Helen Reef

Expedition Report

Team: Dr. Stuart Sandin, Lindsey Bonito and Clinton Edwards (Scripps Institution of Oceanography), Brian Sullivan (Google), Amber Jackson (Anthropocene Institute), Wayne Andrews, Surech Hideyos, Governor Thomas Patrias (OneReef in the Hatohobei State)

Goal:

Establish a scientific baseline for coral reef health at Helen Reef and assess the effectiveness of the technology and infrastructure used for enforcement of the Helen Reef no-take marine protected area (MPA).

Summary:

The coral reefs at Helen have many species of fish, corals, and other groups. This is not surprising given how close the island is to the so-called center of biodiversity for coral reefs near to Indonesia. Most impressive, however, is that the reefs of Helen show very high levels of ecosystem health. There are lots of fish, and many of these fish are the larger individuals that are often targeted by illegal, unreported fishing. Sharks, snappers, and big groupers are common, and countless species of other fish that eat seaweed, plankton, invertebrates, and everything else were abundant and oftentimes were quite large.

On the bottom, there is an abundance of diverse corals and other organisms building the reef. Helen experienced a major coral bleaching and death in 1998, however, the reef appears already to have recovered almost completely from this event. The fact that the reef can regrow from a severe coral mortality event in 10-15 years is really encouraging, as it suggests that the reef ecosystem at Helen is healthy and vibrant.

During the 3 days spent at Helen Reef, the team maximized time and resources to complete12 scientific dives. The dive sites were strategically selected and co-located where PICRC had previously surveyed the fish assemblages. The GPS coordinates and collaboration with PICRC was established before we left Koror. The team documented approximately 2400 sq meters of the coral reef environment (0.002% of total MPA).

In addition to the scientific collects, Brian Sullivan from Google used his underwater

street view camera to collect 360 degree panoramic views of the marine landscape. These images have been stitched and GPS location has been recorded.

During the site visit on the island of Helen Reef we found that the island is a narrow strip of sand that houses a small community of 5-7 rangers and a large community of migratory birds. Although the island's population is small, they are well equipped and trained to protect Palau's largest no-take MPA, Helen Reef. The rangers use a Simrad radar to detect illegal fishing and vessel movement, this piece of technology assists the rangers to effectively deploy their patrol boat and conserve gas. The Simrad radar has a range of 36 NM, which ensures coverage of the entire MPA, and although initially we thought that this radar would not be powerful enough to detect small wooden pangas, the rangers claim that it's capacity for detection is sufficient. This radar functions off of a working solar panel system and back up generator, which also provides power for charging the satellite phone and running the RO system. The patrol boat is equipped with another Simrad radar, radio and two large motors. The rangers claim it is effective in chasing and approaching illegally fishing vessels. Both the Simrad radar and the patrol boat are new additions to the island, delivered 3 months ago by Dr. Eric Terrill at Scripps Institution of Oceanography.

Site Assessment:

Helen Reef is becoming longer and narrower with time, and consequently near shore infrastructure is vulnerable to erosion and decay. During the site visit it became clear that the greatest need is construction of a new ranger station.

Simrad Dome Radar, Satellite and Solar Panel adjacent to the Ranger Station

Extreme erosion near Ranger Station's foundation

A study of the islands morphological shifts, conducted by Pat Colins at the Coral Reef Research Foundation, shows that the best spot to rebuild the station is on the eastern side of the island. Wayne Andrews of OneReef intends to return in January 2015 with a team to rebuild this structure using local materials in 2-3 months.

In addition to the ranger station, the technologies and infrastructure used for enforcement of the Helen Reef no-take MPA are a Simrad radar, patrol boat, weather station, solar panels, and generator. The rangers and the Hatohobei state government are satisfied with the capabilities of these technologies. They are also very grateful to receive a reverse osmosis system and satellite phone from AI!

The Simrad radar and patrol boat are both new additions to Helen Reef. Just 3 months ago the radar was delivered by Dr. Eric Terrill at Scripps Institution of Oceanography. The patrol boat is equipped with radar, radio and two large motors. The rangers claim it is effective in chasing and approaching illegally fishing vessels.

The Simrad radar is mounted on a new tower that also holds a solar panel and satellite. The Simrad has a range of 30 NM and is equipped with ARPA target tracking and a NMEA sentence with ship size, bearing, speed, GPS, date/time, etc that can be exported for analysis on vessel movement within the MPA. The rangers claim that the detection capabilities far surpass that of the previous radar, which was a used Furuno model with a 64NM range. According to the Governor the Furuno never worked properly and required 4x the amount of energy to run (48 Volts) in comparison to the Simrad (12 Volts). Note that the solar panel mounted next to the radar is additional to the existing 30 solar panels inside the ranger station and that the satellite was installed for communication purposes but, according to the Governor, it did not work properly and eventually stopped working all together.

One concern is that the Hatohobei state government intends to expand the diameter of the Helen Reef MPA by 10 miles in the next 1-2 years. Once this expansion is complete a higher power radar would be necessary. I would recommend the Furuno because it has a 90NM range and requires only 24 Volts.

Conservation Rangers on patrol boat.

Field Work Analysis:

According to Dr. Sandin, "the reefs of Helen are among the healthiest that I have visited. The best comparisons that I have are the uninhabited and protected reefs in the remote Pacific, including those in the Line Islands and Phoenix Islands to the east of Palau. A distinctive set of characteristics of an uninhabited and putatively 'intact' coral reef, like those in the Pacific Remote Islands Marine National Monument (US) or those in the Phoenix Islands Protected Area (Republic of Kiribati), are high amounts of fish biomass (especially of the top predators), an abundance of reef-building corals and coralline algae, and a water column with few bacteria and hence limited amounts of disease of the marine organisms. The reefs at Helen reveal all of these characteristics, and as such I would call this a very healthy and intact coral reef."

Dr. Sandin's lab from Scripps Institution of Oceanography has been conducting ecological studies of coral reefs from across the Pacific for the past 10 years, with a particular goal to assess the health and functioning of reef ecosystems from across gradients of environmental and anthropogenic condition. Much of this work involves fairly standard coral reef monitoring protocols (e.g., fish counts, benthic photographs) that they employ over interesting and informative geographies. In recent years, however, with the advances in digital imagery, they have added a novel data stream to these assessments in the form of underwater photomosaics.

In this application, they collect extensive imagery from individual locations on a coral reef to create a large-scale 'snapshot' of the reef surface through photographic mosaicking. Using a diver-driven underwater imaging system, they collect images sufficient to provide a top-down view (the underwater analogy to satellite view) of the reef surface. The images that they collect cover an area ranging from 100-250m2, and they use these images as representative

snapshots of individual reef sites within an island. The value of these coral reef photomosaics is three-fold – (i) to advance our understanding of coral reefs and their health (with one-time image collection), (ii) to track changes in coral reefs through time (with repeated image collection), and (iii) to help stakeholders to visualize the environments that they may never visit first-hand through diving.

(i) Mosaics as a reflection of reef ecology and reef health. A primary value of the photomosaics is that they capture not only the relative amount of area that particular coral reef groups cover on the bottom (e.g., answering the question, "what is the percentage cover of coral at a particular site?") but also a view of the size-structure and distribution of the constituent species (e.g., answer the questions, "are the corals at a particular site likely to be old [large sizes]?" and "is there evidence that seaweed is overgrowing corals, perhaps causing disease or death of the corals?"). As such, the larger scale view of the coral reef, when post-processed carefully as ecological data layers, provides a significantly improved assessment of the status and health of the coral community beyond that afforded by integrated measures of percent cover alone. Much like the advances made through the application of spatial tools to the study of forest, grassland, and other terrestrial ecological questions, the underwater photomosaics provide an important step in our advanced understanding of coral reef ecology. By addressing fundamental questions about the distribution and structure of the coral reef organisms, we have a capacity to more faithfully describe future trends and thus better offer advice about the 'health' of reef ecosystems.

(ii) Mosaics as an ongoing tool for monitoring. The value of underwater mosaics is increased when the imagery is collected repeatedly at the same location. Rather than simply

documenting the spatial distribution of coral reef organisms, time-series offer a view into the life-and-death processes of the organisms on the reef. Such a view into the demography of reef organisms has historically been quite challenging to collect, as it required the observer to tag and to re-visit countless individual organisms for on-site assessments of their condition. Our vision is to use the photomosaics on Helen reef as permanent reference sites for tracking the changes in the reef environment. We plan to re-visit each of the 200m2 plots that we photographed around Helen reef (most of these plots being co-located at sites where PICRC has previously surveyed the fish assemblages), targeting surveys occurring annually or every two years. By overlaying images from subsequent surveys upon one another, we can learn about whether the coral reef organisms are tending to grow or to shrink, to die or to recruit new, and whether particular species are tending to do better than others. In short, the series of mosaics allows us to watch the change in the reef in a way that is only possible by speeding up time.

(iii) Mosaics as a visualization tool for stakeholders. Beyond the scientific value of larger scale reef imagery, the photomosaics (and other creative underwater imagery) provide terrific opportunities for engaging with local partners. Many of the stakeholders who are engaged with the conservation of Helen reef may not have a clear impression of what the marine environment looks like, let alone be able to consider how this is changing through time. By sharing large-scale images of the reef itself, these individuals are able to explore the reef habitats virtually, looking at the organisms that make the reef itself while talking with partners and other community members about the stories behind each of these organisms. Such immersive approaches to experience marine habitats, and to experience them while being able to discuss the observations immediately, are rare. Already, we have found our Tobian friends and partners on this ship to engage much more actively when we are looking at the reef through imagery rather than simply discussing memories that may or may not be shared among individuals. The power of visualizations should not be undervalued.

Conclusions:

Helen reef is a healthy marine ecosystem that supports not only a diverse community of marine organisms but also a proud and vibrant community of people. As a refuge for biodiversity and as an invaluable resource for the Tobian people, supporting the conservation of Helen reef is very important. Helen reef is special in that there is local capacity and drive to manage the natural marine resources effectively, with a goal not only to conserve but to improve the marine ecosystem for the coming generations. Such a spirit of natural resource stewardship deserves respect and support.

Next Steps for Conservation:

1) Work with OneReef to build a sustainable ranger station for Helen Reef. Wayne Andrews of OneReef intends to return in January 2016 with a team to rebuild this structure using local materials in 2-3 months.

2) In the next 3-4 months, the Sandin lab will stitch together the photomosaics, identify coral individuals, and analyze the spatial statistics of coral abundance and diversity at Helen Reef. Stuart has a team of local UCSD volunteers who have been trained in coral identification will sit down and classify the families within the 200m(2) image. This work results in an understanding of diversity on the reef and the spatial statistics of coral abundance. Fish counts were not recorded during this expedition, although Dr. Yim has fish count data at the sites where the photomosaics were collected from in early 2000s. The Sandin lab will process the photomosaics and plans to re-visit each of the 200m(2) sites (most of these sites being co-located at sites where PICRC has previously surveyed the fish assemblages), targeting surveys occurring annually or every two years.

3) 360 degree panoramic views of the marine landscape at Helen Reef will be uploaded and geolocated into underwater street view in Google Maps.

4) The upcoming scheduled trips to Helen Reef are in January 2015 (Wayne brings materials to rebuild ranger station) and March 2015 (donor trip)

December 2-15, 2014
Helen Reef Dive lat/long

Island	Date	Dive Number	Site/GPS ref #	Lat Long	Avg Depth
Helen	12-08-14`	1	Site 30 outside/ GPS #2	N 02 degree 57.098' E 131 degree 50.566'	30 ft
Helen	12-08-14`	2	Site 29 outside/ GPS #3	N 02 degree 50.679' E 131 degree 48.601'	25 ft
Helen	12-08-14`	3	Site 25/ GPS #757	N 02 degree 52.637' E 131 degree 45.247'	40 ft
Helen	12-08-14`	4	Site 30 inside/ GPS #758	N 02 degree 57.164' E131 degree 49.433'	10 ft
Helen	12-09-14	1	Site 9/ GPS #4	N 02 degree 52.656' E 131 degree 44.214	30 ft
Helen	12-09-14	2	Site 15 outside/ GPS #5	N 02 degree 56.177' E 131 degree 46.054	30ft
Helen	12-09-14	3	Site OR 1/ GPS #7	N 02 degree 53.423' E 131 degree 44.198'	30 ft
Helen	12-09-14	4	Site 21 outside/ GPS #8	N 02 degree 51.458' E 131 degree 43.745'	30ft
Helen	12-10-14	1	Site 29 inside/ GPS #9	N 02 degree 50.667' E 131 degree 47.659'	30ft
Helen	12-10-14	2	Site 22 B/ GPS#10	N 02 degree 50.210' E 131 degree 45.613	30ft
Helen	12-10-14	3	Site OR 1 inside	N 02 degree 52.803 ' E 131 degree 44.583'	30ft
Helen	12-10-14	4	Site 15 inside/ GPS	N 02 degree 56.096' E 131 degree 46.788'	30 ft