewhere in Apra Harbor because it seemed likely that reefs within the harbor would not be readily comparable with those elsewhere around the island. Given the expectation that reef fish assemblages in open areas on the exposed and relatively inaccessible east side of Guam might differ from those in open areas on the west side of Guam, open sites were pooled separately into two sectors: Guam East; and Guam West (Fig. 1).

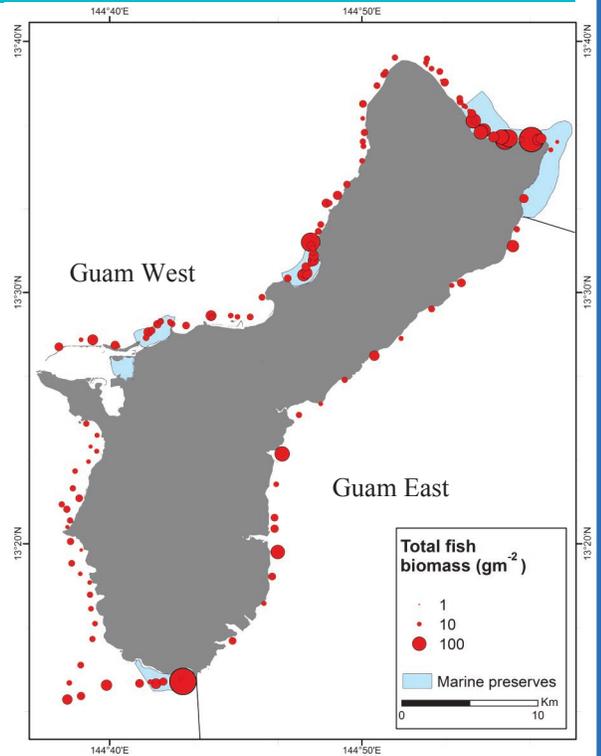


Figure 1. Total reef fish biomass at Guam survey sites. 'Guam East' consists of all reefs from the SE edge of the Pati Point MP to the eastern edge of the Achang Reef Flat MP.

Overview of Coral Reef Fish & Benthic Condition

- Total reef fish biomass varied substantially among sites, but many of the highest biomass sites were within marine preserves, including the 6 sites with highest biomass and 15 of the top 20 sites by biomass (Fig. 1). Among open sites, biomass tended to be higher at sites on the east coast of Guam; mean biomass at east coast open sites was nearly double that at west coast sites (Figs. 1 & 3A).
- Benthic cover varied among sites, but there were no clear differences between MP and open sectors overall; coral and macroalgal cover averaged ~ 20% and ~ 25%, respectively, in MPs and in open sectors. Sites on the SW coast had consistently low coral cover and abundant macroalgae (Fig. 2 A&B). Turbid water and conspicuous fine sediment on reefs there suggested terrigenous sedimentation may be a factor. Low biomass of herbivorous fishes (Fig. 2C) could also contribute to relative algal dominance of those reefs.

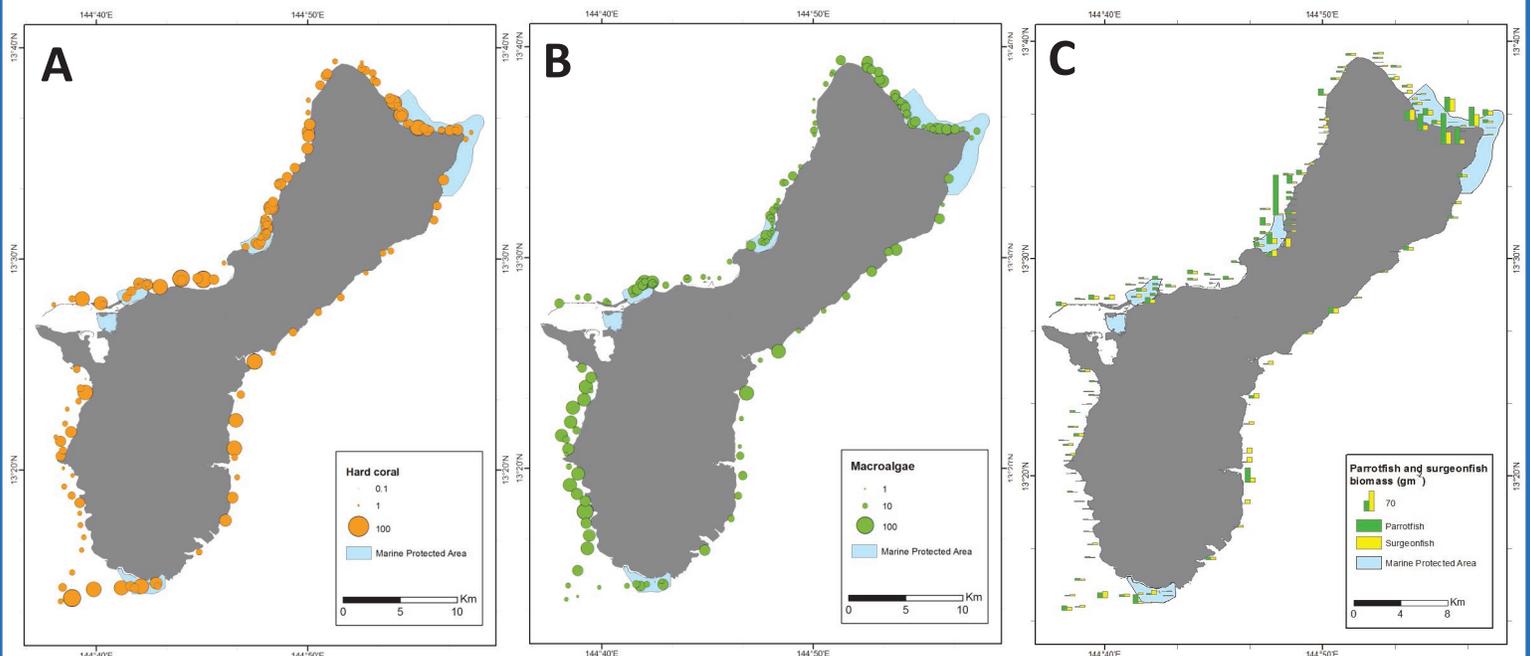


Figure 2. Benthic cover and herbivorous fish biomass at Guam survey sites. Benthic % cover was visually estimated by divers in broad functional categories, including (A) Hard Coral; and (B) Upright Macroalgae. Figure C shows biomass of two main herbivorous fish families: parrotfishes and surgeonfishes.

Reef Fish Assemblages inside and outside of Guam Marine Preserves

- Mean total reef fish biomass in Guam Marine Preserves (MPs) was 2.4 times that in Guam sites open to fishing overall (Fig. 3B), but the difference between MP and Guam-west open sites was much larger than between Guam MP and Guam-east open sites (3.0 and 1.8, respectively, Fig. 3B).

- MP sites had higher mean biomass than open sites for all families analyzed, but the differences were statistically significant only for parrotfishes and surgeonfishes.

- Large piscivorous fishes, i.e., sharks, large jacks, large-bodied grouper, some snappers and emperors, were rarely encountered, but sightings were more frequent at Pati Point MP than elsewhere (Fig. 4). Collectively, total piscivore biomass in MPs was 6.8 times that in open areas (95%CI: 1.2-17.6).

- Pati Point MP was the only location where reef sharks were recorded during point-count surveys, and was also the location where three of five observations of giant humphead wrasse (*Cheilinus undulatus*) occurred (Fig. 4).

- There was no indication that fish assemblage differences between MP and open reef areas were driven by systematic differences in habitat quality, as overall mean coral and algal cover and mean structural complexity were nearly identical between MPs and both east and west open sectors.

Comparisons between Guam and Other Islands in the Mariana Archipelago

- The availability of data gathered by the RAMP using consistent methods, design, and personnel at ~ 40 Pacific Islands allows for robust comparisons within and across multiple Pacific archipelagos and can provide context and perspective to local survey and monitoring programs elsewhere in the Pacific.

- CRED surveys islands in the Mariana Archipelago from Guam to Farallon de Pajaros (Fig. 5). Southern islands are adjacent to human population centers, but northern islands are unpopulated or sporadically very lightly populated. Results from 2011 surveys, such as relatively high biomass in Guam MPs, and substantial contribution of piscivores and of large fishes to total biomass (Fig. 5) indicate that, in several respects, fish assemblages in Guam MPs are more comparable to those in northern islands than at southern islands. However, interpretation of north-south differences is complicated by habitat differences between those regions and uncertainty about the extent of human impacts on northern islands.

- Other results of interest include distinct differences in parrotfish assemblages, with survey biomass at northern islands dominated by three large-bodied species (*Scarus forsteni*, *S. rubroviolaceus*, and *Chlorurus microrhinos*). In contrast, *C. sordidus*, was rarely recorded during northern island surveys but was the largest component of parrotfish biomass at southern islands.

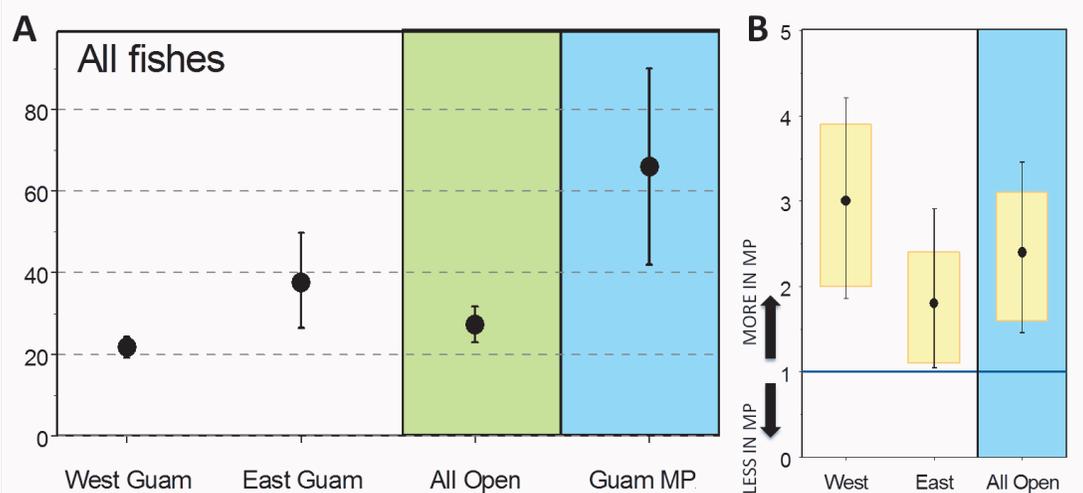


Figure 3. Total reef fish biomass in Guam Marine Preserves (MPs) and open areas. (A) mean and 95% quantile range [QR] of total reef fish biomass; (B) Biomass ratio [BR], i.e., biomass in MPs divided by biomass in open areas. Yellow boxes are 80% QR of the BR, errors bars are 95% QR. The blue horizontal line in (B) represents BR = 1. QRs that do not overlap 1 indicate statistically significant difference between MP and open areas, e.g., entire QR > 1 indicates that biomass is higher within MPs. 'Guam MP' and 'All Open' in (A) are weighted means, weighted by reef area (< 30 m hardbottom) per MP or sector. QRs are comparable to confidence intervals and were calculated using a bootstrapping approach.

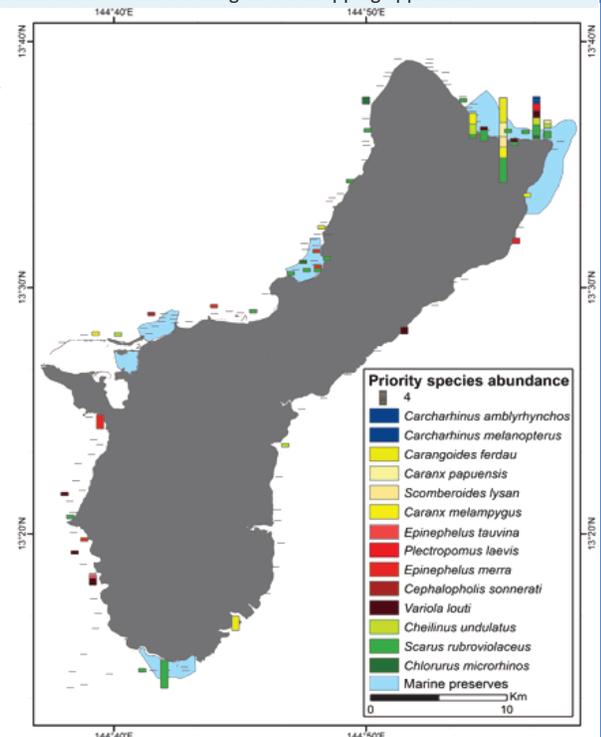


Figure 4. Species of special interest recorded within paired point count cylinders during surveys. Data are number of individuals per species within the 353.4 m² of reef per survey.

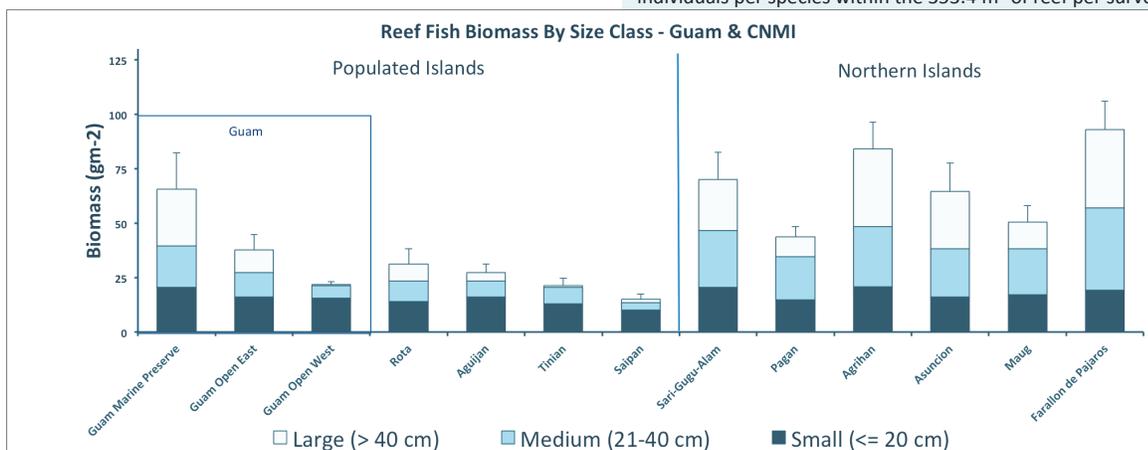


Figure 5. Total reef fish biomass in 3 size classes (based on total length) at Guam MPs and open sectors, and per island or island group in Guam and CNMI. 'Sari-Gugu-Alam' is the weighted mean of sites at Sarigan, Guguan, and Alamagan. Columns represent mean biomass per island, MP, or sector and error bars are 1 standard error of total fish biomass.