UNEP

Mesophotic Coral Ecosystems

A lifeboat for coral reefs?

SUMMARY

An aggregation of Schoolmaster Snappers (Lutjanus apodus) at Bajo de Sico, Puerto Rico, 50 m depth. Observed spawning aggregations of Schoolmaster Snappers in this area are known to consist of over 500 individuals (photo Héctor Ruiz, HJR Reefscaping).

Foreword

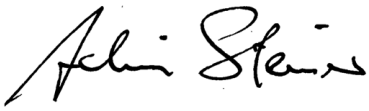
It should come as no surprise to you that coral reef ecosystems are in trouble. Humans have left an indelible mark on these ecosystems, resulting in almost 20 per cent of coral reefs disappearing. Unless we change the status quo, another 35 per cent are expected to be lost in the next 40 years.

Coral reefs provide both tangible and intangible benefits to the lives of millions of people. From providing food and income to protecting our coasts from damaging storms, coral reefs make an incalculable contribution to coastal communities, as well as to the organisms that depend on them.

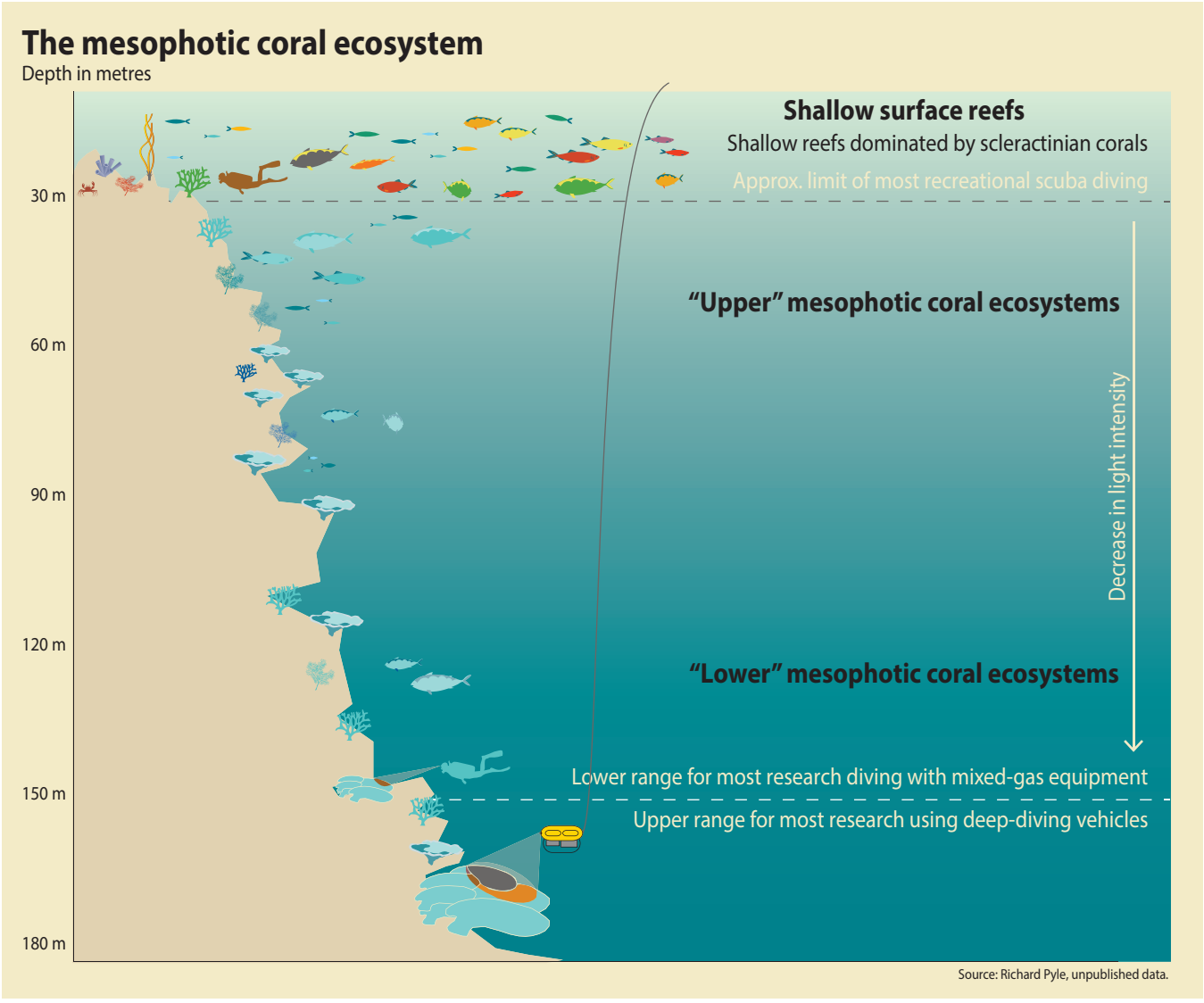
Is there something we can do to help improve their chances of survival? In 2014, the United Nations Environment Programme convened a workshop to examine whether there were additional management strategies that we could employ to increase the resilience and resistance of coral reef ecosystems to arrest their decline. One of the recommendations of the *Scientific Workshop on Coral Reef Resilience in Planning and Decision-support Frameworks* was to develop knowledge products on emerging issues, such as investigating the role of little-known mesophotic coral reef ecosystems (MCEs) in coral reef resilience. Could these intermediate depth reefs serve as "lifeboats" for increasingly stressed coral reef ecosystems?

This report aims to address this question by bringing together thirty-five MCE experts from around the globe to document what is known about MCEs, the threats they face and the gaps in our understanding. MCEs are one of the few remaining ecosystems on earth that remain largely unexplored. While MCEs are deeper and more remote than shallow coral ecosystems, they are still subject to some of the same impacts such as bleaching and habitat destruction. We are just beginning to understand MCEs, but they have provided a glimmer of hope that, in some locations, they may resist some of the most immediate impacts of climate change, and may be able to help re-seed damaged or destroyed surface reefs and fish populations. Their ability to do this depends on how well we manage them.

I hope this report can help catalyze greater efforts to understand and protect mesophotic deep reefs, as a key part of efforts towards achieving the Sustainable Development Agenda and in particular target 14 on oceans.



Achim Steiner
UNEP Executive Director and Under-Secretary-General of the United Nations



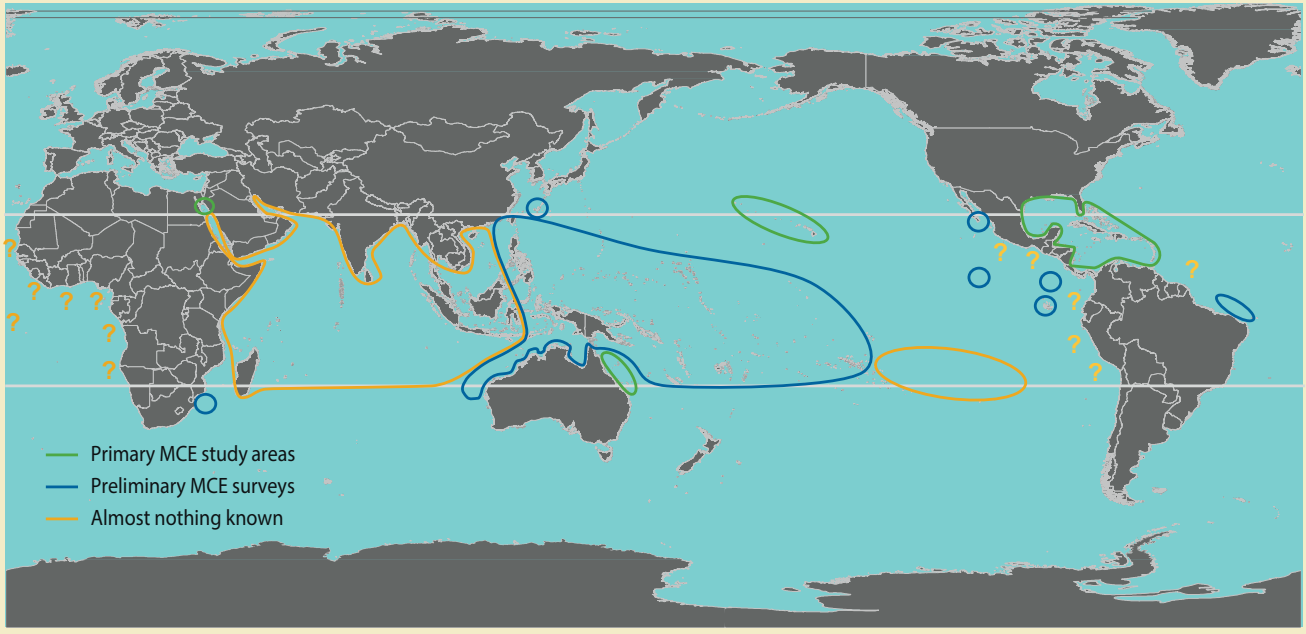
MCEs can form on high-angle continental and insular slopes as illustrated here, or on low-angle outer insular shelves and on the tops of submerged banks. Decreased light penetration rather than reduced temperature appears to be the primary limiting factor controlling the depth distribution of MCEs at most locations.

Summary

Picture a coral reef — most people will probably imagine brightly coloured corals, fish and other animals swimming in well-lit shallow waters. In fact, the coral reefs that live close to the surface of the sea — the ones that we can swim, snorkel, or dive near and see from space — are only a small portion of the complete coral reef ecosystem. Light-dependent corals can live in much deeper water (up to a depth of 150 m in clear waters). The shallow coral reefs from the surface of the sea to 30–40 m below are more like the tip of an iceberg; they are the more visible part of an extensive coral ecosystem that reaches into depths far beyond where most people visit. These intermediate depth reefs, known as mesophotic coral ecosystems (MCEs) are widespread and diverse, however they remain largely unexplored in most parts of the world, and there is little awareness of their importance among policy makers and resource managers.

With the global climate heating up, the world's shallow coral reefs are predicted to experience increasing levels of catastrophic bleaching. This review of mesophotic coral ecosystems stared in 2015 — the hottest year on record in modern times.

Current extent of MCE studies



Source: Adapted from Richard Pyle, unpublished data

Extent of MCE investigations to date (adapted from Richard Pyle unpublished data). At least 80 countries (those with documented shallow reefs; Spalding et al. 2001) have potential MCEs. Countries that do not have surface reefs, but potentially have MCEs, include those on the west coasts of Africa and South America.

Key differences between shallow and mesophotic coral ecosystems

	Shallow-water coral reef ecosystems	Mesophotic coral ecosystems (MCEs)
Depth range	• 0 to approx. 30–40 m. • Lower depth corresponds to a moderate faunal transition. • Detectable in satellite images.	• From approx. 30–40 m to deeper than 150 m. • Lower depth limit varies by location due to di erences in light penetration and other abiotic factors. • Not detectable in satellite images.
Dominant habitat-building taxa	• Dominant species are zooxanthellate scleractinian corals, octocorals, calcareous and foliose macroalgae and sponges.	• Dominant species are plate-like and encrusting zooxanthellate scleractinian corals, octocorals, antipatha-ians, calcareous and foliose macroalgae and sponges.
Light levels	• Generally well-lit environments. Shallow reefs can become light-limited in turbid waters (e.g. near estuaries).	• Generally middle- to low-light environments.
Thermal regime	• Generally stable thermal regime. Shallow, stratified waters with high residence time may be subject to extreme thermal events causing coral bleaching.	• Generally temperatures are cooler and naturally more variable on MCEs than on shallower reefs, especially those located on the continental slope, which are subject to internal waves. Deeper water column may protect MCEs from extreme (warm) thermal events.
Hydrodynamic regime	• Subject to breaking waves and turbulence, except in sheltered lagoons. • Wave-induced shear stress and mobilition of seafloor sediments. • High residence times within lagoons.	• Below the depth a ected by breaking waves. • Seafloor generally una ected by wave motion. Powerful storms can directly and indirectly impact MCEs (resuspend sediment or cause a debris avalanche), especially in the upper mesophotic zone (30–50 m).

This review asks the question — **can MCEs provide a "life boat" for shallow coral reefs that are suffering decimation from rising sea surface temperatures and other anthropogenic impacts?** The geological record tells us that shallow reefs in many places, including Australia's Great Barrier Reef, have been wiped out numerous times in the past, due to changes in sea level. In fact scientists think that MCEs may have acted as nurseries for the recolonisation of the shallow reefs when sea level returned to favourable levels. So could this happen again?

Thirty-five scientists from around the globe were involved in the study, which found that **MCEs could act as "lifeboats" for some species**. Many common shallow corals and reef fish are found at mesophotic depths, suggesting that shallow and mesophotic coral ecosystems are connected. Because of

this **MCEs could serve as a safe haven for some species of coral and fish**.

MCEs exist in a zone that is often out of reach — too deep for conventional scuba diving but too shallow for most undersea vehicles. Existing on the edge of darkness, the few that have been studied are proving to be much more complex than ever imagined. They appear to be **as diverse, and in some cases more diverse, than their neighboring shallow reefs**. And they provide a refuge for some shallow water reef species that are facing increasing threats from human activities. For their inherent biodiversity and the wide range of ecosystem goods and services they provide, MCEs **should be considered for coral reef conservation and fisheries management measures**.

Bright blue ascidians, known as sea squirts, are found thriving at 50 metres (164 feet) among corals, greenish brown algae (Lobophora) and red, orange, and brown sponges off La Parguera, Puerto Rico (photo Héctor Ruiz).

Recommendations

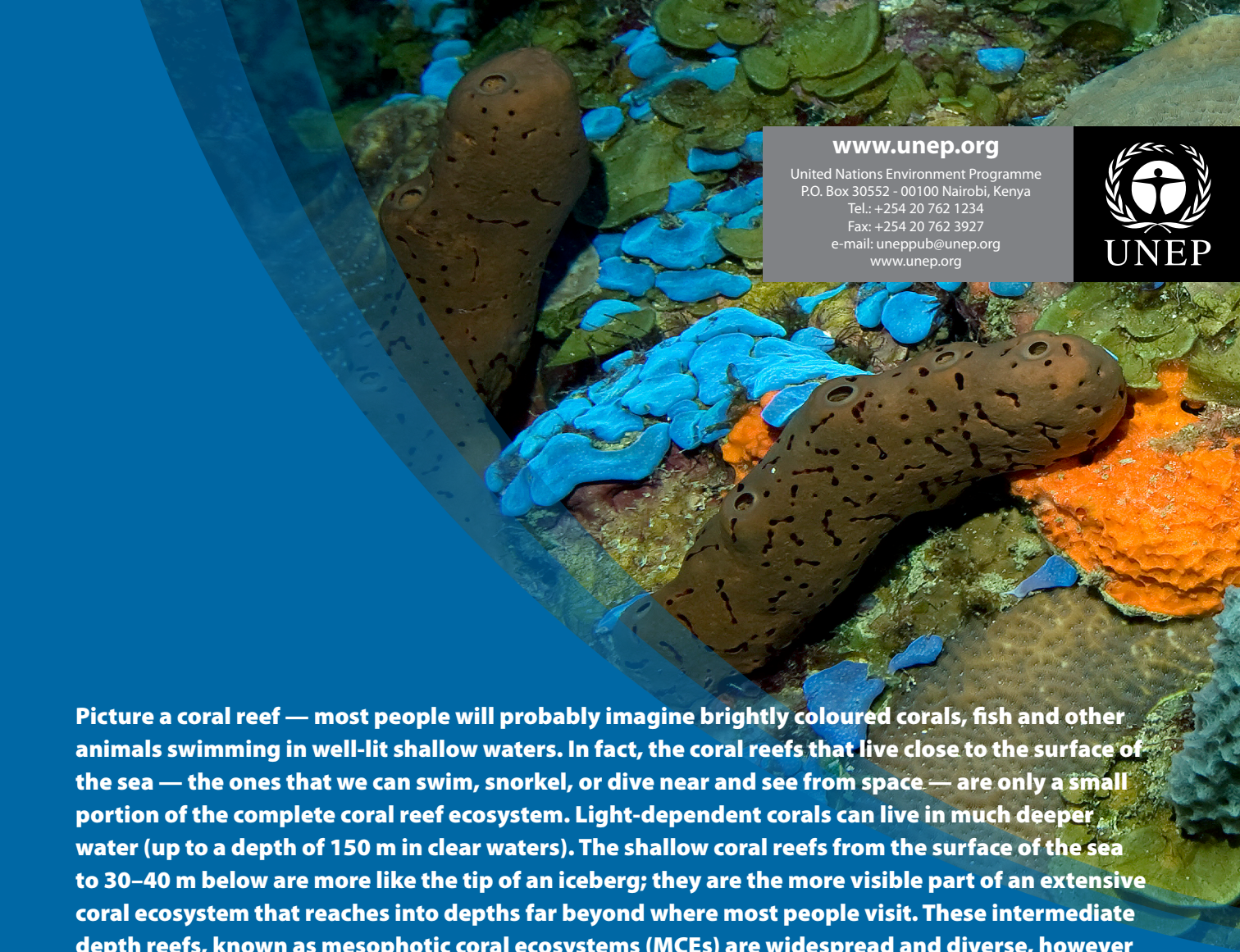
Locate where mesophotic reefs exist by developing detailed maps, and increase the understanding of the geological and physical processes that control reef distribution to enable us to predict where they occur. Managers should determine if they occur in their jurisdiction and if they are under threat.

Fill in the gaps on the map by prioritizing the equatorial regions of the Indo-West Pacific region, eastern Atlantic Ocean, and the Pacific coasts of Mexico, Central America and South America, where almost nothing is known about MCEs.

Increase our understanding of how they are connected to shallow reefs to enable us to determine the extent to which MCEs can serve as a refuge for, or reseed, existing reefs. Managers should determine if existing marine managed areas for shallow reefs need to be extended to include nearby MCEs.

Raise awareness amongst managers and policy makers of the potential importance of MCEs, including the ecosystem goods and services they provide and their potential importance to the survival of shallow coral ecosystems, and **encourage measures to protect and reduce stresses on MCEs** e.g. through conservation planning, marine spatial planning and fisheries management.

Expand shallow reef monitoring programmes to include MCE habitats, so that we can understand the relationship between the state of shallow reefs and their deeper mesophotic neighbours.



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This is a summary for decision makers of the report *Mesophotic coral ecosystems — A lifeboat for coral reefs? Available at unep.org/publications.**

* Baker, E.K., Puglise, K.A. and Harris, P.T. (Eds.). (2016). *Mesophotic coral ecosystems — A lifeboat for coral reefs?* The United Nations Environment Programme and GRID-Arendal, Nairobi and Arendal, 98 p.