Ask the Expert: Dr Philip Dustan answers questions on fieldwork in Menjangan Island, Bali.

1. Why did you choose to do your reef study around Menjangan Island? What was so special about the area?

Menjangan Island and the neighbouring reefs offer a wide range of reef habitats to test our methodology of digital rugosity. The area is very diverse as it's within the Coral Triangle, which is the centre of marine biodiversity. Menjangan Island is also a marine protected area within the bounds of Bali Barat National Park. Additionally, there were earlier studies in the area of the fish and coral so our studies could help track ecological change in the region.

2. How long did it take you to organise the expedition? And what things did you have to consider?

Planning for this expedition took place in a number of sections:

Planning, logistics, funding, and permissions.

We decided to do the project in Bali as collaboration between the Biosphere Foundation, Wildlife Conservation Society, and the College of Charleston (me) (http://www.biosfirindonesia.org/menjangan.php).

Funding for the project was in the form of multiple grants with the RGS grant as the centrepiece. The proposal took about three months to write, rewrite, and submit. Then we had to wait for a few months to find out if it was going to be funded. At the same time, the Biosphere Foundation was organizing our expeditionary ship, Mir (http://www.biosfirindonesia.org/mir.php). Her home port is Singapore. So, before we could begin work, Mir had to be sailed from Singapore to Jakarta, then to a port in the south of Bali and finally to a small harbour near Menjangan Island. The

process involved multiple meetings, forms, and official permissions for entry along with the granting of an entry permit for the ship and her crew. This took a significant amount of planning, energy, money, and patience.

Logistics include planning for the voyage and living on board in addition to the logistics of the research. Mir is equipped with a generator, water maker, and air compressors. She was our home, laboratory, and research platform.

3. What three main hopes did you have for the study?

1. Our principle goal was to test the hypothesis that digital rugosity, a new method for estimating coral reef structural complexity, could be used as estimator of ecological integrity (an important aspect of coral reef community health).
2. Our sampling stations were sites that had been surveyed by Wildlife Conservation Society biologists in 2000 so we could compare our data with the earlier study to estimate ecological change. The repeat survey allowed us to evaluate the effectiveness of the marine conservation efforts in Bali Barat National Park.
3. Community education and involvement:
Many coral reef conservation issues occur at the local level. The local people who utilize the resources of the reef do not always realize how fragile these underwater communities are. They tend to see the reef almost as an unlimited resource for food and materials. They use reef rock as a building material and even harvest corals to make cement! Many fishermen do not realize that anchoring breaks coral skeletons, thus fracturing the very structure of the reef.

The Biosphere Foundation (BF), working through ‘Friends of Menjangan’, has a very strong effort for community involvement and education. BF hosted an Earth Day event to raise ecological awareness of the fishermen and their children of the local communities. They had snorkelling lessons for kids, organized a major trash pick-up on Menjangan Island, and installed signs about coral reef conservation on the island.

The Biosphere Foundation has also developed a program to protect reefs from anchor damage by maintaining existing mooring buoys installing additional mooring buoys at dive sites.

4. What activities did you typically undertake each day out in the field? Was there a daily routine?

My day would begin at about 05:30 local time by watching the sunrise with a cup of strong Balinese coffee in hand. Bali is such a beautiful place that one has to pause each day at sunrise and sunset to celebrate its majesty. From my perspective, creation happens each day anew in Bali.

We used the local fishing boats to take us to our study sites. This helped to support the local economy and took advantage of the local knowledge possessed by the fishers. A typical boat is about 8 to 10 meters long, built of wood and powered by a 40 hp Yamaha outboard. The boats are quite stout and easily carried our gear and three to 6 people.

The diving schedule was rigorous consisting of as many as 4 dives a day each of 1 to 1.5 hours duration. We typically had three of us working a site, myself, Carol Milner, and Orla Doherty. The first person in the water would establish transects using open reeled fiberglass tapes (3 x 50 meter) and make observations on the largest fish. Large fish are usually shy and swim away from divers so it was important to look for them first. Next, a diver would survey fish along transects (Orla), then digital rugosity (me) and coral cover (Carol). By this time, the fish observer had finished and she would reswim transects surveying for coral conditions and damage along the swath of the transect. The last person in the water would pick up the transect tapes. The total time to survey 3 transects was usually 60-80 minutes underwater.

5. What equipment did you need and what was it used for?

Our equipment consisted of:

1. SCUBA gear for breathing underwater.

2. Plastic slates and pencils for recording data and notes.

3. Underwater cameras for recording the reef substrate, various coral conditions, fish, substrate, etc.

4. Open reeled fiberglass survey tapes were used to delineate transects.
5. A digital water level gauge to measure topographical complexity. Hydrographers normally use this instrument to measure subtle changes in groundwater levels. I had the idea that it could be “inverted” and used to make very precise depth measurements of the reef substrate. This is the essence of our Digital Reef Rugosity technique which describes the topographical complexity of the coral reef.

6. In what ways do the local people/communities make use of the sea and reef? What evidence did you see of this?

The local people principally use the sea to supply fish. They fish o the reef with hook and line, nets, and explosives. The explosives are homemade carbide bombs (usually made of plastic soda bottles or liquor bottles). We saw lots of damage from fish bombing as well as line, hooks, and fishing nets entangling the corals.

Another group of fishers troll offshore for tuna. In addition, another group of fishers collect reef fish for the tropical aquarium trade. These men use hookah diving gear (a compressor on their boat with a long breathing hose to the bottom). They capture the small fish with hand nets and slurp guns. While it is illegal, they often use a weak solution of cyanide to stud the fish making them easier to capture. We saw evidence of this in the form of branching corals with their interior branches dead giving the appearance of a hollowed out ball.

Another group of men operate floating fish farms where they raise small fingerling grouper up to .5 kg size for the live fish market in Hong Kong.

We also visited a salt factory where seawater is evaporated in very large shallow fields or pans. These are easily seen on GoogleEarth at 8 07 32.3 s lat. 114 35.2 E long.

But by far the greatest use of the sea has become the tourist trade. Fishermen take locals to Menjangan Island for worship at the temples on the island and they take tourists to the reef to snorkel and SCUBA dive. There are about 200-250 boats that are involved with the tourist trade and it has become an economic engine for the area. There are a few dive shops in the area and being a divemaster has become a very prestigious occupation.

7. What support did you give and receive from the local community and how important is the study for them?

Given the expressed interest in protecting Menjangan reef by the community, Biosphere Foundation initiated a project called “Friends of Menjangan” with its local NGO partner based in BBNP, Yayasan Dwi Asih Sejahtera. The aim of the ‘Friends of Menjangan’ project is to bring together all interested stakeholders to work together and make a difference for the future of Menjangan Island and its reef.

The management of the project is local, the funds to support the conservation initiatives are local and international, and the membership includes everyone who visits the land or reef of Menjangan Island. This concept was embraced with enthusiasm by the community and its inaugural event was held on May 6th and 7th at Labuan Lalang and Menjangan Island. Members of all stakeholders were present including fishermen, central government, local government, temple priests, schools, local NGOs, international NGOs, resorts, dive operators, tour-guides, tourists and the media. The overall objective of ‘Friends of Menjangan’ is to coordinate a comprehensive community-based conservation program involving

everyone who cares about Menjangan and its reef.

We received a lot of support from the fishers whose boats we chartered to go to the reef. They would frequently stay out longer that they would with tourists for the reduced rate they asked form us. During the second week of our work we noticed that they were beginning to bring their children with them. At first we thought nothing of it but then began to think that maybe they wanted to show their kids these crazy people who would go diving for hours and then incessantly talk about what they seen.

We also received support from Bali Barat National Park by waiving our daily entrance fees the park.

8. Your job wasn't over when you left Menjangan. What had to be done next and how long did it take?

Surveying the reefs is just the beginning of our science project. The data we collect must be entered into computer files, checked, and rechecked for accuracy. The water level gauge that we use to measure digital reef rugosity must be downloaded into a computer file, edited, and parsed into files containing individual transect data. This process can take 30 minutes to an hour for ach transect and we worked on 66 transects. After the data are organized the real analysis begins followed by synthesis and report writing. In all we figure that we spend about two weeks working on data for every day we spend in the field! It is meticulous work at every step of the job.

9. What are the current management techniques in place to protect the reef? How much do you think that your activities in Menjangan will influence these management methods?

Mooring buoys protect the reefs from anchoring. So, one of the most important immediate things we have done to help reef conservation on Menjangan Island is probably the maintenance of old moorings and installation of new ones.

The results of our research will show how well the marine reserve no-take regulations work (change over time in and outside of the management zones).

Development of Digital Reef Rugosity will help us develop a method for reef triage, as it will shed insight into the ecological condition of reefs.

10. What are the most important discoveries from the research? And how will the findings influence your and others future study?

Our research into Digital Reef Rugosity has shown us that both biological and physical habitat complexity are both significant components of coral reef fish community structure. While other work has demonstrated that rugosity is an important component of fish species diversity, this is probably the first work that has revealed the importance of both coral biological diversity and physical complexity across such broad spectrum of reef conditions. Fish abundance responds to physical complexity (increased rugosity) by increasing abundance, while increased fish species diversity is correlated with increased coral diversity. An explanation for this might centre on structural complexity providing increased living space while biological diversity allows for more specialized species niche packing. The inescapable conclusion is that both biological and physical complexity are co-requisite components of a healthy coral reef ecosystem.

From a conservation point of view the yield of some degraded fishing grounds might be improved by artificially increasing rugosity but this will probably not restore the fish community to its previous community structure. Improving rugosity may promote increased fish abundance; it may not be as effective by itself to restore species diversity. In many ways this is analogous to the differences between the biodiversity of tree farms or urban landscapes and natural forests. All provide structural complexity but natural forests support much greater species diversity of birds, insect, and mammals due to the increased biological diversity of the trees and woody plants that have coevolved complex species interactions with their associated fauna. There is every reason to expect coral reefs follow similar patterns of community assembly as the highly diverse Indo-Pacific reefs possess a relatively high degree of endemism and co-evolution between species. Our data are consistent with the vision of a coral reef community being highly co-evolved system with multiple layers of species-specific interactions comprising the community matrix.

11. What were the highlights of the experience? Did you find anything that surprised you?

Bali is such a spiritual land that there were surprises every day. But two experiences stand out above all. The first was a discussion with a young fisherman who was our boat captain on day. After finding signs of fresh blast fishing on the reef he told us a story about how he and some friends had stayed out at Menjangan overnight to ward off fishers from Java who came to blast fish during a local religious holiday, Nyepi, on which the Balinese stay at home to pray and meditate. They had to chase the poachers away to protect the reef because in his words he said “If there is no reef I have no job”. At that point I realized that the idea of the marine protected area had the support of the local people whose economic livelihoods were tied to the reef.

The second came on the last day I dove in Bali. We decided to dive on part of the reef that we had not seen yet. The reef has a shallow slope with a spectacular reef wall community that starts at about 8 meters continuing vertically down to about 30meters depth. We swam with the current along the face of the wall

investigating spectacular corals, fish, and fluorescing bright orange crustose red algae. Finally we had to begin our ascent. As we reached the top of the wall we came upon a section of reef was as perfect and beautiful a reef as any of us had ever seen. We named it Symphony Reef because the reef was a symphony of colour, corals and fish with a magical beauty. There were unicorn fish, large wrasses, and schools of other fish we had not seen anywhere in the last month of diving. The reef was covered with large whorled colonies of lettuce coral whose individual fronds were paper-thin translucent calcium carbonate. The whole place was absolutely magical. Later, on the way home in the boat, my colleague Abigail Alling said our experience was a gift from the reef to us on the last day of our expedition.

However, the following June, 2012, we revisited the very same reef to find large parts of it completely destroyed from crest to drop off. Much of the area was smashed into mere fragments of what had been delicate foliose leaves of stony coral colonies. Deeper, debris from the shallows continued to damage the benthos as it cascaded downslope. Local fishermen blamed anchoring by dive boats while others suggested that blast fishing might have also contributed to the destruction. In the year between our visits, we found that many of the moorings we had installed around Menjangan Island were no longer active. Mooring lines that broke had not been repaired. Other mooring blocks designed for one or two boats had been drug through the reef when they were asked to hold more than 5 or ten boats. Biosfir Indonesia is now endeavouring to obtain the equipment necessary to install more robust moorings that are anchored into the reef substrate as well as instituting a program of mooring repair to insure reliable mooring for the burgeoning dive industry of Menjangan Island.