JULY 2026 VOL. 1.3

Coral Matters

THE CORAL REEF RESEARCH HUB MAGAZINE

MARINE PROTECTED AREAS

How much do they help coral reefs?

Also in this issue: Paper from the Past: The landmark study that changed Caribbean coral reef science forever; Paradox in Paradise: Protection status is only part of the restoration picture; Partnership spotlight with SSI Blue Oceans

Regulars include: Reef roundup; photographer spotlight; stories from the field, coral career column; get the right gear

In This Issue:

CoRR Hub News

Welcome to **Issue 3** of **Coral Matters**, and a warm welcome from everyone at The Coral Reef Research Hub. We recently received some wonderful feedback from one of our readers and CoRR Hub member, and their thoughtful letter actually inspired the theme of this issue. So, rather than our usual CoRR Hub News feature, we decided to share their letter with you instead.

The CoRR Hub Team

Dear CoRR Hub,

I read your article in Coral Matters Issue 2 with great interest and wanted to share my thoughts from a practical perspective. The news and especially social media is currently dominated by coral planting initiatives. These projects undoubtedly play an important role in raising public awareness, educating people about coral reefs, and engaging local communities in conservation. However, in the face of reef decline occurring on an unprecedented scale, we also need to question whether coral planting has become a solution that is easier to promote than it is to scale. Can restoring isolated patches of reef ever be enough to safeguard ecosystems that extend across hundreds or even thousands of square kilometres?

Perhaps more importantly, coral planting does not address the root causes of reef decline. Corals evolved in extremely nutrient-poor waters, yet many reefs are now exposed to nitrogen concentrations far exceeding the conditions under which they evolved to survive and adapt. Simply planting corals into degraded environments does little to resolve these underlying environmental pressures.

Alongside the global challenge of reducing greenhouse gas emissions, there are two practical interventions that can be implemented locally and at ecosystem scale: improving water quality -particularly by reducing nitrogen inputs - and protecting herbivorous fish populations through well-managed no-take marine protected areas. Both measures enhance the resilience of entire reef systems and provide corals with a far greater opportunity to survive, recover, and adapt to future environmental change.

Many scientists working outside the coral planting sphere have been highlighting these issues for decades, long before a substantial body of peer-reviewed evidence emerged to support them. Perhaps the time has come to give these fundamental drivers of reef health the same level of attention, discussion, and investment that coral planting currently receives. I would love to see Coral Matters explore this topic further in Issue 3, perhaps with a feature examining the role of Marine Protected Areas and the extent to which they can - or cannot - help address some of these challenges.

Finally, I would like to congratulate everyone involved in producing this excellent new magazine and for creating The Coral Reef Research Hub itself. As an active member, it has been fantastic to watch the community continue to grow, bringing together career development, professional networking, and scientific knowledge sharing in one place. I'm especially excited about the upcoming launch of the mobile app, which I understand is now nearing completion. I genuinely believe it has the potential to be a game changer, and I can't wait to see how the platform continues to evolve over the months and years ahead.

Best Regards,

Bob Freeman

Reef Roundup: Around the World

Noteworthy coral news from around the world:

1. **South-China Sea:** Researchers have discovered a rare coral reef blue hole at Huangyan Dao in the South China Sea, providing a unique opportunity to study reef formation, marine biodiversity and the geological evolution of coral reef ecosystems. (CGTN, 2026)

2. **Red Sea, Israel:** A new study has found that artificial light pollution from coastal development disrupts the sleep, behaviour and brain health of coral reef fish, highlighting another growing human pressure on already vulnerable reef ecosystems. (The Cool Down, 2026)

3. **Worldwide study:** Scientists have identified more than 166,000 km² of coral reefs across 71 countries with the potential to resist and recover from climate change, providing new opportunities to prioritise conservation efforts by protecting the world's most climate-resilient reef ecosystems. (Smithsonian magazine, 2026)

4. **New Zealand:** Scientists have discovered an enormous 300–400 year old black coral colony in the deep waters of Fiordland, New Zealand, providing an important refuge for this slow-growing protected species and highlighting the value of identifying and conserving ancient coral habitats. (Science Daily, 2026)

5. **Indonesia:** A new 20-year study has found that many of Indonesia's coral reefs have shown remarkable resilience to rising ocean temperatures, but warns that this heat tolerance has clear limits, with increasingly frequent and severe marine heatwaves likely to overwhelm even the most resilient reefs if climate change continues unabated. (The Conversation, 2026)

6. **United States:** NOAA has released a new National Coral Reef Resilience Strategy outlining a coordinated roadmap through 2040 to strengthen the resilience of U.S. coral reefs by combining research, monitoring, restoration, pollution reduction and climate adaptation to better protect these ecosystems from mounting environmental threats. (National Ocean Service, 2026)

7. **Hawai'i:** Hawai'i has renewed its pioneering coral reef insurance policy, providing up to US$2 million in rapid funding for emergency reef repairs following storm damage and demonstrating an innovative financial approach to improving coral reef resilience in the face of climate change. (Khon News, 2026)

In more detail: Roundup 3

Scientists have identified more than 166,000 km² of coral reefs across 71 countries that appear to have a greater capacity to resist and recover from the impacts of climate change, offering new hope for the long-term conservation of these threatened ecosystems. By combining global environmental datasets with information on reef condition, researchers identified areas that experience conditions likely to promote resilience, including natural resistance to marine heatwaves and the ability to recover following disturbance.

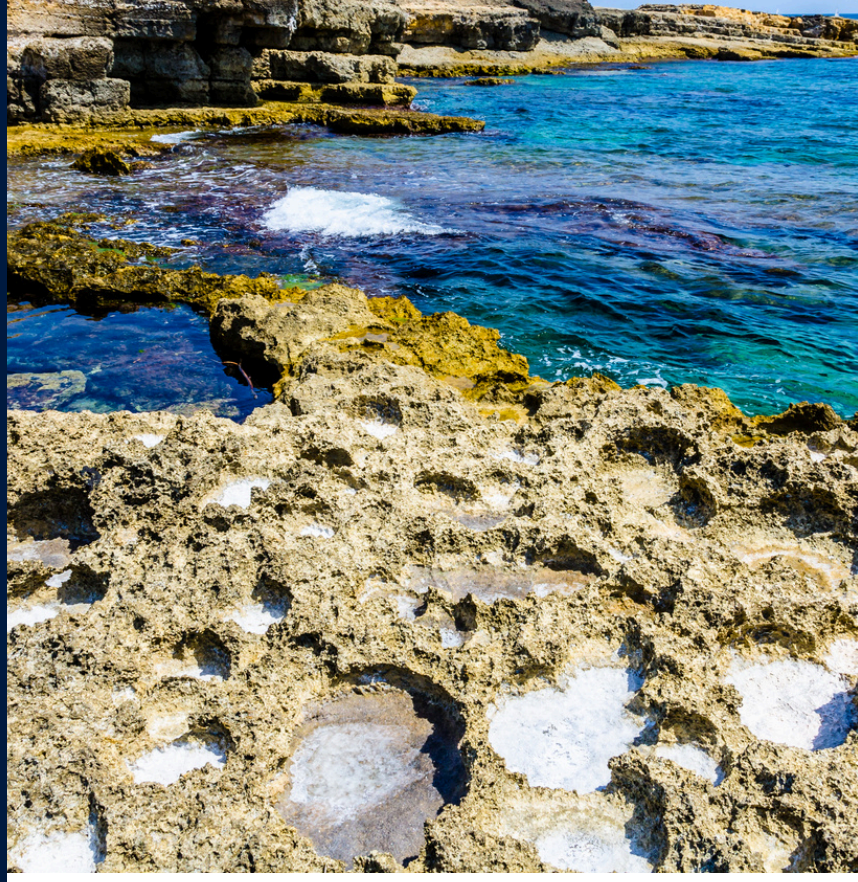
The findings provide a valuable framework for prioritising future conservation efforts, allowing governments and conservation organisations to focus protection, monitoring and restoration on reefs with the greatest potential to survive a warming climate. While these climate-resilient reefs are not immune to the effects of global warming, protecting them could help preserve biodiversity, maintain ecosystem services and provide important refuges that support the recovery of surrounding coral reef ecosystems as climate change continues to intensify.

The largest concentrations of these resilient reefs were found in the Bahamas, Cuba, Australia, Indonesia and the Philippines, although resilient reefs were identified throughout the Caribbean, Pacific and Atlantic Oceans.

Marine Protected Areas

How much do they help coral reefs?

Marine Protected Areas (MPAs) have become one of the most widely used conservation tools for protecting marine biodiversity and restoring degraded ecosystems. Defined as clearly designated geographical areas that are managed to achieve the long-term conservation of nature, MPAs range from fully protected no-take reserves, where all extractive activities are prohibited, to multiple-use areas that permit sustainable fishing and tourism under carefully managed regulations (Dudley, 2013). Over the past three decades, the number and size of MPAs have increased dramatically, driven largely by international commitments to halt biodiversity loss and protect at least 30% of the world's oceans by 2030. While the expansion of these protected areas represents a significant achievement for marine conservation, their effectiveness depends not simply on the area they cover, but on how well they are designed, managed and enforced.



The primary objective of an MPA is to reduce human pressures on vulnerable marine ecosystems, allowing habitats and species the opportunity to recover naturally. Coral reefs, in particular, benefit from reduced fishing pressure because herbivorous fish populations are able to recover, helping to control macroalgal growth that would otherwise compete with corals for space and light. Similarly, predatory fish populations often increase within well-managed reserves, restoring more natural food-web dynamics and improving ecosystem resilience (Mumby & Harborne, 2010). Protection also allows many commercially important species to survive for longer, grow larger and produce significantly greater numbers of eggs than individuals subjected to continual fishing pressure. Since larger females often produce disproportionately more larvae than smaller individuals, protecting breeding adults can substantially enhance reproductive output and improve the long-term sustainability of fish populations (Roberts et al., 2001).

One of the most important ecological benefits of well-designed MPAs is their ability to increase fish recruitment both within and beyond their boundaries. As fish populations recover, adult fish frequently move into surrounding waters, while larvae produced inside protected areas are dispersed by ocean currents to neighbouring reefs. This process, known respectively as spillover and larval export, can replenish fish stocks outside protected areas and improve catches for surrounding fisheries (Russ & Alcala, 2011). Numerous studies have demonstrated that fish biomass inside fully protected reserves often exceeds that of adjacent fished reefs by several hundred percent, with neighbouring fisheries subsequently benefiting from increased recruitment and adult movement across reserve boundaries (Lester et al., 2009). Consequently, well-managed MPAs are increasingly recognised not only as conservation tools but also as effective fisheries management strategies that can support long-term food security and sustainable livelihoods.

Several marine reserves around the world illustrate the remarkable ecological recovery that can occur when protection is implemented effectively. Apo Island in the Philippines is frequently cited as one of the earliest and most successful examples of community-based marine conservation. Following the establishment of a no-take reserve in the early 1980s, fish biomass increased dramatically within the reserve, while local fishers experienced improved catches in adjacent fishing grounds due to spillover effects (Russ & Alcala, 2011). Similarly, Cabo Pulmo National Park in Mexico experienced an increase in fish biomass of more than 400% over a decade following protection, representing one of the most successful examples of marine ecosystem recovery documented anywhere in the world (Aburto-Oropeza et al., 2011). Other notable examples include the Great Barrier Reef Marine Park in Australia, where extensive no-take zones have contributed to improved fish populations and enhanced ecosystem resilience despite continuing pressures from climate change (McCook et al., 2010), and the Medes Islands Marine Reserve in Spain, where decades of protection have resulted in significant increases in large predatory fish and overall biodiversity (Sala et al., 2012). Collectively, these examples demonstrate that when MPAs are appropriately designed, adequately funded and effectively enforced, they can produce substantial ecological and socioeconomic benefits.

Despite these successes, not all marine protected areas achieve their conservation objectives. In many regions, MPAs exist only on paper, with legal designation but little or no practical protection. These so-called "paper parks" may contribute towards international conservation targets by increasing the reported area of protected ocean, yet they often fail to reduce destructive activities such as overfishing, illegal harvesting or habitat degradation (Gill et al., 2017). Without effective management plans, sufficient funding and active enforcement, the ecological condition of these areas may remain largely unchanged despite their protected status.

Even where legislation exists, enforcing marine protection presents considerable logistical and financial challenges. Many developing nations possess extensive coastlines but lack the vessels, personnel and technological resources required to monitor protected areas effectively. Illegal, unreported and unregulated (IUU) fishing therefore continues within many reserves despite legal restrictions. This challenge becomes even greater for very large marine protected areas that may cover hundreds of thousands of square kilometres. Although satellite surveillance, vessel monitoring systems and patrol vessels have improved enforcement capabilities in recent years, maintaining effective surveillance over such vast areas remains expensive and, in many cases, financially unrealistic. Consequently, illegal fishing can continue to undermine conservation efforts despite the legal establishment of protected areas.

To offset management costs, some MPAs generate revenue through entrance fees, diving permits or tourism levies charged to recreational users and commercial tour operators. These fees can provide an important source of funding for conservation activities, scientific monitoring and ranger patrols while simultaneously encouraging sustainable tourism. However, administering such systems requires additional staff and infrastructure to collect fees, monitor compliance and ensure transparency in the allocation of funds. For many developing nations, maintaining these systems represents another significant management challenge, particularly where visitor numbers fluctuate seasonally or tourism revenues decline unexpectedly.

While MPAs are highly effective at reducing direct human impacts such as fishing, they cannot solve every threat facing coral reefs. One of the greatest limitations of protected areas is that they offer little defence against declining water quality originating outside their boundaries. Sedimentation, nutrient enrichment from agricultural runoff, untreated sewage, coastal development and industrial pollution can continue to degrade reefs regardless of their protected status. Similarly, MPAs cannot prevent marine heatwaves, coral bleaching or ocean acidification associated with global climate change. Consequently, marine protection should never be viewed as a standalone solution but rather as one component of a broader integrated coastal management strategy. Improvements in watershed management, sewage treatment, sustainable agriculture and coastal planning are often essential if coral reefs within MPAs are to realise their full recovery potential (Mumby & Steneck, 2008).

Equally important is the support of local communities. Conservation measures imposed without consultation often generate conflict, particularly where fishing communities perceive MPAs as restricting their livelihoods. In contrast, involving local stakeholders in planning, management and decision-making greatly increases compliance and long-term success (Cinner et al., 2012). Effective community outreach helps explain that temporary fishing restrictions can ultimately increase fish abundance through spillover and larval export, leading to larger catches in surrounding waters over time. Furthermore, healthy marine ecosystems frequently attract divers, snorkellers and ecotourists, creating new employment opportunities in guiding, hospitality, transport and marine recreation. In many successful examples, tourism has diversified local economies, reducing dependence on fishing while increasing appreciation for marine conservation. When local communities experience tangible economic benefits, they are far more likely to support and actively protect marine reserves.

Globally, the effectiveness of marine protected areas presents a mixed picture. Numerous scientific studies demonstrate that well-enforced no-take reserves consistently outperform partially protected or poorly managed areas in terms of fish biomass, biodiversity and ecosystem resilience (Edgar et al., 2014). However, many existing MPAs continue to suffer from inadequate funding, weak governance and insufficient enforcement, limiting their conservation value. Furthermore, even the best-managed reserves cannot fully protect coral reefs from climate-driven disturbances, emphasising the urgent need to reduce greenhouse gas emissions alongside local conservation efforts. Protecting coral reefs therefore requires a combination of effective marine protection, sustainable fisheries management, improved water quality, strong governance and climate action.

Marine protected areas remain one of the most powerful tools available for conserving marine biodiversity, but they are not a universal solution. Their success depends upon thoughtful design, sufficient financial investment, scientific monitoring, effective enforcement and, perhaps most importantly, the support of the communities that depend upon the sea. When these elements work together, MPAs can restore fish populations, enhance biodiversity, improve fisheries through spillover, generate sustainable tourism and strengthen the resilience of coral reef ecosystems. However, where protection exists only in legislation, without management or community engagement, the promise of marine conservation remains largely unrealised. As nations continue working towards ambitious global conservation targets, the emphasis must shift from simply increasing the number of marine protected areas to ensuring that existing protected areas genuinely protect the ecosystems they were created to conserve.

Paper from the Past

A Landmark Study that Changed Caribbean Coral Reef Science

Original Publication

Gardner, T.A., Côté, I.M., Gill, J.A., Grant, A. and Watkinson, A.R. (2003) 'Long-term region-wide declines in Caribbean corals', Science, 301(5635), pp. 958–960. Accessed 29th June 2026.

Published in Science in 2003, Gardner et al.'s paper Long-term region-wide declines in Caribbean corals is widely regarded as one of the most influential studies ever conducted on Caribbean coral reefs. Prior to its publication, many scientists had reported localised reef degradation and suggested that Caribbean reefs were in widespread decline, but these conclusions were often based on individual case studies or regional monitoring programmes. Gardner and colleagues were the first to compile data from hundreds of reef surveys across the entire Caribbean into a single large-scale meta-analysis, providing compelling quantitative evidence that coral cover had declined by approximately 80% over the previous three decades, from around 50% in the 1970s to just 10% by the early 2000s. Perhaps most importantly, the authors demonstrated that this decline was remarkably consistent across multiple Caribbean subregions, indicating that reef degradation was not simply the result of isolated local events but a basin-wide phenomenon driven by multiple interacting stressors.

The significance of this study extended far beyond its headline figures. For many years, reef scientists had argued that overfishing, coastal development, declining water quality, coral disease, hurricanes, and the 1983 mass mortality of the long-spined sea urchin (Diadema antillarum) were collectively pushing Caribbean reefs into a downward ecological trajectory. However, until Gardner et al. synthesised the available evidence, there had been no comprehensive analysis capable of demonstrating the scale and consistency of these declines across an entire ocean basin. The paper therefore transformed anecdotal observations and fragmented datasets into robust scientific evidence, validating many of the concerns that reef ecologists had been expressing for decades and fundamentally changing perceptions of the condition of Caribbean coral reefs. It also helped shift the conservation narrative from protecting individual reefs towards managing reef ecosystems at regional scales, recognising that widespread environmental pressures required coordinated management responses rather than isolated local interventions.

Pristine Caribbean beaches do not reflect the situation under the water

Although the paper painted a sobering picture, it also highlighted an important opportunity for conservation. If the decline of Caribbean reefs was occurring at regional scales, then equally ambitious management strategies would be required to reverse it. Well-designed and effectively managed Marine Protected Areas (MPAs) have since become one of the principal tools used to enhance reef resilience by rebuilding fish populations, protecting herbivorous species that suppress macroalgal growth, and reducing local fishing pressure. However, the continuing decline of many Caribbean reefs suggests that MPAs alone are insufficient unless they are adequately enforced, supported by local communities, and integrated with broader measures addressing water quality, coastal development and climate change. Gardner et al.'s landmark study therefore remains as relevant today as it was over twenty years ago, serving as both a warning of the scale of reef degradation and a reminder that successful coral reef conservation requires ecosystem-scale management rather than isolated conservation actions.

Marine Protected Areas may hold some hope for fish populations (*Haemulon flavolineatum*)

Sadly, many Caribbean reef areas have been reduced to rubble

Paradox in Paradise

Protection status is only part of the restoration picture

By Sophie Coxon

Marine protection regulations, such as MPAs (marine protected areas), no-take zones, and seasonal or restricted access zones are used across the oceans to promote nature recovery and prevent further deterioration and loss of marine ecosystems, habitats and species. When managed effectively, these measures can be exceptionally successful in protecting both coastal and pelagic environments (Gallagher et al., 2016), enabling populations of species to recover and thrive, and providing adequate time for ecosystem processes to settle, stabilise, and strengthen resilience against threats such as invasive species and the cumulative impacts of climate change. However, protection status varies widely by region, can have various levels of enforcement, and most importantly, is only part of the large suite of conditions required to achieve true ecological protection (Giakoumi et al., 2018).

The location, condition, and disturbance level of the area under protection each have a significant influence on the ecological health of an area, which may partially or completely negate the positive effects of protection measures. This is particularly true of marine environments, where the lack of natural borders and presence of water means that movement - both of organisms and pollutants - is unrestricted. As well as enabling species to inhabit and disperse across wide ranges, this element of marine habitats makes them particularly vulnerable to pollution (Dar et al., 2022); noise, chemicals and sediment all travel much further in water than on land, multiplying the subsequent impact on marine life. If a marine protected area is established within close proximity to a source of pollution, such as agricultural effluent, sewage output, or industrial waste, the protection measure - such as restricted fishing rights - may be futile. The establishment of protected areas is a fundamental part of achieving restoration, however it is essential that the rest of the picture is not overlooked, and that the root and source of ecological decline is addressed.

An example of this issue is presented in the island nation of the Maldives, a coral archipelago in the Indian Ocean. The original islands are made of coral sand, much of which has been ground down and passed through the guts of the colourful parrotfish which graze its reefs. Known for its distinctive white beaches, turquoise water and incredible water clarity, the Maldives is one of the world's most popular diving spots and luxury beach holiday destinations. Due to its isolated, pelagic location, the Maldives has an immense abundance of marine life, from macro reef life to charismatic dolphins, whales and manta rays (Hilmi et al., 2023). Turtles, sharks and shoals of tuna and trevally also grace its waters, and the diversity of life observed on an average dive in Maldivian waters is astounding.

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Ironically, the marine life that the nation has based most of its income on suffers severely from both direct and indirect impacts of tourism and development. As the popularity of the Maldives as a holiday destination has boomed (Shenaan & Schänzel, 2024), so has the construction of resorts, hotels, and tourist infrastructure. However as a nation of small islands, the Maldives faces a growing challenge: a lack of land to build and expand on (Van der Pol et al., 2023). Whilst in urban centres this is usually overcome by building up rather than out - such as in the capital city of Malé - tourists travel specifically for the beach holiday and tropical island escape, expecting beach bungalows, sea views, and lots of peace and quiet. This has led to the uniquely engineered solution of building more land.

Land reclamation - the process of depositing sediment in an area of water in order to create new “land” for development - has been used across the world as an urban planning solution to lack of space for industrial development, agriculture or housing (Wang et al., 2023). An area of water is closed off with an impenetrable wall, and then infilled with millions of tonnes of dredged soil, rock and sand, which has caused environmental damage before it has even been used (Subraelu et al., 2022). In the Maldives, this method has been used to create entire new islands, often specifically for the purpose of a luxury holiday resort. In 2025, I spent a month on an artificially constructed island, in the North Malé Atoll, monitoring fish at a reef restoration site. To a tourist, the island seems like a fragment of paradise. To a marine biologist, it is paradoxically an ecological war zone. Built from foreign sand imported from the Middle East, the island was a huge, sloping mass of rough white grit underlying manicured beaches of soft, refined sand, not a shell or stone to be found upon them. The vegetation had been selected by designers, not by nature, and seemed homogenous, lacking not only diversity in size, shape and flower, but also in its ability to bind the island together. As soon as you stepped off the boat, there was a strange feeling of falseness, perhaps from the lack of bird or insect noise, perhaps from the unnatural perfection that hums design can create. Whilst the Maldivian government has implemented a strict no-fishing policy within a 1km radius of all resort islands, fishing is only one threat to the reefs and marine life that once thrived here.

Beneath the surface, a different narrative exists. Artificial islands are often constructed on reef mounds, as these natural features provide a stable base close to the surface. This particular island had the remains of a coral reef surrounding it; dilapidated, black and brown coral skeletons, carpeted with thick algae mats and sponge colonies littered the seascape. Not far off, the existing reef could be seen, a safe distance from the island’s radius of impact, a stark contrast to the barren and almost arid landscape directly below. The main reason for this is sedimentation. Under natural conditions, sediment is bound to the seabed by a tapestry of coral, sponge, and algae, which prevents large quantities being immobilised by currents and storms, helping to maintain high water clarity which is essential for coral health (De’ath et al., 2010). Where sediment is dumped in excess during land reclamation, there is no natural stabilisation to prevent dispersal. As currents shift and storms roll in, loose sediment is mobilised, causing plumes of silt and sand, milky-white water with severely limited visibility, and subsequent smothering of benthic organisms upon settling (Liu et al., 2018). As this process continues, the sand is repeatedly replaced by island authorities, and the reefs below are buried deeper and deeper.

The coral restoration site on the island I visited had been translocated twice previously due to sedimentation issues. Despite the most recent location being further offshore and hence slightly less impacted by island runoff and sediment movement, the young corals were visibly struggling, with layers of sand covering much of their surfaces. At times, the visibility would drop to near zero when a delivery of sand was deposited on the island, flushing rays, turtles and juvenile reef sharks out of the island lagoons where they go to rest. As the impacts of climate change - such as increased frequency and severity of storms and extreme weather intensify (Shaw et al., 2016), which will exacerbate the occurrence of sedimentation, the challenges facing reef restoration projects are multiplying. Without proper management and regulation of restoration site location, as well as adequate restriction and monitoring of land reclamation activities, reefs in areas such as the Maldives face a very real possibility of collapse - a loss that will impact not only the marine environment, but also the people and economy that depends upon it (Hilmi et al., 2023). A beach without seaweed and a litter of shells is not clean, but abnormal. Our idealised version of “pristine” is often not at all what we assume - and the wildness and mess of nature is in fact, very necessary.

Sophie Coxon is a recent graduate with an MSc in Marine Systems & Policies, having gained a distinction at the University of Edinburgh. She is a PADI Advanced Scuba Diver, qualified Scientific Diver, and enjoys freelance writing on the side!

Stories from the Field

Institute for Socio-Ecological Research (ISER) Caribe

Getting the complete picture

By Joseph Townsend

Editors note: Following on from the main feature in our previous issue, this edition's "Stories from the Field" takes us to Puerto Rico in the Caribbean, where we hear from a team working on an ambitious coral reef restoration project.

Coral reefs, as we know them, are intricate and complex. As scientists, managers, and practitioners, we face the challenge of collecting information and capturing that complexity through our fieldwork and analysis. Our efforts reflect this complexity, and stories of long, difficult field days are all too familiar in this profession. It begs the question: What would it take to capture a truly "complete" snapshot of a coral reef?

Above: Freshly outplanted coral fragments.
Below: Outplanted corals fusing to rapidly create a colony after 20 months

French Grunts (*Haemulon flavolineatum*) and Staghorn Coral (*Acropora cervicornis*) living in harmony (Joseph Townsend)

This was the challenge for our team on the Caribbean Reef Project, a collaborative effort by organisations across the wider Caribbean to restore more than five acres of coral reef in Puerto Rico using a holistic approach that restores both the habitat and its associated organisms over a four-year period. This approach, known as ecosystem-based restoration, incorporates the restoration of important organisms, such as herbivorous sea urchins and crabs, alongside corals to help restore ecological balance, rebuild reef structure, and recover the ecosystem services that coral reefs provide to both people and the natural world. As the monitoring team for the project, our role is to capture and quantify the full effects of these restoration activities, from individual coral colonies all the way up to the ecosystem scale, turning what might seem like a simple "snapshot" survey into a daunting task.

The key to meeting this challenge has been teamwork. Beyond carefully monitoring the survivorship and health of outplanted corals, different teams work together to assess every connected component of the restored reef. Two dive teams are required to monitor the living community: one focuses on coral health, the benthic community, and mobile invertebrates, while the other is dedicated to monitoring the complete fish assemblage. Beyond the biological community, additional teams visit the sites to measure water quality and nutrient levels, quantify reef-scale carbonate production and erosion, model wave attenuation, investigate coral recruitment and settlement, and capture large-scale photomosaic images that document changes to the reef through time.

A diver attaches two ceramic tiles to the reef to monitor what organisms are recruiting and settling there (Joseph Townsend)

Another day in the “office” to get the best understanding of the reef ecosystem (Dr. Travis Courtney)

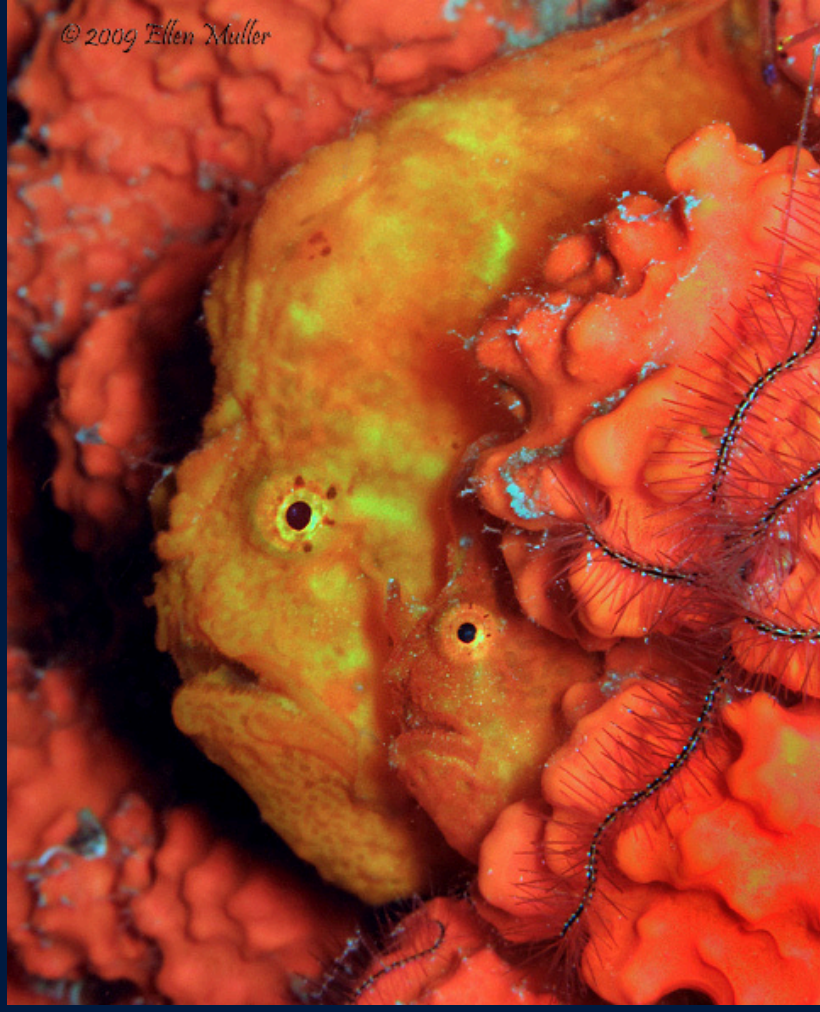
Collecting this volume of information from a single location requires considerable resources and pushes our dives to the limits of what is safely achievable. Every six months, our monitoring team visits each of the five restoration sites across Puerto Rico to document changes through time. Each field campaign quickly becomes a series of multiple, multi-hour dives, with days where we spend more time beneath the surface than above it. Careful planning, steady work, and close coordination between teams allow us to collect the extensive datasets required while also deploying and maintaining the markers, sensors, and cameras that will be used during our next survey six months later.

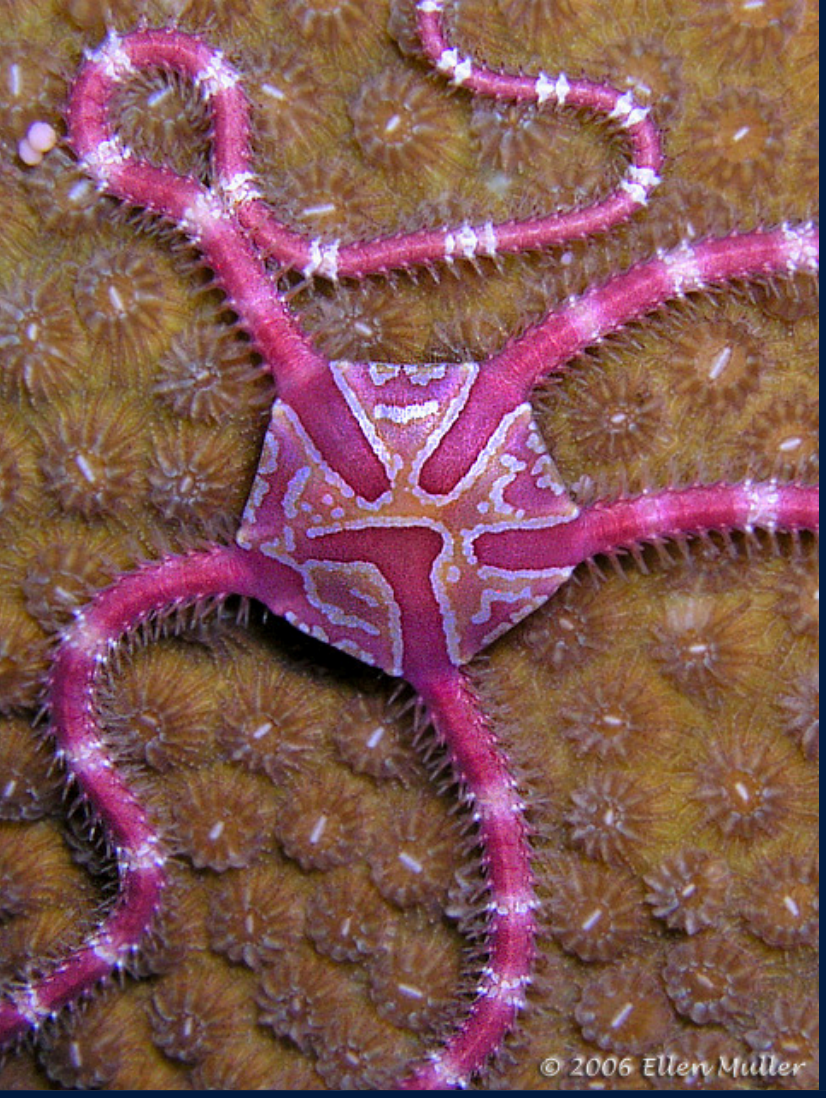
The result of all this work? We don't fully know yet. Reef restoration is still ongoing, with more than another year remaining before the project is complete. Only then will we be able to assess the full extent of ecosystem recovery. However, spending so much time on these reefs gives us an intimate understanding of each site and its community. We can already observe losses caused by recent coral bleaching events in Puerto Rico, alongside encouraging signs of recovery, including the growth of outplanted corals and the arrival of new recruits. It is a reminder that early mornings, long hours underwater, and countless surveys can, with the right planning and coordination, provide an extraordinary opportunity to understand ecosystem recovery. For an ecosystem as infinitely complex as a coral reef, capturing a true "snapshot" is never simple - but it is hugely valuable.

Photographer Spotlight

Ellen Muller

For more than two decades, Ellen Muller has been capturing the remarkable beauty and diversity of Bonaire's underwater world through her stunning photography. Originally moving to Bonaire from the United States in 1980, Ellen discovered her passion for underwater photography in 2001 and has since become one of the Caribbean's most respected underwater photographers and naturalists. Her images are celebrated not only for their technical excellence but also for their ability to reveal the intricate behaviours, colours, and relationships that make coral reef ecosystems so extraordinary.





Photograph Captions:

Previous page:

Top right: Two frogfish (family Antennariidae) hide amongst sponge with brittle stars for company

Bottom right: A Secretary Blenny (*Acanthemblemaria maria*) looks nervously from its coral hole

Bottom left: A male Yellowhead Jawfish (*Opistognathus aurifrons*) are mouthbrooders, and incubate their fertilised eggs inside their mouths until they hatch.

This page:

Top: A beautifully intricate Ruby Brittlestar (*Ophioderma rubicundum*) browsing over a boulder star coral colony (*Orbicella sp.*)

Bottom: A Glass Goby (*Coryphopterus hyalinus*), taking a break on a brain coral, possibly *Colpophyllia natans*.

Following page:

Top: A Flaming Reef Lobster (*Enoplometopus antillensis*) coming out for a feed.

Bottom: A Caribbean Reef Squid (*Sepioteuthis sepioidea*) under the waters surface at night.

Some of Ellens pictures also feature in the book An Underwater Guide to Anguilla, British West Indies (Wynne, 2019)

Collaborative Partner Spotlight

The SSI's Blue Oceans Program

For the past several months, **The Coral Reef Research Hub** has been proud to have developed a collaborative partnership with the **SSI Blue Oceans Program**, a global marine conservation initiative developed by **Scuba Schools International (SSI)**. With a strong emphasis on education, awareness, and positive action, the programme encourages divers, ocean enthusiasts, and marine professionals to become active stewards of the marine environment. Rather than simply enjoying the underwater world, Blue Oceans inspires people to understand it, appreciate the challenges it faces, and contribute to its long-term protection through informed conservation practices.

The Blue Oceans Program provides a comprehensive range of educational resources covering many of the most pressing issues affecting marine ecosystems today. Topics include coral reef ecology and conservation, marine biodiversity, shark conservation, marine debris and plastic pollution, sustainable diving practices, climate change, and the importance of healthy marine habitats such as coral reefs, seagrass meadows, and mangrove forests. By presenting these subjects in an engaging and accessible way, the programme helps divers and ocean users better understand the ecosystems they visit and the role they can play in protecting them.

A key strength of the Blue Oceans Program is its focus on turning knowledge into action. Through conservation campaigns, citizen science initiatives, underwater clean-up events, species monitoring programmes, and community outreach activities, participants are encouraged to actively contribute to marine conservation rather than simply learning about it. The programme also recognises the unique position of the global diving community. Every year, millions of divers visit coral reefs and other marine environments, providing an incredible opportunity to build a worldwide network of informed ocean ambassadors. By promoting responsible diving practices and encouraging participation in conservation initiatives, the Blue Oceans Program helps ensure that recreational diving contributes positively to the protection and long-term sustainability of the ecosystems upon which it depends.

Our collaboration with the SSI Blue Oceans Program reflects the shared values of both organisations. While the Coral Reef Research Hub focuses on supporting coral reef scientists through professional networking, career development, education, and knowledge sharing, the Blue Oceans Program complements these objectives by engaging the wider diving community and fostering greater public understanding of marine conservation. Together, we hope to strengthen connections between researchers, conservation practitioners, dive professionals, and citizen scientists, helping to create a more informed, collaborative, and proactive global community working towards healthier oceans.

Get The Right Gear

Writing underwater made easy!

Synthetic Waterproof Paper

Recording accurate data underwater presents unique challenges, and one simple piece of equipment that is often overlooked is the paper itself. Synthetic waterproof paper provides a practical alternative to conventional paper by remaining durable, tear-resistant, and fully functional even after prolonged exposure to seawater. It allows researchers to print customised underwater survey forms, making it ideal for recording benthic cover, fish counts, coral health assessments, quadrat surveys, and other field observations without the risk of pages becoming waterlogged or falling apart. They can also be filed away like normal paper, so all your survey work results can remain archived on hardcopy forever!

A great example of this type of material is TerraSlate Waterproof Paper, a synthetic paper that can be printed using standard office printers and written on underwater with a pencil. Unlike traditional rigid dive slates, individual waterproof sheets can be organised on a clipboard or within a waterproof folder, allowing multiple survey forms to be carried and used during a single dive. For students, citizen scientists, and professional researchers alike, synthetic waterproof paper is a simple but highly effective tool that can make underwater data collection more organised, efficient, and reliable. Just remember to use with a rust-proof clipboard!

Plastic Stacking Pencils

Finding a reliable writing tool for underwater fieldwork can be surprisingly difficult. While traditional wooden pencils have been the standard for decades, they eventually become waterlogged, require regular sharpening, and can snap or splinter after repeated use in marine environments. A practical alternative is the plastic stacking pencil, which contains multiple graphite inserts housed inside a durable plastic body. When the writing tip becomes blunt, you simply remove it from the front and insert it into the back of the pencil, automatically advancing a new point—no sharpener required.

Plastic stacking pencils are lightweight, compact, cheap and ideal for recording data on underwater slates or synthetic waterproof paper. Because the outer casing is plastic, they are unaffected by prolonged exposure to seawater and can be used repeatedly over many field seasons. The only real drawback is that if one of the graphite inserts is accidentally dropped during a dive, the remaining inserts may no longer feed correctly, rendering the pencil difficult or impossible to use. For this reason, experienced field researchers often carry a spare stacking pencil or a few replacement inserts in a secure pocket of their BCD. It's a small precaution that can save an entire day's worth of underwater data collection.

Coral Career Column

Learning your limits

One of the most common mistakes made by undergraduate and early-career coral reef scientists is designing a research project that is simply too ambitious. It's natural to be enthusiastic and want to answer the biggest questions in coral reef ecology, but successful research is built on realistic objectives rather than grand ideas. Before finalising your project, ask yourself whether you have the time, funding, equipment, logistical support, and expertise needed to complete it successfully. A well-executed study addressing a focused research question will almost always have greater scientific value than an overly complex project that cannot be completed or analysed properly.

Knowing your limits also means recognising your own experience and skill level. If you are new to fieldwork, begin by mastering proven survey techniques before attempting highly technical methodologies or multi-disciplinary studies. Seek advice from supervisors and experienced researchers, simplify your objectives where necessary, and remember that every successful scientist has built their career one manageable project at a time. Research should challenge you, but it should never overwhelm you. A carefully planned project that you can confidently deliver will provide a much stronger foundation for your future career than one that is overly ambitious from the outset.

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...and in case you didn't know...

The Coral Reef Research Hub is a global career development platform and **professional networking** community for coral reef professionals, researchers, early-career scientists, and undergraduates. At its core is a free, social media–style interface that enables members to search other member profiles, connect, form niche research groups, and collaborate across disciplines and regions.

The Hub also provides targeted **career development** support, particularly for undergraduates and early-career scientists, through opportunity listings, training courses, a mentorship programme, knowledge-sharing masterclasses, publication hosting, a small research grants scheme, and more. Together, these resources create a comprehensive and growing ecosystem designed to support progression at every stage of a coral reef career.

By bringing together a **global community** dedicated to reef science and conservation, The Coral Reef Research Hub serves as a unique online resource that not only connects individuals but actively supports their professional growth and research ambitions. Built by coral reef scientists for coral reef scientists, we believe that together, we are stronger.

COMING SOON: CoRR Hub Mobile App

Our Mobile App is now in late stage development and almost ready for beta-testing. If you are a CoRR Hub member and would like to be part of our beta-testing group please get in touch today!

Citation: CoRR Hub (2026) Coral Matters Magazine. Vol.1.3 28 pages. Available at: www.thecoralreefresearchhub.com/coralmatters/
Published on 1st July 2026.