Coral-reef monitoring in the Federated States of Micronesia

Chuuk State

Progress Report 2011- 2012

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Summary of reporting period progress:

Coral-reef monitoring in Chuuk has grown extensively during the project period in terms of its spatial coverage, database development, and insight offered. Monitoring activities during 2012 were conducted through a partnership between the Chuuk Conservation Society, Chuuk Marine Resources, and the Pacific Marine Resources Institute. Standardized monitoring protocols were used to collect data at 10 long-term sites across Chuuk Lagoon, inclusive of channel, patch, and inner reefs (Figures 1 and 2).

Protocols

Protocols began with taking a GPS coordinate for each monitoring site, and recording the date/time, a unique site identifier, a local name, the direction of transect placement, and surveyor information (i.e., the development). Transect lines were then established (5 x 50 m) within a homogenous habitat at the appropriate depth contour (6-8 m for channel/outer reefs, 3-5 m for patch/inner reefs), and a suite of standardized methods were used to generate ecological data.

Fish population data were collected from 12 stationary-point-counts (SPC's) conducted at equal intervals along the transect lines. During each SPC the observer recorded the name and size of all food-fish within a 5 m circular radius, at the highest taxonomic resolution possible (both local and scientific names were used), for a period of 3-minutes. Size data were converted to biomass using length-to-biomass coefficients reported in fishbase (www.fishbase.org).

Benthic substrate data were collected from digital photographs of 0.5 x 0.5 m quadrats that were placed at 1 m intervals along the transect lines. The benthos under each of five random points was assigned a pre-defined substrate category using the freely available computer software, Coral Point Count (http://www.nova.edu/ocean/cpce/). The benthic categories chosen for analysis were corals (to genus level), turf algae (less than 2 cm), macroalgae (greater than 2cm, to genus level if abundant), fleshy coralline algae known to overgrow coral (*Peyssonnelia*, *Pneophyllum*), crustose coralline algae, sand, and other invertebrates (genus level if abundant). Means, standard deviations, and standard errors were calculated based on the five, 50 m replicates, with n = 300 individual points per transect and n = 1500 data points per site.

Sea cucumbers, sea urchins, and other conspicuous macroinvertebrates were counted within 50 x 2 m belt transects. Similar to the fish, both local and scientific names were used to record macroinvertebrates to the highest possible taxonomic resolution.

Database development

Standardized databases were generated to store the collected field data following the guidance established by the Micronesian Challenge (MC) measures group. Local databases were established in Microsoft Excel, and will be transferred into the Microsoft Access, MC-database once it becomes finalized. Local data storage in Excel is intended to enhance user access and query through pivot tables and other automated features that generate data summaries. Data are stored both locally and also regionally within the Pacific Marine Resources Institute main database framework.

Figure 1. Map of the Western Pacific Ocean showing the atolls that comprise Chuuk State.

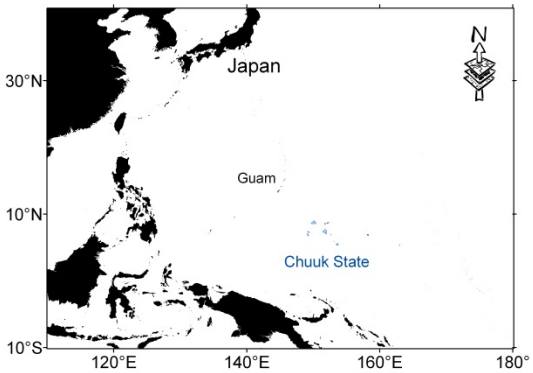
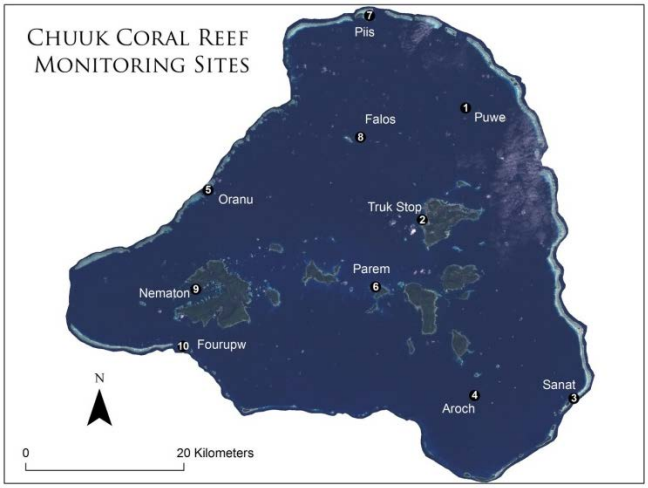


Figure 2. Chuuk Lagoon and the established long-term monitoring sites. Both unique site identifiers and local names are shown.



Monitoring results and outcomes

General patterns for Chuuk:

Coral coverage across Chuuk lagoon ranged between 20 – 40%, and was relatively consistent across the varying reeftypes (overall mean of 31% ±7 SD; Figure 3). However, there were substantial difference in coral species abundance patterns, as *Porites* were dominant corals within all reef types, but patch and channel reefs also had high abundances of branching *Pocillopora* and *Acropora*, and *Acropora* tables, which provided enhanced reef structure and architecture.

Two measures of reef 'health' were generated from the benthic substrate data to examine relationships between and within reeftypes: 1) a ratio of calcifying versus non-calcifying substrate, and 2) coral assemblage evenness (Figure 4). Higher calcification ratio's suggests that reef substrates are dominated by corals or clean coralline algae substrate known to facilitate reef growth. High evenness indices suggest that the coral coverage was not dominated by one, or a few species, but rather was evenly spread across many.

As expected, both benthic substrate ratio's and coral evenness were highest for channel reefs and declined across patch and inner reefs. These are common features of coral reef ecosystems that are driven by wave energy, proximity to land and watersheds, and bathymetric depth. However, more interestingly, comparisons of monitoring sites within each reeftype revealed novel patterns.

Patterns within reeftypes:

Among channel reefs, calcification ratio's and coral evenness suggested that reef integrity was highest for Oranu, moderate for Piis and Fourupw, and lowest for Sanat (Figures 2 and 4). Interestingly, benthic integrity patterns were supported by fish abundances and trophic structure. Oranu had the highest fish abundances spread across four major trophic groups, and notably, the largest number of apex predators (sharks) (Figure 5). The disproportionally high abundance of sharks reported for this site was likely caused by dynamite fishing, as local knowledge and aggressive shark behavior both suggested the use of explosive fishing techniques. It is interesting then to consider what the secondary impacts of dynamite fishing are based upon our existing datasets.

Dynamite fishing has long been attributed to the destruction of corals and mass harvesting of fish. However, the indirect consequences of dynamite fishing on Chuuk appear to be increased shark activity, which is known to limit spearfishing effort. Thus, given an intermittent frequency of dynamite fishing, coupled with a reduced spearfishing effort, fish stocks might actually become enhanced as compared with other reefs where spearfishing is most pronounced. The current evidence supports this logic, as heavy spearfishing and limited dynamite fishing are anecdotally reported for Piis, where less fish were found in comparison to Oranu (Figure 5). It is also interesting that the highest calcification ratio's were reported for Oranu, suggesting that high

Figure 3. Benthic substrate coverage at Chuuk monitoring stations (channel reefs – top graph, patch and inner reefs – bottom graph).

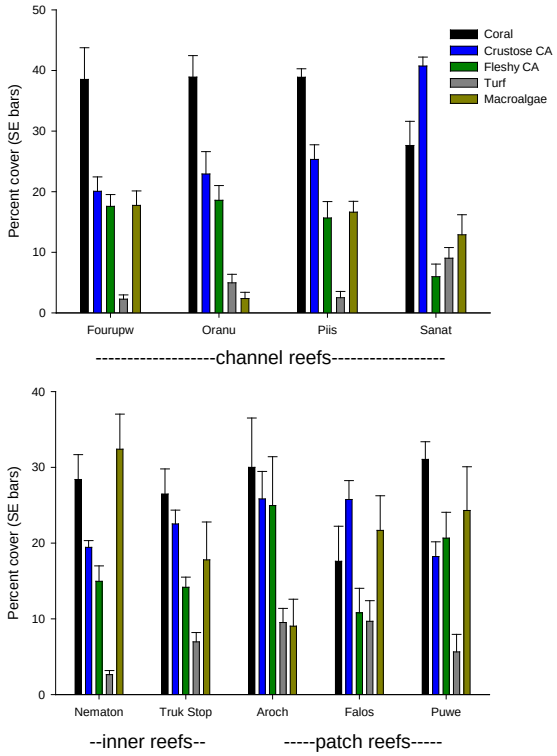


Figure 4. Ratio of calcifying versus non-calcifying benthic substrates (black bars) and coral assemblage evenness (grey bars) at Chuuk monitoring sites.

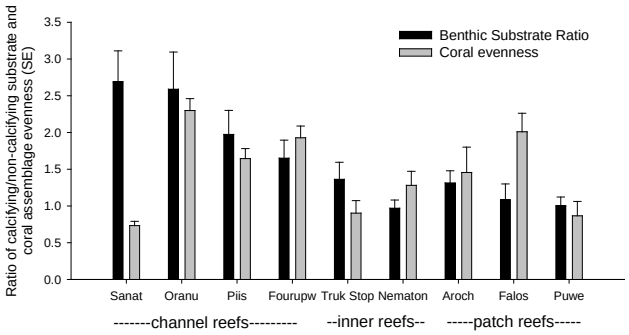
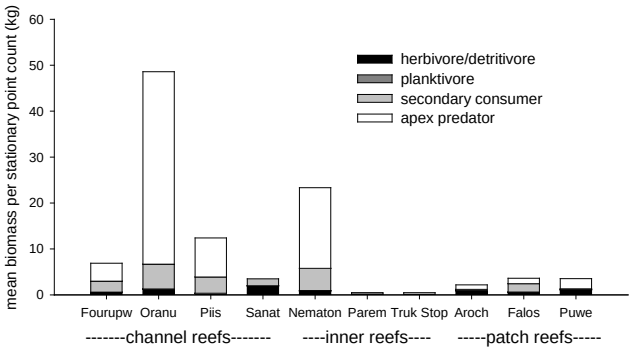


Figure 5. Fish biomass by major trophic group for Chuuk monitoring sites.



abundances of larger herbivores and detritivores play a key role in cleaning (i.e., grazing and scraping) reefs. However, it is not suggested that dynamite fishing enhances Chuuk's reefs, as coral colony datasets (collected but not analyzed yet) indicated a prevalence of juvenile colonies where suspected dynamite fishing was highest; a likely consequence of explosions and damage to the reef substrate. In conclusion, the current levels of dynamite fishing ironically appear to protect fish stocks in comparison to reefs where heavy spearfishing exists. This translates into more favorable substrates due to greater fish function, however, the explosions displace the larger coral colonies, as small colonies offering less architecture were noted. Thus, reefscapes become negatively altered, with an unknown ability and time frame for potential recovery. Because dynamite fishing is a top concern for Chuuk, future monitoring and data analyses will be dedicated to examining this situation.

Among patch reefs, Falos appeared to have a disproportional abundance of sharks, also indicating relatively high use of dynamite fishing as compared with other sites. However, there was less distinction between the measures of reef integrity among patch reefs. There was a fairly strong indication that Aroch consistently held higher calcification potential and coral evenness, but the remaining two sites were similar. Overall, it appeared that Chuuk patch reefs were all recovering from a past (~1-2 years) crown-of-thorns starfish event, and as such, continued monitoring to evaluate recovery rates with respect to fish function and other environmental parameters will best to define the current situation for patch reefs (Figure 6).

Inner reefs showed the strongest signs of human influence, as turf, fleshy coralline, and macroalgal abundances were maximal (Figure 4). While inner reefs all had similarly low integrity, in terms of their benthic substrates, fish assemblages differed markedly. Shark abundances were disproportionally high at Nematon, again suggested a persistent use of

Figure 6. Evidence of Crown-of-Thorn starfish activity on the patch reefs in Chuuk was seen in many areas (left), but not all (right).

dynamite fishing in comparison to other sites. High shark abundances were again associated with higher abundances and sizes of food fish, however unlike the channel reefs, the compromised states of benthic substrates at all sites may be a consequences of proximity to land and associated human influences and pollution generation.

Future directions

Monitoring in Chuuk has grown a great deal over the past year, both in terms of infrastructure, data generation, and available data to begin informing management. However, monitoring is still in its early stages, as trends through time are needed to confirm the numerous patterns we are beginning to observe. Ultimately, monitoring trends through time will provide rates of growth, death, and overall coral reef dynamics. Our understanding of how Chuuk's reefs change through time, what management is needed, and whether or not existing management is working will hinge upon rate-of-change assessments. As such, our programmatic goals are to continue with the outlined, standardized approach towards monitoring, and continue working with regional partners to improve our ability for analyzing and translating the outcomes.