

Coral Matters

THE CORAL REEF RESEARCH HUB MAGAZINE



FRIEND OR FOE? CAN AI HELP CORAL REEFS?

When humans and AI collaborate

Also in this issue: Has a coral reef 'tipping point' been reached? What were the big climate stories from 2025?

Regular: Reef roundup; photography feature; stories from the field, coral career column; get the right gear



Coral Matters Magazine



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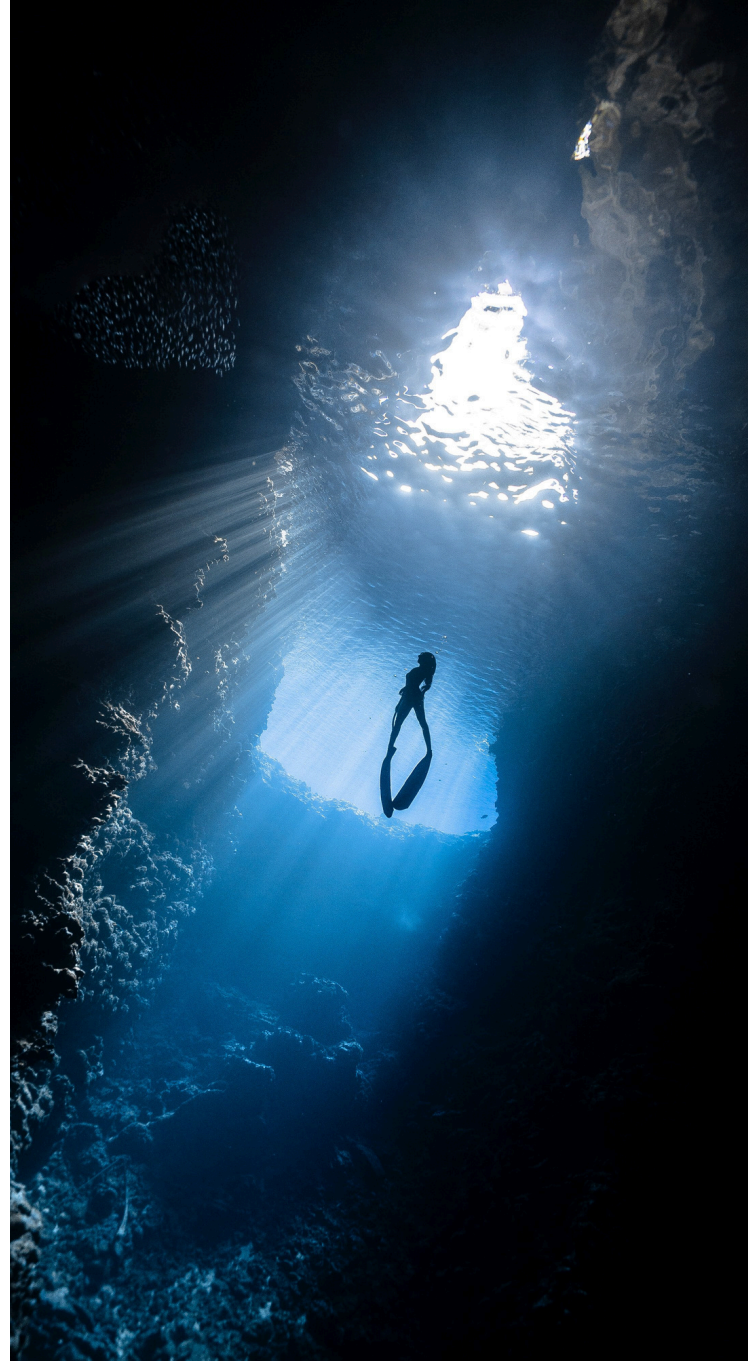
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Photo credit: Dr Stuart P. Wynne

CoRR Hub News

Welcome to the first issue of Coral Matters, a magazine produced by The Coral Reef Research Hub that aims to bring you up-to-date coral related news, research, help and advice from around the world.

This marks an exciting time for The Coral Reef Research Hub, as we have huge plans for 2026. As our global community continues to grow on our professional networking and career development website, we are excited to announce that soon we will be releasing an app version of this platform. With a bespoke mobile friendly design and essential push notifications, it will never have been easier to get connected and stay connected via your phone. So stay tuned for future updates!

Beyond our app, we are also going to be developing and expanding our existing mentorship and internship programs, adding an array of educational courses, and beginning a series of career development webinars and workshops. Plus there are a number of surprise additions coming too! Exciting times!

....and of course, there is Coral Matters, our new magazine. We are currently looking for contributors who have stories, advice, photos, or anything else coral related to share. As it stands, we have four regular features where you can share your stories, questions, products, research or even just get a shout-out through. These are:

- Photography Feature
- Stories from the field
- Coral Career Column
- Get The Right Gear



If you have something you would like to contribute or have suggestions for future editions of our magazine, please get in touch! We wish everyone an amazing 2026!

The CoRR Hub Team



Noteworthy coral news from around the world:

- 1. Great Barrier Reef, Australia:** Record coral spawning was documented across much of the Great Barrier Reef in December, demonstrating continued reproductive activity despite elevated thermal stress. (Breaking Travel News, 2025)
- 2. Southern Great Barrier Reef, Australia:** A combination of extreme heat and pathogenic black band disease caused widespread mortality of massive corals, highlighting synergistic stressor impacts on reef health. (EurekAlert!, 2025)
- 3. Red Sea, Egypt:** Scientists report that coral reefs drive daily microbial cycles in surrounding waters, revealing an overlooked role for reefs in regulating microbial dynamics and broader ecosystem functioning. (Phys.org, 2025)
- 4. Caribbean Basin:** Scientists warn that reef fish populations are severely depleted, but recovery strategies could enhance both reef ecosystem function and sustainable seafood production. (Phys.org, 2026)

5. Caribbean & West Atlantic:

Caribbean coral cover has declined by nearly half since 1980, with macroalgae proliferation linked to thermal stress and local pressures such as overfishing. (GCRMN Report, 2025)

6. **Papua New Guinea:** A cruise ship grounding incident damaged reef structures off the PNG coast, underscoring ongoing threats from maritime impacts on fragile coral habitats. (The Guardian, 2025)

7. **Canary Islands & global:** A mass die-off of key reef-grazing sea urchins has hit the Canary Islands and broader regions, threatening herbivory dynamics critical for preventing algal dominance on coral reefs. (ScienceDaily, 2025)

In more detail: Roundup 5

Recent assessments by the Global Coral Reef Monitoring Network indicate that coral cover across the Caribbean has declined by approximately 40–50% since the early 1980s, marking one of the most severe long-term regional losses recorded globally. This decline is attributed primarily to repeated marine heatwaves causing mass bleaching events, compounded by hurricanes, coral disease outbreaks, and chronic local stressors such as poor water quality and coastal development. The Caribbean has experienced particularly frequent thermal anomalies in the past decade, limiting recovery time between disturbances and pushing many reefs beyond ecological tipping points.

The report also highlights a pronounced ecological phase shift in many locations, with reduced coral cover accompanied by widespread proliferation of macroalgae. This shift is closely linked to the loss of key herbivores, especially reef fish and the long-spined sea urchin *Diadema antillarum*, whose populations were historically decimated by disease and overfishing. Reduced herbivory allows algae to outcompete juvenile corals for space, suppressing recruitment and reinforcing reef degradation. Together, these findings underscore that Caribbean reef decline is driven not by climate stress alone, but by the interaction between global warming and long-standing regional management failures, emphasizing the need for integrated climate mitigation and local conservation action.



Friend or Foe?

Can AI help coral reefs?

When humans and AI collaborate

Coral reefs are experiencing rapid global decline as a result of climate-driven ocean warming, marine heatwaves, acidification, declining water quality, and cumulative local stressors. Despite decades of advances in reef ecology and management, the scale and rate of degradation increasingly outpace the capacity of traditional monitoring and restoration approaches. In this context, artificial intelligence (AI), machine learning, and autonomous systems are emerging as potentially transformative tools for coral reef science and conservation. Their application raises both optimism and concern: optimism that AI can enhance decision-making and restoration at scale, and concern regarding over-reliance on opaque technologies or displacement of human expertise.

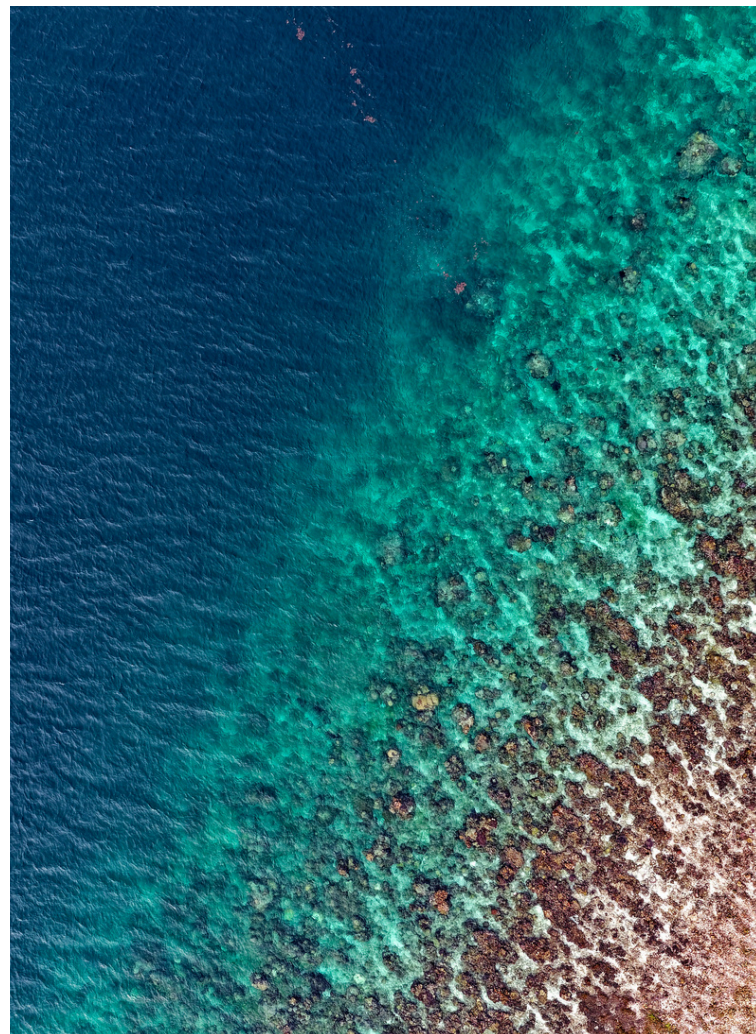


Recent research demonstrates that AI is being applied across multiple stages of reef conservation, from environmental monitoring and predictive modelling to restoration planning and physical deployment. One of the most visible advances is the integration of AI with robotics to support large-scale coral restoration. Autonomous and semi-autonomous systems guided by computer vision and decision algorithms are now capable of identifying suitable reef substrates, deploying coral larvae or fragments, and operating over spatial scales that would be prohibitively expensive or logistically infeasible for human divers alone (AIMS, 2024). These systems do not function independently of scientists; rather, they embed ecological rules, habitat suitability models, and expert-defined objectives within automated workflows.



AI has also begun to influence how future reef trajectories are modelled. Recent studies show that data-driven AI climate and ecosystem models can outperform traditional statistical and mechanistic approaches in predicting reef exposure to thermal stress and identifying potential refugia under climate change scenarios (ICRI, 2025). These models integrate heterogeneous datasets, including historical temperature records, oceanographic projections, and ecological responses, to produce spatially explicit risk assessments. While such predictions do not replace process-based understanding, they provide decision-makers with additional tools to prioritise conservation actions in an increasingly uncertain climate future.

Beyond restoration, AI has substantially expanded the analytical capacity of reef monitoring programs. Machine learning techniques are increasingly used to process large volumes of underwater imagery, satellite data, and acoustic records, enabling rapid classification of benthic communities, detection of coral bleaching and disease, and estimation of reef structural complexity (González-Rivero et al., 2020; Li et al., 2024). Such approaches address a long-standing bottleneck in reef science: the time and labour required to convert raw observations into actionable ecological indicators. Reviews of coral reef surveillance systems indicate that convolutional neural networks and related architectures consistently outperform manual and semi-automated methods in classification accuracy, particularly when trained on large, well-curated datasets (Li et al., 2024).



Concerns that AI may “replace” coral scientists are not supported by current evidence. Instead, the literature emphasises that AI systems depend fundamentally on human knowledge at every stage: defining research questions, selecting training data, interpreting outputs, and translating results into management actions (ReefBites, 2025). AI models lack ecological intuition and contextual awareness, and their outputs are sensitive to biases and gaps in training data. Without expert oversight, there is a risk of overconfidence in algorithmic results or misapplication in complex reef environments. Furthermore, ethical and practical considerations—including energy use, data ownership, and equitable access to technology—require human governance rather than automated solutions.

Importantly, AI does not address the root causes of coral reef decline. It cannot prevent greenhouse gas emissions, halt marine heatwaves, or substitute for strong environmental policy. Its value lies in extending human capacity: increasing spatial and temporal coverage of observations, accelerating analysis, and supporting restoration efforts where intervention is ecologically justified. When applied judiciously, AI enables scientists and managers to work more efficiently and at scales commensurate with global reef loss, while retaining human responsibility for interpretation and action.

In this sense, AI is neither friend nor foe, but an enabling technology. Its effectiveness depends on collaboration between ecologists, engineers, data scientists, and local stakeholders, as well as transparency in model design and application. As coral reefs approach ecological thresholds, the integration of AI with human expertise offers a means to improve responsiveness and precision in conservation efforts. However, technological innovation must remain aligned with ecological principles and societal values if it is to contribute meaningfully to the persistence of coral reef ecosystems in the Anthropocene.





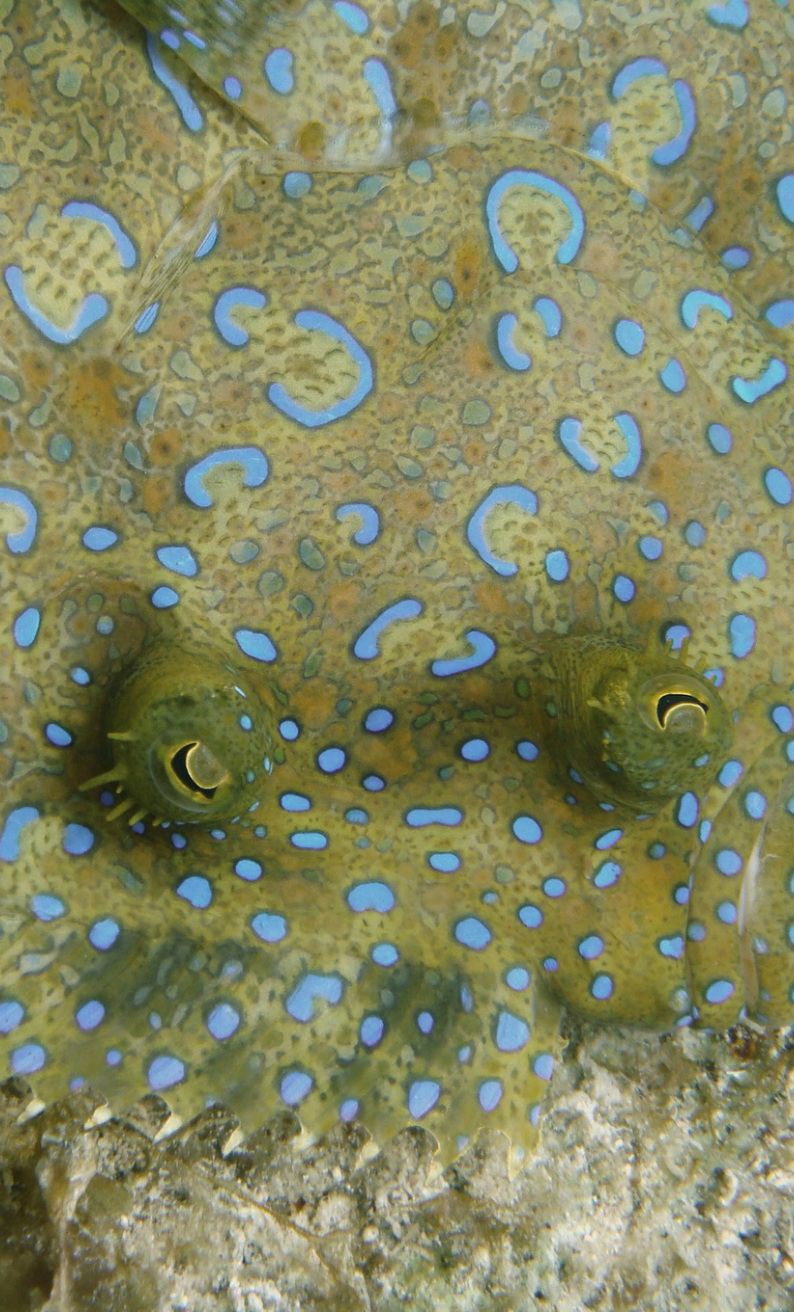
Photography Feature:

Anguilla: British West Indies

Anguilla is a small, low-lying island in the northeastern Caribbean Sea, part of the British West Indies and located east of Puerto Rico and north of Saint Martin. Known for its limestone geology, extensive fringing reefs, and sandy shoals, the island supports productive coastal and marine ecosystems that underpin local fisheries and tourism. Anguilla has a dry climate relative to many Caribbean islands and a long history of maritime livelihoods closely linked to the health of its surrounding coral reefs and seagrass habitats.

As with most of the Caribbean, the coral reefs around Anguilla have suffered significant declines over recent decades (Wynne, 2017). Despite this, there is still amazing marine life to see underwater and numerous purposefully sunk ship wrecks provide some very exciting diving opportunities for all certification levels. The following images capture some of the amazing sights there are to see in and around this beautiful island.





Clockwise from top left: A peacock flounder (*Bothus mancus*) with vibrant colours and stalk-like eyes gazes around the reef; a juvenile filefish (Monacanthidae) hides among *Halimeda* sp. algae within a seagrass bed; a finger coral colony (*Porites porites*) with numerous fish near Sandy Island.

Previous page: Shoal Bay East beach on the north side of Anguilla; a reef shark (*Carcharhinus perezi*) cruises around the waters looking for opportunity.



Top to bottom: A pair of caesar grunts (*Haemulon carbonarium*) swim happily around a small reef near Meads Bay, Anguilla; sculptured slipper lobsters (*Parribacus antarcticus*), usually a nocturnal species, are rarely seen on the reef during the day; a gruff looking red hind grouper (*Epinephelus guttatus*) loiters near an overhang on the off-shore seal island reef system.





Clockwise from top left: A banded coral shrimp (*Stenopus hispidus*) forages around the rocks for lunch; a huge pillar coral colony (*Dendrogyra cylindrus*), now sadly rare due to stony coral tissue loss disease (Dahlgren et al, 2021), near Limestone Bay, Anguilla. This colony is now sadly dead.

Inset: These images, and hundreds more taken by Dr. Stuart P. Wynne can be found in his book 'An Underwater Guide to Anguilla, British West Indies (Wynne, 2019).



Has a coral reef ‘tipping point’ been reached?

What might the future look like for coral reefs?

Recent media reporting has increasingly characterised coral reefs as having reached, or imminently approaching, a climatic tipping point, implying a transition from recoverable disturbance to sustained and self-reinforcing decline. In Earth-system science, a tipping point denotes a critical threshold at which incremental forcing triggers a qualitative change in system state through internal feedbacks, leading to reduced reversibility on human timescales. Applied to coral reefs, this concept refers primarily to the interaction between rising ocean temperatures, biological stress limits, and ecological feedbacks that constrain recovery following repeated disturbance.

The basis for this concern lies in the thermal sensitivity of reef-building corals. Elevated sea surface temperatures disrupt the symbiosis between corals and endosymbiotic dinoflagellates, single-celled algae known collectively as Zooxanthellae. This disruption can cause bleaching and, under prolonged stress, coral death. While bleaching itself is not inherently fatal, recovery requires extended periods of sub-threshold temperatures to allow restoration of energy reserves, reproductive capacity, and recruitment. Empirical evidence shows that the frequency and duration of marine heatwaves now exceed these recovery requirements across many reef regions, resulting in cumulative physiological impairment and population decline (Hughes et al., 2017; Hughes et al., 2018).

This process has been documented at unprecedented scale during the fourth global coral bleaching event, formally confirmed by NOAA in April 2024 and continuing through 2025. Satellite-based heat stress metrics and in situ observations indicate that approximately 84% of the global coral reef area experienced bleaching-level thermal stress during this period, exceeding the spatial extent of previous global events (NOAA, 2024; ICRI, 2025a; NOAA Coral Reef Watch, 2025). Notably, severe bleaching has occurred across a wide range of biogeographic settings, including reefs historically considered buffered by high natural variability or favourable oceanographic conditions. This spatial synchrony reduces the likelihood of regional larval supply from less-affected source reefs and weakens metapopulation-level persistence (Reuters, 2025; The Guardian, 2025).



Ecologically, repeated bleaching alters reef trajectories through interacting biological and structural processes. Thermal stress reduces coral growth rates, fecundity, and larval settlement success, while selectively removing species that contribute disproportionately to three-dimensional reef structure. Declining structural complexity is associated with reduced fish biomass, altered trophic interactions, and diminished herbivory, increasing the likelihood of macroalgal dominance. Once established, algal-dominated states suppress coral recruitment and survival, creating barriers to recovery even under improved thermal conditions (Hughes et al., 2017; Hoegh-Guldberg et al., 2007). Importantly, functional degradation—such as a shift from net carbonate accretion to net erosion—can occur prior to near-total coral loss, with significant implications for coastal protection and fisheries (Hoegh-Guldberg et al., 2007).

Long-standing projections have anticipated such outcomes. Early syntheses identified rapid warming and ocean acidification as primary drivers of declining calcification, increasing bleaching frequency, and reduced reef accretion potential (Hoegh-Guldberg et al., 2007). Subsequent assessments by the IPCC estimated that global warming of 1.5°C would result in the loss of 70–90% of warm-water coral reefs, increasing to over 99% at 2°C, reflecting a steep non-linear escalation of risk over a narrow temperature range (IPCC, 2018). Recent synthesis efforts, including the Global Tipping Points Report 2025, place warm-water coral reefs among the most climate-sensitive ecosystems, with a central estimate for large-scale degradation around 1.2°C of warming, overlapping with present-day global mean temperatures (Lenton et al., 2025).



Recent media interpretations have sometimes framed these findings as evidence that coral reefs are already irreversibly lost. Scientific commentary has emphasised a more nuanced interpretation. While many reef systems are now experiencing chronic disturbance with limited recovery potential, outcomes remain spatially heterogeneous. Local persistence is influenced by thermal exposure patterns, water quality, depth, circulation, and species composition, and some reefs continue to retain ecological function despite repeated stress (Science Media Centre Spain, 2025). The threshold identified in recent reports is therefore better understood as a transition into a regime of high risk and declining resilience rather than a singular global endpoint.

The implications for management and policy are nevertheless substantial. Stabilising or reversing large-scale reef decline requires rapid reductions in greenhouse gas emissions to limit further warming, as local interventions alone cannot offset the thermodynamic driver of mass bleaching at global scales (IPCC, 2018; NOAA, 2024). At the same time, reducing non-climatic stressors, protecting areas with lower thermal exposure, and maintaining ecological processes such as herbivory can influence the rate and extent of degradation and preserve ecosystem services in the near to medium term (ICRI, 2025b). Restoration and assisted approaches may contribute to maintaining components of reef biodiversity and structure in targeted contexts, but their effectiveness remains contingent on broader climatic conditions (Lenton et al., 2025).



Taken together, current observations, projections, and synthesis reports indicate that coral reefs are now operating within a narrow and rapidly shrinking climatic margin. Whether this state is described as having reached a tipping point depends on scale and definition, but the evidence supports the conclusion that continued warming will increasingly constrain recovery and accelerate long-term loss of reef structure and function unless global temperature trajectories are altered.

Stories from the field

What it means to never give up

By Dr. S.P.Wynne (@stuart-wynne)

Going back many years I remember when I first started getting into coral reef research. I was in the middle of my MSc, having taken a number of years off to travel the world (not the typical gap year!). During this time I had expanded my dive certification to divemaster, and was ready to try and get into the coral reef research world in person. For my MSc project I decided to focus on a coral fishery species, where my work would ‘unfortunately’ (not) mean having to travel overseas to collect data. ‘Wow’, I thought to myself, who needs to travel aimlessly when you can do research in amazing tropical places?

Little did I know, but the species I had chosen to survey was a particularly cryptic member of the Palinuridae (spiny lobster) family. Having read all the papers I could find on the subject (remember this is many years ago before the internet is what it is today!), and decided to go for a belt transect methodology. ‘No problem’ I thought. My supervisor advised that I should try and contact someone who had researched these creatures before, so I spent the next week or two hunting down email addresses and writing to people.



Despite having written dozens of emails and even a few ‘snail mail’ letters, I only received a reply from one person, and although they had some experience with the species I was interested in, they had done mostly trap-based surveys, and belt transects on some Palinuridae cousins. I was advised that my methodology seemed sound, with a suggestion that I may need to look into reef recesses to see tell-tale antennae that would aid my population counts. I was happy, this seemed like a sound plan, and so over the following few weeks I started getting my gear together and prepared to leave.

When I arrived 'on location' I quickly sorted out a housing solution for my three month stay and chatted to locals about potential study locations and favourite fishing areas. After a day or two I had chosen my twelve study sites and generally settled in enough to feel ready to get cracking with the survey work.

Excitedly the next morning I headed to the most picturesque beach I had ever seen, and snorkelled out to the offshore reef. It was quite a distance, but as the beautiful sunshine glinted through the crystal clear water I pushed away fears of sharks and finned quickly across the sand channel and onto my first study site. I laid the transect out, and waited at one end for a few minutes to let the sea life get back to their usual business.

The transect was quite deep, but I was able to duck-dive down and survey a bit at a time, looking under ledges and within reef recesses as I went. I saw plenty of Palinuridae, but unfortunately not any of the species my study was aimed at. Not good. I headed back to shore, disheartened but confident things would get better.

A week or so later, having visited all my chosen study sites I still had not seen even a brief glimpse of my study species. I was lost and wondering what my next step would be, there was no way that I could head back to University without a dataset!

After a few days considering my options I decided to talk to the fishermen about it. When I explained my situation they looked at me like I was stupid and said 'well, they only come out at night', and then rolled about laughing. Not helpful. But then my luck changed. 'We get our best catches when we go out at night and snorkel for them' said one fisherman. Genius.

However, my excitement soon faded when the implications set in. I would have to go out onto the reef at night snorkelling. Well, luckily I am quite adventurous, so I ploughed ahead with the idea and gave it a go. I hung two glow sticks on posts about 100 m apart each evening just before sun set (there was very little coastal development at most of my sites so I needed a visual reference of how to find my way back to land!), got myself kitted up and off I went just after dark. Lo and behold there they were, my elusive Palinuridae species, foraging around the reef in the moonlight. I had a torch with me of course, but I do have to admit it was easy to imagine shark shaped shadows everywhere I looked.

I ended up with a great dataset, a stern talking to from my supervisor (not happy about the health and safety implications!), and a reputation around the island as being the crazy foreigner who goes out snorkelling on the reef at night!....and, even better, I was offered a job on the island working as a coral and fisheries surveyor! My perseverance paid off, and not giving up changed my life forever! I have never looked back.

Although it ended well for me, difficulties in networking within academia and management is the reason why I appreciate the work that The Coral Reef Research Hub is doing. By bringing everyone together and making it easier for researchers to find each other and collaborate is a truly game changing thing. I can not wait to see what the future brings. I fully recommend you join their growing community today!

Their motto: Together we can make a difference!

The Top Five

Climate stories from 2025

2025 Among the Warmest Years on Instrumental Record

Global temperature analyses for 2025 confirm that mean surface temperatures remain at or near the highest levels observed in the modern instrumental era, consistent with ongoing anthropogenic forcing. Synthesised datasets indicate that 2025 is likely to be one of the warmest years since systematic records began in the mid-19th century, with multi-year sequences potentially exceeding previous warming benchmarks. The persistence of elevated temperatures reflects the continued accumulation of long-lived greenhouse gases and their influence on the Earth's energy balance.



Sustained warmth across land and ocean surfaces alters the frequency and magnitude of climatic extremes by raising baseline thermal conditions. Higher temperatures increase the probability of heatwaves, intensify hydrological extremes, and interact with natural climate variability to amplify regional impacts. The persistence of near-record temperatures across consecutive years underscores the limited capacity of short-term variability to offset long-term warming trends driven by greenhouse gas emissions (WMO, 2025).



The absence of explicit fossil fuel phase-out language has implications for the credibility of international climate governance. Scientific mitigation pathways indicate that continued reliance on coal, oil, and gas is incompatible with limiting warming to 1.5°C, and delays in addressing fossil fuel dependency increase the likelihood of exceeding critical climate thresholds. The COP30 outcome therefore highlights a disconnect between negotiated outcomes and the requirements identified by climate science (Associated Press, 2025).

Global Coral Bleaching Event Reaches Unprecedented Extent

Observational data confirm that the ongoing 2023–2025 coral bleaching event represents the most geographically extensive bleaching episode on record, affecting approximately 84% of global coral reef area. Elevated sea surface temperatures have persisted across all major ocean basins, exceeding physiological thresholds for many reef-building coral species.

Prolonged thermal stress disrupts coral–symbiont relationships, leading to bleaching, reduced energy acquisition, and increased mortality risk. The spatial synchrony of this event reduces opportunities for recolonisation from less-affected regions and increases the probability of long-term structural degradation, with consequences for marine biodiversity, fisheries, and coastal protection (NOAA Coral Reef Watch, 2025).

COP30 Fails to Include Binding Fossil Fuel Phase-Out

The 30th Conference of Parties under the UNFCCC (COP30) concluded without an explicit commitment to phase out fossil fuels, despite scientific evidence that rapid reductions in fossil fuel combustion are necessary to meet global temperature targets. Negotiations resulted in a compromise text that avoided binding language on fossil fuel transition, reflecting continued geopolitical divisions between producer and consumer nations.

International Plastic Treaty Negotiations Stall

Efforts to finalise a legally binding global plastics treaty failed in December 2025, following prolonged negotiations over production limits, chemical regulation, and financial mechanisms. Disagreements between nations over the scope and enforceability of the treaty prevented consensus, delaying coordinated international action on plastic pollution.

The absence of a binding agreement has implications beyond waste management, as plastic production is closely linked to fossil fuel extraction and greenhouse gas emissions. Continued growth in plastic production is expected to increase emissions across supply chains while exacerbating ecological pressures in marine and terrestrial environments, reinforcing interactions between pollution and climate change (UNEP, 2025).

The International Court of Justice Clarifies Legal Obligations of States on Climate Change

In 2025, the International Court of Justice issued an advisory opinion affirming that states have legal obligations under international law to mitigate climate change and address harm resulting from greenhouse gas emissions. The opinion emphasised that failure to act on climate change may constitute a breach of existing legal duties, including those related to human rights and environmental protection.

This clarification strengthens the legal basis for climate accountability and may influence future litigation and policy development. By linking scientific evidence of climate harm to legal responsibility, the ruling provides a framework for integrating physical climate thresholds into legal assessments of state conduct, potentially reshaping international climate governance (ICJ, 2025).





Coral Career Column

How To Become A Coral Reef Scientist

In this regular feature we will be answering your coral career questions, and also featuring career advice from our very own life and business coach! So, please get in touch with your questions, and we will do our best to give you an answer!

For this issue, we thought we would answer the question that we get asked the most 'How do I become a coral reef scientist?'. Because of the frequency we get asked this question we have produced a workbook based course that takes you step-by-step through career journey options. This workbook can be accessed by signing up as a premium member to our career development and networking site and following the link below!

<https://www.thecoralreefresearchhub.com/courses/fundamentals/>

Get The Right Gear

In this regular feature we will be reviewing underwater equipment recommended by our members....things that we feel all coral reef scientists should have in their tool kit.

The first of these products is one we have had extensive use of, which is made by our project partners over at OM Systems - the affordable and compact TG-7 and underwater housing.

For the price, this underwater photography system gives incredible results, with extreme close-up macro settings, and an effective resolution of 12MP. It is also compatible with a number of attachable lenses that can provide amazing wide angle views, as well as HD video capture and built-in flash. Of all the cameras we have used, this one is the best we have found that is compact enough to make it manageable underwater when taking photo-quadrats or video transects. For us this is a must have!

And to make things even better, we can offer our premium members amazing discounts on this and other OM Systems products. To take advantage of these discounts simply sign up to our career development and networking site as a premium member and follow the link below!

<https://www.thecoralreefresearchhub.com/product-partner-discounts/>



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