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The Gulf of Aqaba's Reefs of Hope

Assigning World Heritage Status
to the Coral Reefs of the Gulf of
Aqaba, Northern Red Sea





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Summary

The Gulf of Aqaba region has hosted human enterprise, culture, and the exchange of innovative ideas and perspectives for millennia. The highly biodiverse coral reefs of this northern Red Sea site exhibit a unique resilience to global warming, which may hold the key to preserving the Earth's corals as ocean temperatures continue to warm. However, the future of this region is under threat not only from a changing climate, but also from pollution, coastal development, and over-fishing. Coral reefs and marine life are not beholden to political borders, and urgent conservation efforts are needed, on both regional and national levels, to secure the Gulf's unique, temperature-resistant coral reefs and their

interdependent ecosystems. Success will secure the lives and livelihoods of millions of people in the Gulf of Aqaba region and preserve critically endangered ecosystems for future generations. To accomplish this transboundary conservation effort, we propose that the Gulf of Aqaba region, including some of the coastal waters of Jordan, Israel, Egypt, and Saudi Arabia, be considered for inclusion on UNESCO's list of World Heritage Sites. Such designation could spur the region-wide collaboration between scientists, policymakers, and the broad range of local stakeholders necessary to secure the sustainable development of these vital coastal areas.



The Gulf of Aqaba region

The Gulf of Aqaba region boasts a combination of attributes unrivaled on our planet. Not only is this area historically significant, but its unique geography has also generated sites of unparalleled natural beauty and breathtaking biodiversity. This area is home to many endemic organisms, including naturally heat-resistant coral reefs that may hold the key to protecting corals from the damaging effects of global warming.

Historical significance

The Red Sea, including the Gulf of Aqaba region, formed the backdrop to thousands of years of remarkable human history, brilliance, and endeavor. Ancient Egyptian civilizations fished and sailed these waters. Significant trade routes, both east-to-west and west-to-east, have long ferried natural resources and the products of human invention and ingenuity, promoting the cross-cultural exchange of ideas. Trade in the Gulf of Aqaba is documented from as early as the Fourth Dynasty of Egypt (2,613–2,494 BC, with the Pharaohs being among the first to recognize the Red Sea's importance as a transportation route between South and East Asia and the Mediterranean Sea. The Canal of the Pharaohs was dug from the River Nile to the Red Sea more than 3,500 years before the opening of the Suez Canal.

For centuries, explorers and researchers across multiple disciplines have been drawn to the Gulf of Aqaba region by biblical stories of the Israelites' exodus and the parting of the Red Sea. In the 18th century, the Danish scientific expedition Arabia Felix set out to explore the lands of the Old Testament, including the region's natural history and geography. This expedition was the first to scientifically document much of the fish and invertebrate life widespread through the Indian and Pacific Oceans, including the Red Sea. Decades later, in the 1960s, Jacques Cousteau selected a location in the Red Sea off the coast of Sudan as the most suitable spot for his second underwater village, Précontinent II.



Geography and natural environment

The Gulf of Aqaba region contains extraordinary sites of natural beauty and aesthetic importance. The region is also an outstanding example of critical ongoing ecological and biological processes. The diversity of corals and other marine flora and fauna in the Red Sea is unparalleled north of the Tropics.

The Gulf of Aqaba is a narrow, semi-enclosed section of the northern Red Sea, bordered on the west by the Sinai Peninsula and on the east by the Arabian Peninsula. Its coastal areas lie within four countries: Egypt, Israel, Jordan, and Saudi Arabia (Figure 1). A part of the Syrian-African rift, the Gulf lies in a relatively narrow (6–25 km) and deep (180 km) valley that extends in a northeast-southwest direction. This semi-enclosed gulf receives seawater from the Red Sea, with the only entrance/exit point being the relatively shallow (290 m) Straits of Tiran. The Red Sea itself is constrained by the narrow southern entrance and shallow sill of Bab-el-Mandeb, or “Gate of Tears” (at 137 m in depth). As a result, the only source of water into the Red Sea—and thus into the Gulf of Aqaba—is the very warm surface water of the Indian Ocean.

The oligotrophic waters of the Red Sea, combined with the Gulf’s relatively warm temperatures (for a high latitude basin) and generally untampered by freshwater runoff from the otherwise arid adjacent coastal lands, support some of the most spectacular and biodiverse ecosystems on Earth. The Gulf functions as a unified marine ecosystem comprising shallow habitats, coral reefs, and deep-sea areas, all of which are ecologically interdependent.

Shallow waters in the Gulf of Aqaba are characterized by continuous carbonate coral reefs that fringe the desert shores. Owing to the warm surface water that enters the southern Red Sea from the Indian Ocean over a shallow sill at the Bab-El-Mandeb, the Gulf of Aqaba’s temperature at a depth of 800 m is higher than 20°C, whereas most oceans exhibit temperatures around 4°C at equivalent depths.¹ Warm temperatures allow tropical coral reefs to flourish at this relatively high latitude, making these coral reefs the Earth’s northernmost carbonate reefs.

The reef environments of the Gulf of Aqaba are some of the richest and most diverse on Earth, providing habitat for tens of thousands of marine species. Recent studies of the Red



Figure 1. The Gulf of Aquaba.

Sea highlight the importance of this area as an evolutionary incubator, supporting the evolution of new species, and contributing unique genetic lineages to other regions.² Owing to its relative isolation, along with selection processes along its south-north axis, speciation in the Red Sea has resulted in an exceptional level of endemism, genotypes and species of flora and fauna that are found nowhere else on the planet.³

Unique coral reefs

The coral reefs of the Red Sea are a rich source of food, livelihoods, coastal protection, and natural products, and they support millions of people living along the coastline.⁴ Fisheries and tourism are critical livelihoods in this region. Egypt generates the most coral-reef-associated tourism income of any nation, with increasing numbers of visitors to its Red Sea coast over the past four decades owing primarily to its alluring charm as an incredibly unique and beautiful underwater world. Tourism contributes US\$1.2 billion to the Egyptian economy annually and supports 275,000 jobs.⁵

Beyond their remarkable beauty, experiments in controlled mesocosms confirm that corals from the Gulf of Aqaba exhibit exceptional thermal tolerance in response to heat stress, surviving temperatures that are 5–6°C above the mean maximum summer temperature of this region. In contrast, corals in the central and southern Red Sea (and most places globally) can only survive at temperatures 1–2°C above the mean maximum summer

temperature.^{6–12} This additional thermal tolerance is attributed to a selection process that occurred as corals recolonized the southern Red Sea, following the last glacial period.⁶

Notably, this increased thermal tolerance has meant that mass bleaching and mortality have not yet been observed in the Gulf of Aqaba's corals, even though they have been exposed to thermal anomalies that normally cause mass coral bleaching and mortality in coral reefs elsewhere.^{6,7,13} In fact, Gulf of Aqaba corals display increased primary productivity at increased temperatures.^{9,14} At current rates of climate warming, the 3–4°C increase in thermal tolerance exhibited by Gulf of Aqaba corals will protect them from bleaching and death for approximately another century, whereas corals in other locations will likely be affected much sooner, possibly by the mid-21st century. This evolutionary "gift" from warmer times has powerful implications for the long-term future of the world's coral reefs.



The case for action

Growing threats to the Gulf of Aqaba region

The Intergovernmental Panel on Climate Change (IPCC) has ranked the Gulf of Aqaba's human population as highly vulnerable, owing to limited access to healthcare and education.¹⁵ As the livelihoods of many people along the Gulf are linked to the health of its coastal and marine ecosystems, destruction of these ecosystems will only exacerbate the region's existing humanitarian crises. Although the Gulf's ecosystems are currently healthy and functional, the entire Red Sea ecosystem is at high risk owing to ongoing population growth, over-fishing, increasing pollution, and habitat degradation caused by coastal development.⁴ Continued expansion of coastal towns and cities generates substantial local pressures on coral reefs and their associated seagrass and mangrove ecosystems.

Like other marine regions, the entire Red Sea is also facing threats from human-induced global warming and ocean acidification.¹⁵ Although coral reefs in the Gulf of Aqaba are particularly resistant to rising sea temperatures, the ability of these corals to withstand global environmental changes rests heavily on the extent to which regional and local disturbances compromise their physiologic performance.^{17,18} Local stressors resulting from human activities will bring corals closer to their resistance thresholds, beyond which they will bleach and die.¹⁹ Given the value of these climate change resistant corals, it is vital that they are protected from the growing pressure of local stressors such as pollution, over-fishing, and unsustainable coastal development.

Large-scale cooperation and coordination are needed

Each of the four countries that border the Gulf of Aqaba have specific regulations and mechanisms to protect their marine environments, including coral reefs, though levels of enforcement have varied with time and place. For example, for more than 30 years, the United Nations-sponsored Environmental Program for the Red Sea and Gulf of Aden (PERSGA) has done much to promote both the establishment of marine and coastal protected areas and the adoption of environmental standards throughout the region. Marine-protected areas already exist at both Eilat and Aqaba, and the whole of the Egyptian coast of the Gulf of Aqaba constitutes a protected area within which any discharge to, or infilling of, the sea is prohibited. Additionally, large marine national parks at Ras Mohammed, Nabq, and Ras Abu Galum are generally well managed. At the time of this writing, efforts to implement management plans for two national parks within the Saudi Gulf of Aqaba are underway and completion should be a priority. Israel and Jordan occupy much shorter lengths of coast, but both have active research and management programs. It is vital that all existing management plans be implemented or refreshed to maintain an effective, long-term vision.

Unfortunately, the current efforts being undertaken by countries bordering the Gulf of Aqaba are insufficient to protect the region into the future. If the Gulf's heat-tolerant coral reefs and their associated biodiverse ecosystems are to endure and thrive, a range of regional environmental challenges must be tackled, including over-fishing, unregulated coastal development, and coastal pollution, among others.

Effective and efficient measures to conserve the Red Sea's globally significant coral reefs will require the coordinated, cooperative efforts of all bordering countries. These measures should align with the regional management approaches successfully underway for other reef systems, such as the Great Barrier Reef Marine Park,²⁰ the Coral Triangle Initiative,²¹ and the Mesoamerican Barrier Reef System.²² Each of these iconic coral reef regions has successfully met local environmental challenges, highlighting the diversity of solutions available to mitigate such issues and demonstrating that there is much to be learned from prior initiatives.



Outstanding universal value: meeting UNESCO's criteria

Involvement of a neutral organizing body such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) could drive the regional cooperation needed to both build on the success of prior conservation efforts and promote the coordinated management necessary to protect the Gulf of Aqaba's marine and coastal environments long into the future. Designation of the Gulf of Aqaba region as a transnational UNESCO World Heritage Site should be sought as a matter of urgency. The unique geophysical and ecological features of this region clearly meet UNESCO's requirement for "outstanding universal value." Further, to be included on the World Heritage list, sites must satisfy at least one out of UNESCO's 10 selection criteria.²³ The case is strong that the Gulf of Aqaba region meets three of these criteria, as set out below.

Selection criteria (vii)—to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance

The inherent beauty of the desert coastal plains, set against the dramatic backdrop of the jagged mountains of the Sinai Peninsula and Hejaz in western Saudi Arabia and transitioning to exquisite coral reefs and shallow lagoons, provide seascapes that are unparalleled in the world. The shallow, clear waters of the Gulf of Aqaba region are ablaze with vibrant colors and life, and the continuous coral reef system hosts world-famous snorkeling and scuba diving hotspots, including Sharm El-Sheikh, Ras Mohammed, and the Blue Hole at Dahab. Millions of tourists from around the world flock to the Gulf of Aqaba region each year to experience its beauty above and below the water line.

The Red Sea is a biodiversity hotspot, and the Gulf of Aqaba is no exception. The Gulf comprises one of the world's most biologically diverse ecosystems, home to tens of thousands of species, many of which remain undiscovered. Over 5% of scleractinian corals, 2.9% of fishes, 12.6% of polychaetes, 8.1% of echinoderms, and 16.5% of ascidians found in the Gulf are endemic to the Red Sea.²

Selection criteria (ix)—to be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals

The flourishing coastal and marine ecosystems of the Gulf of Aqaba clearly demonstrate significant, ongoing ecological and biological processes occurring in this region. First, the Gulf's geography has generated the unique conditions under which vast communities of flora and fauna can evolve and flourish. Thanks to the Gulf's warm water temperatures, this region is home to the northernmost coral reefs on the planet. The extreme clarity of the water allows the extensive reef system to



extend from the shallows to mesophotic (low-light) depths of up to 120 m – depths largely unrivalled by reefs in other parts of the world. The distinctive conditions in the Gulf’s marine ecosystems spurred the evolution of the region’s amazing biodiversity, much of which remains unexplored. Further, if these ecosystems are preserved, their unique conditions will continue to support the evolution of untold adaptations in marine plant, animal, and other organisms.

Second, large-scale climate change following the last Ice Age imprinted corals in the Gulf of Aqaba with a unique evolutionary history, with this region hosting some of the most robust and “future-persistent” coral reefs in the world. At the current rate of climate warming, the Gulf’s thermally resilient reefs, and thus their interdependent ecosystems, could persist for up to a century or more, many decades longer than corals in other parts of the world. This will only happen if the Gulf of Aqaba region is protected from local and global pressures that could otherwise negatively impact the thermal tolerance and survival of corals.

Selection criteria (x)—to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation

In addition to harboring some of the best-developed, northernmost, deepest, and scientifically important coral reefs on the planet, the Gulf of Aqaba region contains other ecologically significant associated habitats, including mangrove forests (as far north as Nabq), seagrass meadows, tropical (supratidal) saltmarshes, shallow lagoons, and reef flats. Each of these interdependent, biodiverse ecosystems is under threat from climate change and local, human-generated perils.

Islands around the entrance to the Gulf also provide nesting sites for turtles (mostly the critically endangered hawksbill) and several threatened seabird species, including the most northerly colony of boobies in the Indian Ocean region. The coast of the Gulf of Aqaba is a globally significant flyway for migrating birds, including exceptionally large flocks of storks and other shore birds and various raptors, such as the honey buzzard.



The ecosystems of the Red Sea are estimated to harbor greater than 150 species of coral²⁴ and more than 1,000 species of fish, of which over 85% are likely to occur within the Gulf of Aqaba. Over 5% of fish species are endemic to the Gulf proper. Comparable diversities of most invertebrate groups are also reported.³ While fewer species of mangrove and seagrass occur in the Gulf of Aqaba compared with the southern Red Sea or Indian Ocean, the Gulf is one of the two most northerly locations for mangroves, and its seagrass beds exhibit high productivity.

Coral reefs are universally regarded as “important and significant natural habitats for in-situ conservation of biodiversity”, as evidenced by the 19 existing UNESCO World Heritage Sites that include them.²⁵ The reefs of the Gulf of Aqaba have an unparalleled advantage over those already protected: their extreme resistance to rising water temperatures. Over the past 40 years, a large majority of the world’s reefs have suffered serious effects of climate change, with an estimated 50% loss of coral reefs globally following bleaching. It is predicted that, even if global warming remains below the 1.5°C target stipulated by the Paris Agreement, up to 90% of the world’s coral reefs may be destroyed by mid-21st century.²⁶ In the face of continued global warming, the thermal tolerance of the Gulf of Aqaba’s corals is likely to provide these coral reef ecosystems the best chances of surviving relatively intact until the end of this century.^{5,6} Not only would protecting this region conserve its unparalleled biodiversity, but critical scientific insights gleaned from studying heat-resistant corals could significantly contribute to global efforts to preserve corals as the temperature of Earth’s oceans continues to rise. In this sense, the Gulf of Aqaba region is an outstanding example of one of “the most important and significant natural habitats for in-situ conservation of biological diversity”.

Conclusion

The Gulf of Aqaba is of sufficient size, scale, and value to merit urgent consideration as a UNESCO World Heritage site. At 180 km long and 14 km wide, it is a substantial body of water containing hundreds of thermal-resistant coral reefs and their interdependent, biodiverse ecosystems, which are all in imminent danger from climate change and other human-induced environmental damage.

The Gulf of Aqaba region provides the backdrop for vast amounts of human history and culture and encompasses geographically unique ecosystems that warrant its consideration as a “region of outstanding universal value”. The region scores highly on three of UNESCO’s selection criteria, clearly qualifying in terms of area, significance, and potentially involving Jordan, Israel, Egypt, and Saudi-Arabia and their adjacent waters, for designation as a World Heritage Site.

Thanks to ongoing conservation efforts by its four bordering countries, the Gulf of Aqaba’s ecosystems remain relatively undamaged by human activity, preserving its remarkable biodiversity for the moment. However, these efforts will prove insufficient to meet the challenges of the near future. Coastal development in the region has been gathering momentum in recent years, resulting in a growing need to protect these landward and marine areas. More residents and greater tourist activity

could intensify pollution and otherwise harm ecosystems and negatively impact the communities that rely on coral reefs for their survival. World Heritage Site status should be urgently sought, as it could focus existing but insufficient local management plans that aim to secure the future of the Gulf’s unique reefs, ensure the sustainable development of coastal areas, and protect the livelihoods of millions of people.

To achieve designation of the Gulf of Aqaba as a World Heritage Site and to successfully implement necessary protective measures, strong political leadership and transborder cooperation and coordination will be vitally important. A clear, focused, region-wide strategy will be required to engage local and national governments, local communities, and various critical stakeholders as well as to obtain the requisite funding and resources. The success of this effort will require the proper balance of direction setting, mobilization, and intervention, including the development of a plan that will monitor the impacts of tourism on the region’s ecosystem and communities.

With effective “coral reef diplomacy” and international coordination, we can attain the necessary protected status for this ancient and complex region of the world, preserving its irreplaceable history and resources for countless generations into the future.

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