A Status Report on

WILDLIFE & ECOSYSTEMS OF THE RED SEA PROJECT AREA

2022

The Red Sea Development Company

Hawksbill Sea Turtle

in the waters around Waqadi I have had the great fortune to release three hawksbill turtles that, thanks to support from the Fakieh Aquarium, we were able to rehabilitate. While the days leading up to releasing these turtles can be stressful, watching the now healthy turtles return to the sea is incredibly rewarding. We have even been able to satellite tag two of these turtles which has allowed us to see that they have continued to live in the project area. **Dr. Royale Hardenstine**

Contents

Message from the CEO

John Pagano

Chief Executive Officer
The Red Sea Development Company

When it comes to the planet and its environment, we find ourselves in one of the most decisive decades in global history. Climate change is widespread, rapid, and intensifying – with significant impact on natural ecosystems, wildlife, and the global population.

Meanwhile, economic growth has led to the overexploitation of natural resources and habitats, destruction of the natural environment, and significant impacts on natural resources and biodiversity.

Tourism is no exception here – it is an industry that has placed enormous stress on local land and marine areas for decades, with long term and lasting effects that only now are truly coming to light. But this need not be the case any longer – tourism and hospitality can, and must, do better.

At The Red Sea Development Company (TRSDC), we are pioneering an innovative approach to regenerative tourism development with the hope of inspiring others to follow and change the way tourism is delivered around the world.

From the endangered Hawksbill sea turtle to the majestic Sooty falcon and one of the healthiest coral reefs in the world, the Red Sea is home to some of the most diverse wildlife ecosystems on Earth. We are passionate in our belief that creating a world-class luxury destination can go hand-in-hand with protecting and enhancing its natural beauty. Only then can we deliver on our mission to be the world's most ambitious regenerative tourism destination, protecting both people and planet.

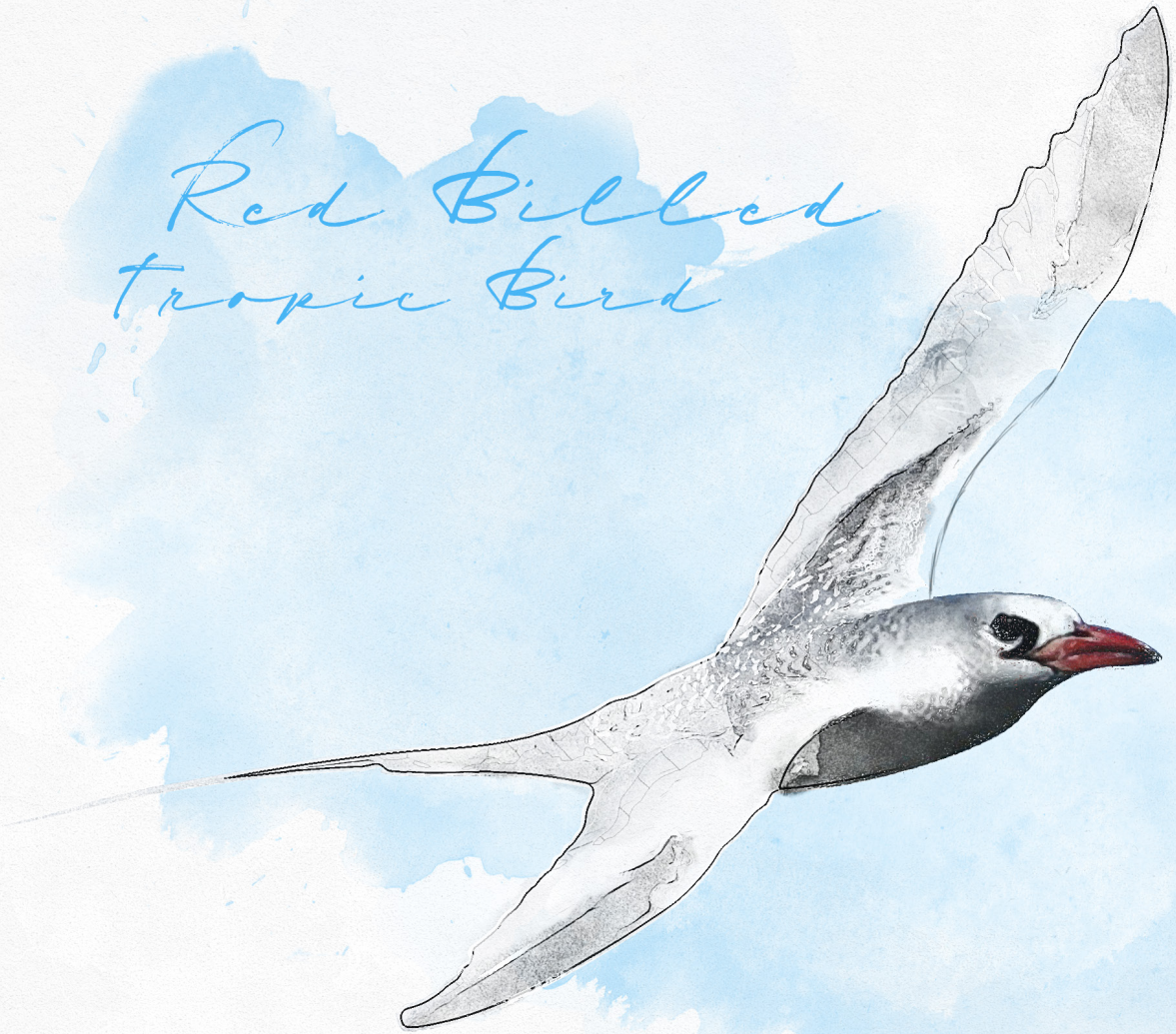
This is the driving force behind our environmental survey programs, and this report. The report is part of a long-running commitment to measure environmental status and progress towards our ambitious regenerative goals. A key aspiration for TRSDC is achieving a 30 percent net conservation benefit by 2040, through the protection and enhancement of key habitats crucial to biodiversity within The Red Sea Project and AMAALA areas.

To measure progress, we must establish a starting point and ensure a comprehensive understanding of the opportunities, challenges, and baseline data. This includes identifying the vast range of specific flora and fauna that inhabit the region, their population numbers, developing our knowledge of how they live, nest, breed, and more.

The findings in this report are not only fascinating but of extreme importance to TRSDC and me personally – underpinning our commitment and holding ourselves to account in delivering a truly sustainable destination that preserves the area's unique environment and biodiversity. By growing our understanding and awareness we can protect and enhance the natural environment and track the success of our many sustainable and regenerative initiatives.

We will continue to report on our progress as we continually challenge ourselves to be better, and do better, as a global pioneer in responsible development. We hope you will join us on this journey as we work to transform our ambitions into reality, and that you find this report and its findings as valuable and interesting as we do here at The Red Sea Development Company.

Red Billed tropic Bird



"The Red-billed tropicbird is a seabird that can be found in tropical and subtropical seas. In the red sea the subspecies indicus can be found, and sometimes it is considered a separate species. Its diet consists of fish and it normally lives offshore, approaching islands only to breed. Courtship and pairing usually lasts three to five weeks, during which this bird performs aerial courtship displays to potential mates. It nests on small, remote oceanic islands and prefers inaccessible spots on cliff, where taking-off is relatively easy. The first nesting record of this species in the red sea project was found in 2021, and it was a great and pleasant surprise. It's 90–107 cm long (including two 46–56 cm tail streamers or feathers) and seeing it flying over the ocean is an amazing sight." **Dr. Licia Calabrese**

Introduction
setting a benchmark for progress

The Red Sea coastline of Saudi Arabia is an area rich in wildlife – both flora and fauna. It is also an unexplored gem of natural beauty, encompassing sweeping dunes, dormant volcanoes, deserts and pristine islands. As the Kingdom of Saudi Arabia looks to open its borders to international travelers – from adventure seekers and cultural explorers to maritime enthusiasts and wellness lovers – it is essential that protecting the diverse native wildlife and environment is prioritized in a sensitive and considered way.

By far the largest effort ever undertaken by a development company and more comparable to activities completed by government agencies on a national scale, this environmental survey and summary report, conducted by the Department of Environment and Sustainability (DES) at The Red Sea Development Company (TRSDC), serves a crucial purpose. It has comprehensively analyzed the populations and habitats of the fascinating wildlife species that inhabit over 200km of vibrant Red Sea coastline that sit within TRSDC's flagship destination – The Red Sea Project (TRSP).

This analysis, and data collected, serves as the foundations for honoring TRSDC's wider commitment to sustainability and transparency – measuring success against key targets in the conservation and protection of the local environment. It is supported by existing initiatives such as TRSDC's Marine Spatial Planning simulation, which utilized specialized software and a dedicated multi-stakeholder planning, and information sharing process to assess developmental impact and enhance biodiversity through tourism development.

Both ground-breaking, luxury tourist destinations are being developed within an area of outstanding natural beauty – with beautifully complex systems of lagoons and reefs. This variety provides habitat for hundreds of species of fish, invertebrates, and marine mammals.

With sustainability at its very core, TRSDC's goals for this highly diverse area are not only to minimize potential negative impacts of development but also to achieve a net conservation benefit. This report will be used as an initial benchmark for TRSDC to measure itself against its stringent sustainability promise and its commitment to leaving the destination a more thriving and healthier place than it was before. As such, these surveys will set key indicators for regular reporting into:

- Condition of the Red Sea's coral reef habitats, including coral cover and diversity
- Population status of reef fishes, sharks and rays, including total fish biomass, fish diversity, and encounter rates with priority species
- Abundance of marine mammals including dugong across our marine environments
- Size of bird breeding populations of key bird species, and measures of their breeding success,
- Size of nesting green and hawksbill sea turtle populations on our islands

In addition to the coral reefs, marine mammals, birds and turtles covered in this report, other survey programs will assess and report on the extent and condition of mangroves, seagrass, and terrestrial habitat.

As the findings show, the waters and islands of the Red Sea are naturally abundant, with spectacular and impressive locations, habitat features, and remarkable natural events, and therefore need careful and scientifically sound stewardship. This begins with making sure our methods are thorough and supported through innovative technologies where possible. More than 25,000 birds' nests were counted, 92 islands were surveyed for evidence of turtle nesting, first investigations of the elusive and vulnerable dugong in our area were made, including partnering with local researches to test the efficacy of using hydrophones to acoustically monitor their distribution and behavior, over 300,000 fishes were counted and more than 280 fish species were recorded, and nearly 300 coral reef sites were visited and analyzed through a mix of direct observation and use of high-tech monitoring solutions such as CoralNet, a machine learning tool that learns how to automatically analyze coral reef survey images. Using such technology allow us to gather much more data than we otherwise could -to build a fuller, more comprehensive picture of our vast and diverse area.

Halavi guitarfish observed at Safayih Island. Juveniles hide in the sand and quickly swim away when approached, making capturing photographs of them a challenge.

- Coral Reef Fish and Habitats
- Birds
- Priority megafauna
- Advanced technology and additional survey efforts

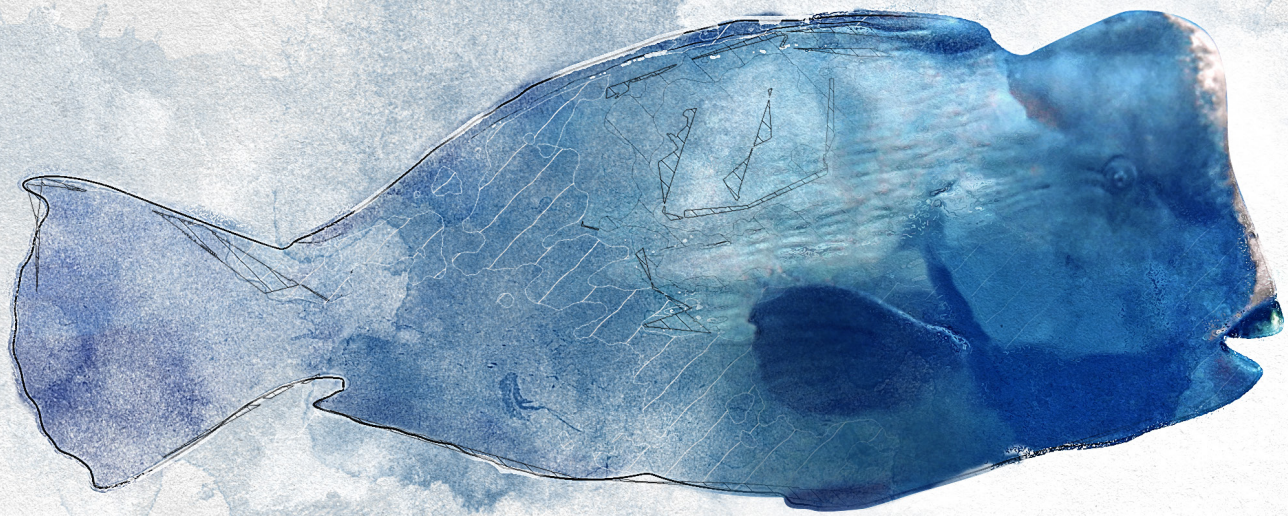
The report is divided into four chapters, three focused on a particular wildlife or environment category and one giving more details on technological approaches that we are using:

All of our habitats are precious and potentially vulnerable, but some habitats in our area are especially important for species that are considered endangered or vulnerable to extinction, such as the hawksbill turtle, the sooty falcon, and the Halavi guitarfish. The work being done to preserve and cultivate this area, and protect these species, is of significance not only to the Red Sea Coast and TRSDC, but to environmental conservation efforts globally.

A hawksbill emerges from its resting place, tucked in the reef, to surface for a breath

Brain Coral

Bumphead Parrotfish



Bolbometopon muricatum, the bumphead parrotfish is an amazing creature. By some distance the worlds largest parrotfish - growing to over a meter long - the terminal males crash into each other using their bumps like battering rams to fight over prime breeding territories. They are rare in many parts of their former range because they are easily fished out as they sleep in large groups in shallow water. Luckily, we regularly see them in some parts of our area. It's always exhilarating to see them - either a fast-moving train of 6-10 individuals, usually in deeper water, or as a large group of up to 100, milling around in shallow water, probably around spawning time. Learning how best to protect this population is one of our top priorities.

Dr. Ivor Williams

1. Coral Reef Fish & Habitats

The coral reef survey is a vital part of the regenerative tourism approach for TRSP and AMAALA, as both destinations are home to thriving coral reefs at a time when many of the world's reefs are experiencing increasing stress. As climate change continues to impact the world we live in, reefs around the world are under threat. There are reasons to believe that the corals of the Red Sea, particularly the northern Red Sea, will be more resilient to climate change than others around the world, but that only increases the importance of properly managing these precious resources.

Properly documenting the status of these resources before significant developments has taken place is important for several reasons, including:

· Understanding the distribution of conditions - knowing not only where the 'best' reefs are, but also those in less good condition, so we can truly assess change over time.

· Enabling assessment and credible reporting of progress towards the project's conservation enhancement goals.

· Building a coral reef ecosystem bank of robust and comparable information for planning and management purposes.

· Supporting future enhancement efforts – identifying which areas and environmental conditions are most suited to particular forms of enhancement.

· Generating an information base, and associated media, to showcase TRSDC's spectacular natural resources and environmental stewardship.

The potential establishment of one or more large, well-managed, no-take Marine Protected Areas (MPA) within the Red Sea project areas could lead to dramatic increases in fish numbers as the, already impressive, systems shift towards 'wilderness' states. Given the current pressures on the world's coral reefs, such MPAs could be of enormous regional and even global significance. Reliable and accurate surveys allow us to credibly document and report such change

In total, the team surveyed fish and habitats at nearly 300 coral reef sites spread widely across reef habitats within the TRSP area. Surveys were conducted between March and September of 2021.

Schoolof bumphead parrotfish outside Ghawar Island

Notable Findings

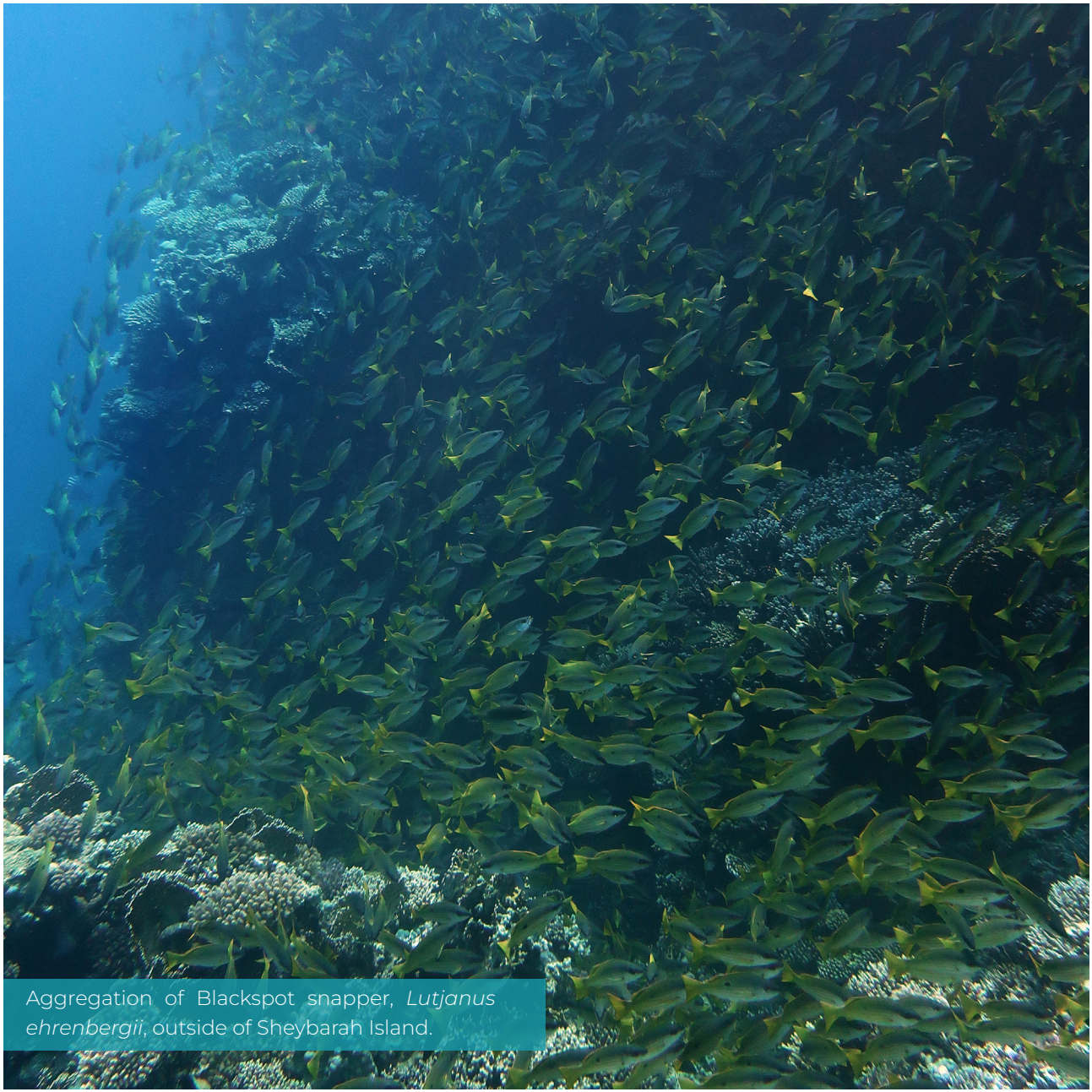
- More than 280 fish species were recorded during the surveys, with wrasse and damselfishes being the most abundant families (40 and 30 species respectively). Other highly diverse families were grouper (18), parrotfishes (16), and butterflyfishes (13).
- Four species of shark were observed during dive surveys, including the endangered whale shark and zebra shark.
- Schools of up to 100 bumphead parrotfishes (the world's largest parrotfish, listed as vulnerable to extinction) were regularly encountered in some areas.
- An ancient coral, around 8 m high, was discovered that is estimated to be over 600 years old. There are many enormous corals in the TRSP area, and we expect to find other, even larger, giants as we continue our work.

Methods

Coral reefs are home to an abundance of marine life including the fish populations that depend on these habitats. Our approach in this baseline was to co-locate surveys of coral reef fishes and their habitat, including corals.

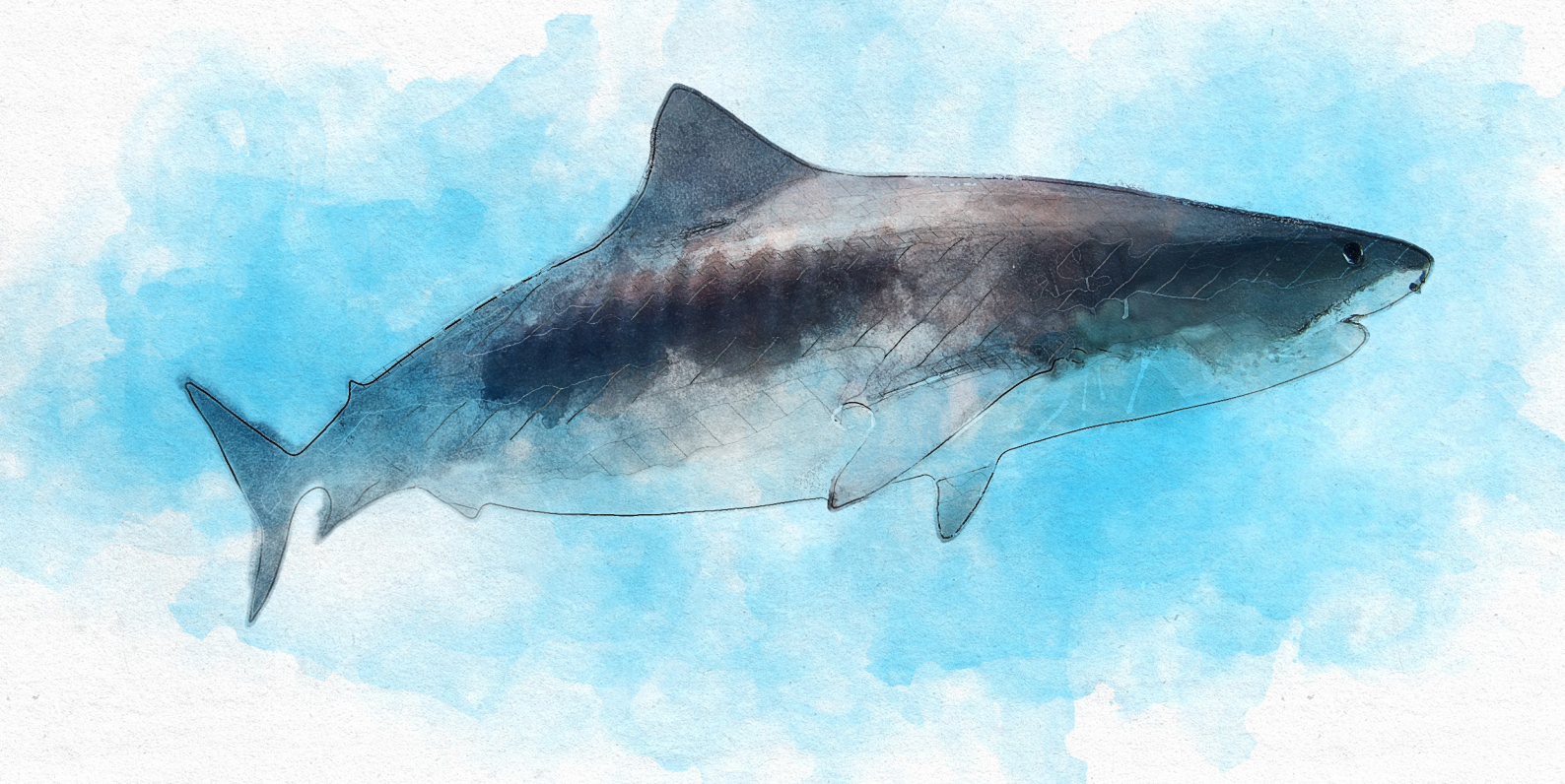
Survey sites were located across all structurally complex coral reef habitats in the TRSP area. To ensure surveys were representative of TRSP reefs, survey locations were distributed using a stratified-random design. First all complex reef areas <20m deep were classified into seven habitat types, and sites were randomly located within those habitats, with highest levels of survey effort in the habitats where we expected highest coral cover, fish biomass, or diversity. Additional focus was paid to reef walls, crests and slopes, as those are the most commonly surveyed reef types across the Red Sea, and therefore data from those sites provide greatest ability to compare our reefs with other reefs in the region.

Accurate records of location, depth, and survey bearings at each site were made to ensure the same sections of reef can be resurveyed subsequently, greatly improving the ability to precisely measure and assess changes over time.



Aggregation of Blackspot snapper, *Lutjanus ehrenbergii*, outside of Sheybarah Island.

Tiger Shark



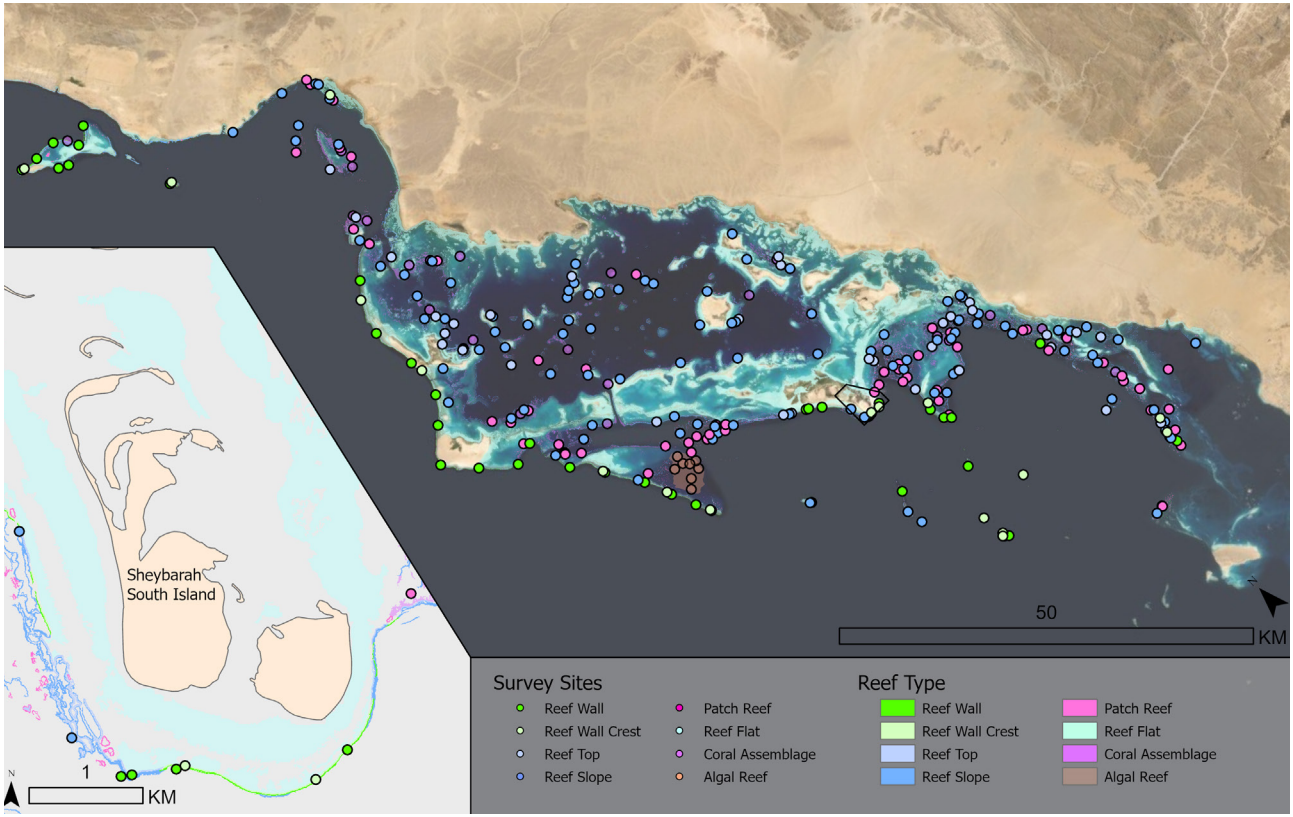
"The team was ready for another survey, and suddenly "Shark" or "Qarsh" could be heard from the fishermen in a nearby boat. After moments of patience, the shark finally approached the boat. Everyone got excited, and their cameras ready. "No way I can miss this chance." I bent over the side of the boat, stretched myself to put the camera in the water, and started shooting as much as possible. I couldn't believe the impressive dark and vertical stripes down its body. A Tiger shark! Tiger sharks are notorious predators with powerful jaws and sharp and highly serrated teeth. These allow them to have a wide range of prey and even crack the shells of sea turtles and clams. They are the second, only to great whites, largest predatory sharks and can reach lengths over 5 m. Even though they are "apex predators" (predators at the top of a food chain), tiger sharks are sometimes hunted by pods of killer whales. Tiger sharks are currently listed globally as Near Threatened, but due to their low repopulation rates, and fishing pressure, this status can easily be changed to Vulnerable in the near future." **Dr. Luis Silva**

Reef Habitat Classes

Habitat Class	Description	Extent (Ha)	# Sites
Reef Walls	Steep outer reef areas (>40° slope)	165.4	39
Reef Crest	Zone at the top of reef walls, generally shallow (1-3 m deep) and high wave-energy	37.5	18
Reef Slopes	Sloping reef (15-40° slope). Includes both offshore and inner lagoon reefs	1,774.8	96
Patch Reefs	Sloping reef (15-40° slope) around large patch reefs (circumference of at least 200 m). These are common features in some parts of the TRSP area, particularly within and just south of the lagoon	540.3	50
Reef Tops	Zones at top of reef slopes and patch reefs. Typically these are relatively flat areas with variable, but often quite low coral cover	321.0	38
Dense Coral Assemblages	Areas with high coral cover based on existing habitat maps, but which did not fall into other categories	3,221.8	21
Algal Reefs	Structurally-complex algal dominated reefs found on the offshore platform outside the lagoon	887.4	16

Note: we only included areas where we could realistically survey over at least 100 m of near continuous reef. There are extensive additional habitats within the Red Sea project where corals and associated fishes are present – typically those are patchy or sparsely populated or too deep for divers to feasibly survey.

Distribution of Survey Sites



At each site, fish abundance, size, and species composition were recorded in belt transects. Photo transects were taken and estimates of cover of corals and other reef organisms was made using the machine learning tool 'CoralNet' (see above and described in detail in the Advanced Technology section) – a machine learning tool capable of automatically analyzing coral reef survey images once it has been 'trained' by a human expert.

Divers also recorded all encounters with species of special interest (rare and priority species) including: bumphead parrotfish, trevally jacks, humphead wrasse, large grouper and snapper species, and sharks and rays. Preserving these important species, is a conservation priority, and therefore our team are also working to identify key habitats (such as nursery and sleeping areas) and to predict timing and location of spawning events. Greater knowledge of that kind would have both conservation and ecotourism benefits.

Humphead Wrasee

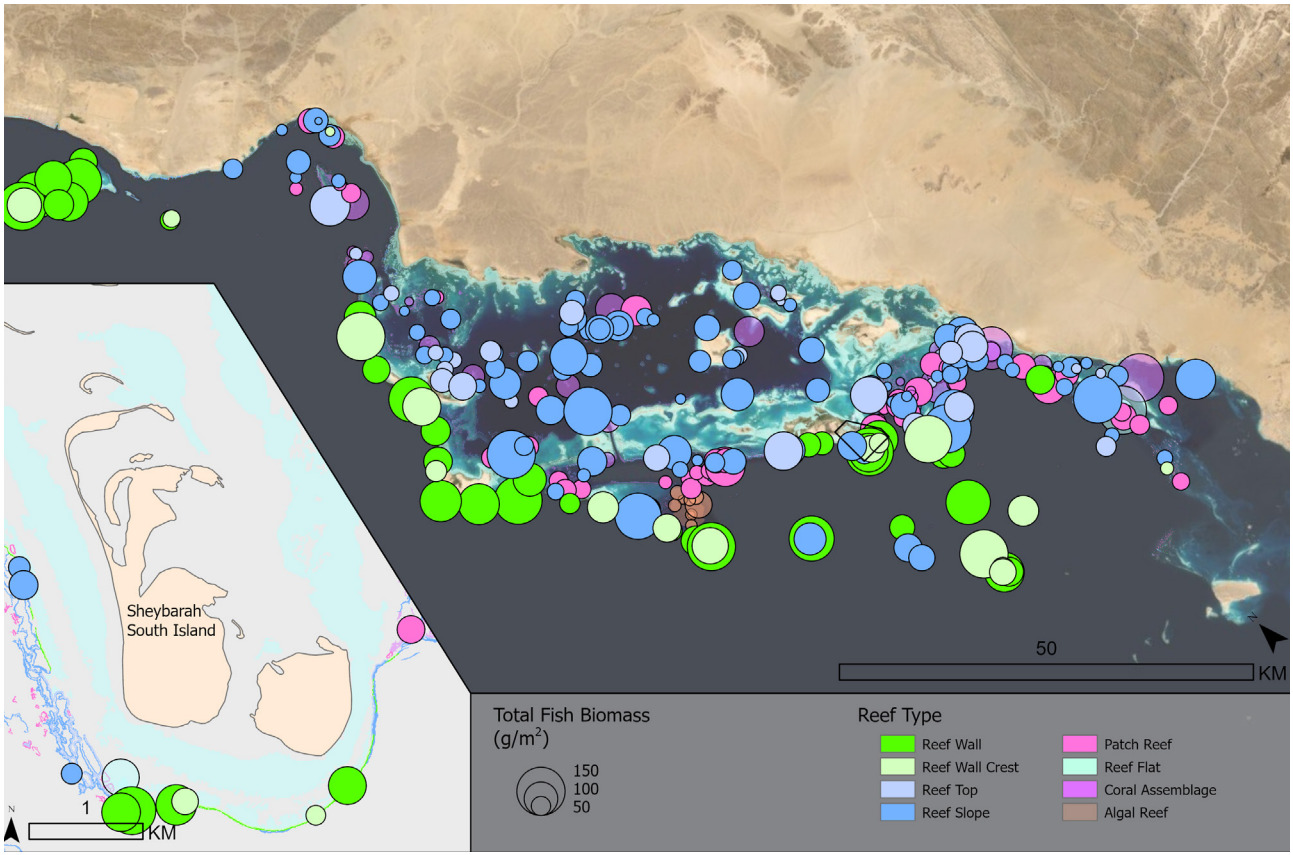
“The humped wrasse (cheilinus undulatus) is the largest wrasse in the world, that can grow from a tiny larva into a 200 kg giant. To achieve this termendous size, they feed on mollusks, crustaceans and sea stars. These fish live for decades, and groups gather to spawn near their home reefs year after year. This makes them easy targets for fishing and unfortunately, populations of this tremendous species are in decline. In the Red Sea, we are dedicated to protecting them ”

Rhonda Suka

Results

Reef fish assemblages

- The dive team counted >300,000 fishes of 280 species of fish in 60 families during baseline surveys
- Reef fish biomass varied between 6.7 gm-2 and 435.7 gm-2 and tended to be highest on outer reefs particularly reef walls and crests. Reef fish biomass was relatively low within the lagoon, particularly at nearshore sites.
- Riykah Island at the northern edge of the TRSP area was a notable biomass hotspot; other high biomass areas included the reef wall along the northern end of the lagoon, and the outer reef extending southwest from Breem.



Bubbles represent fish biomass at each survey site (larger bubbles for more biomass).
Colors represent reef types.

“When I saw my first whale shark I was in absolute awe. As the individual passed by and its tail faded into the distance, I remembered I was supposed to be taking identification photos... at least that time I did not get a single usable photo. Over the years my love and admiration of these amazing sharks has not faded. During fish surveys in 2021 a colleague was on her first ever Red Sea dive, when saw a whale shark north of the lagoon. The lead diver was making noise to get our attention since we were all focused on our work, luckily, we turned around just in time to see the whale shark pass by the reef.”

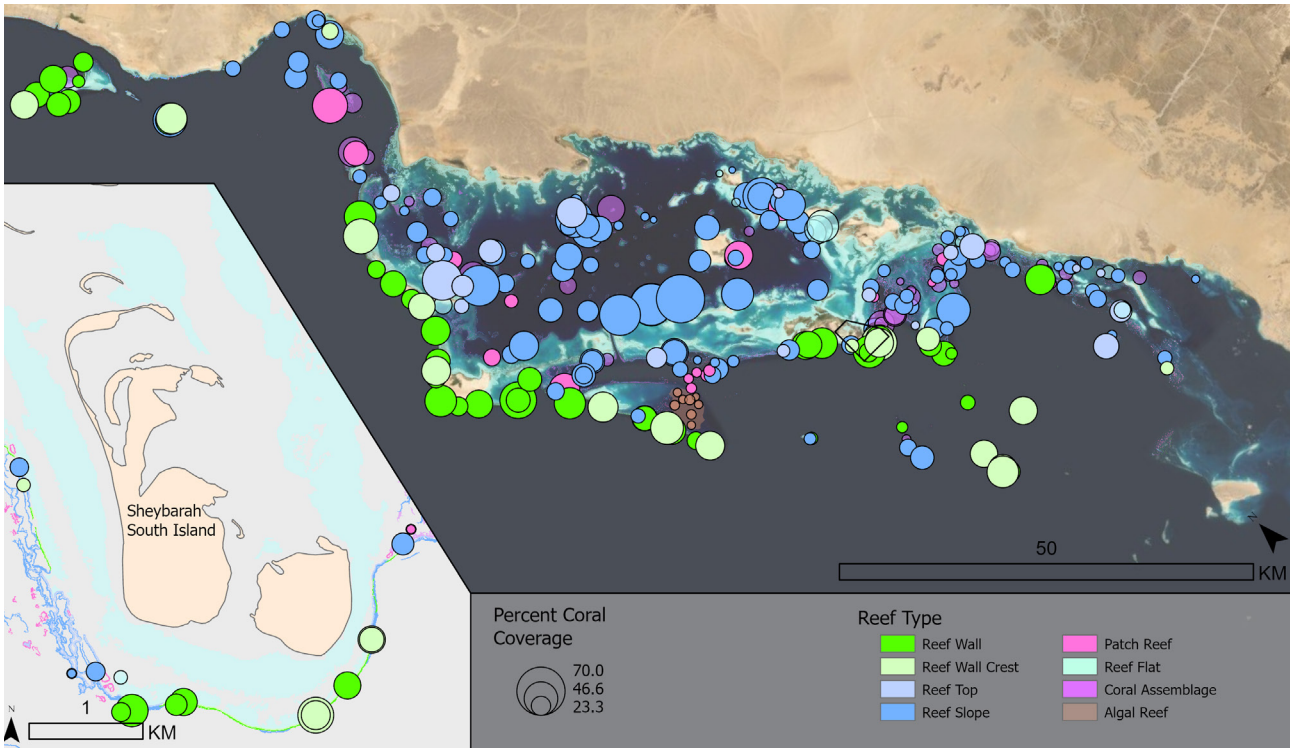
Dr. Royale Hardenstine

- The nurse shark (vulnerable), whale shark, and zebra shark (both classified as endangered) were seen at one site each during surveys. However, there were also 2 other reliable reports of whale shark sightings in our area during the year.
- Bumphead parrotfishes were only observed on the reef wall on the north edge of the lagoon. However, they were fairly frequently seen there, typically in schools, and once in a group of 80-100 large (around 1m) mature individuals. This species, the world's largest parrotfish, is extremely vulnerable to fishery depletion because it is relatively slow growing, long lived, and sleeps in large groups in shallow water so whole schools can easily be fished out in their entirety. They are now highly depleted or even absent across much of their natural range and are listed as vulnerable to extinction.

Sharks observed by dive team in the course of surveys: white-tip reef shark, nurse shark, whale shark, and zebra shark (photo: Viktor Peinermann).

Coral Habitats

- Coral cover was highly variable. The average across all sites was around 20%, but values per site ranged from less than 5% at 28 sites to more than 40% at 21 sites – with a maximum of 71% at a site close to Ummahat.
- Coral cover was highest on reef crests and reef walls (averaging 36% and 28% in those habitats).
- The team discovered several locations with large numbers of massive boulder corals (including the 8m high coral described above). Notable among those areas were sections of forereef at Mardunah and off the Waqadi Reef Wall.
- Some areas were discovered with low coral cover, but strong indications that they had previously been more thriving reef communities (as demonstrated by the physical structure, presumably formed by earlier growth of corals)., suggests this was once a much more vibrant reef, with the potential to return to that earlier state if conditions can be improved.



Coral Cover derived from surveys at each site. Larger bubbles indicate higher coral cover, and bubble colors correspond to reef types.


Osprey

2. Birds

This chapter reports on the population size, distribution, and breeding-seasons of high conservation priority bird species that live and breed across the 92 islands within the Red Sea Project area.

The 14 focal species and their broad breeding seasonality were:

- **Winter breeders:** osprey, caspian tern and red-billed tropicbird.
- **Spring breeders:** brown booby, eurasian spoonbill, saunders's tern.
- **Summer breeders:** white-cheeked, lesser crested, great crested and bridled tern, crab plover, white-eyed and sooty gull.
- **Autumn breeder:** sooty falcon.

Figure 1. Study species: a. Saunder's tern, b. Bridled tern (photo credit Jem Babbington), c. White-cheeked tern, d. White-eyed gull, e. Lesser crested tern, f. Sooty gull, g. Caspian tern, h. Red-billed tropicbird, i. Greater crested tern, j. Sooty falcon, k. Brown booby, l. Spoonbill, m. Crab plover

Documenting population trends, and identify significant biodiversity hotspots and potential breeding sites, is necessary to understand habitat selection and population demography. In particular, knowing when species breed – their life cycle – will improve future monitoring efforts, and provide information needed to protect birds when they are particularly vulnerable to disturbance – i.e., when they are nesting or rearing chicks.

Particular attention is paid to assessing the breeding success of the sooty falcon, a regionally endangered species with important breeding sites on several islands.

Each of the 92 islands was visited at least twice, and some up to 10 times. In total, our team walked > 500 km to identify and locate nests and colonies.

Notable Findings

- Of the 92 islands surveyed, 75 hosted at least one priority species. At those islands, we recorded around 25,000 nests, comprising 1,345 individual nests and 210 distinct colonies.
- 8 breeding pairs of the red-billed tropicbird were observed. These are the first nesting records for this species in the TRSP area.
- The regionally endangered sooty falcon was proven to have a stronghold in the lagoon. The 41 breeding pairs recorded in our area represent around 34% of the estimated Saudi Red Sea population (~120 pairs) and 2% of the global population (~2,000 breeding pairs).
- The most widespread species were the white-cheeked tern and the Osprey.

Crab plover

Sooty Falcon

Species	# colonies	# of islands where species present	# breeding pairs	Average breeding pairs per colony
Colonial Species				
Brown booby	1	1	35	35
Greater-crested tern	1	1	264	264
Eurasian Spoonbill	1	1	10	10
Crab plover	19	16	1,832	96
White-eyed gull	25	11	1,339	54
Bridled tern[1]	79	35	4,017	51
White-cheeked tern	74	47	11,758	159
Lesser-crested tern	10	10	4,453	445
Single Nest Species				
Sooty gull		40	168	
Saunder's tern		17	57	
Red-billed tropicbird		3	8	
Osprey		47	71	
Caspian tern		39	88	
Sooty falcon		9	41	

[1] Precise estimate not possible due to pairs nesting in thick vegetation. The range of population estimate was 2678-5356 breeding pairs (average 4017).

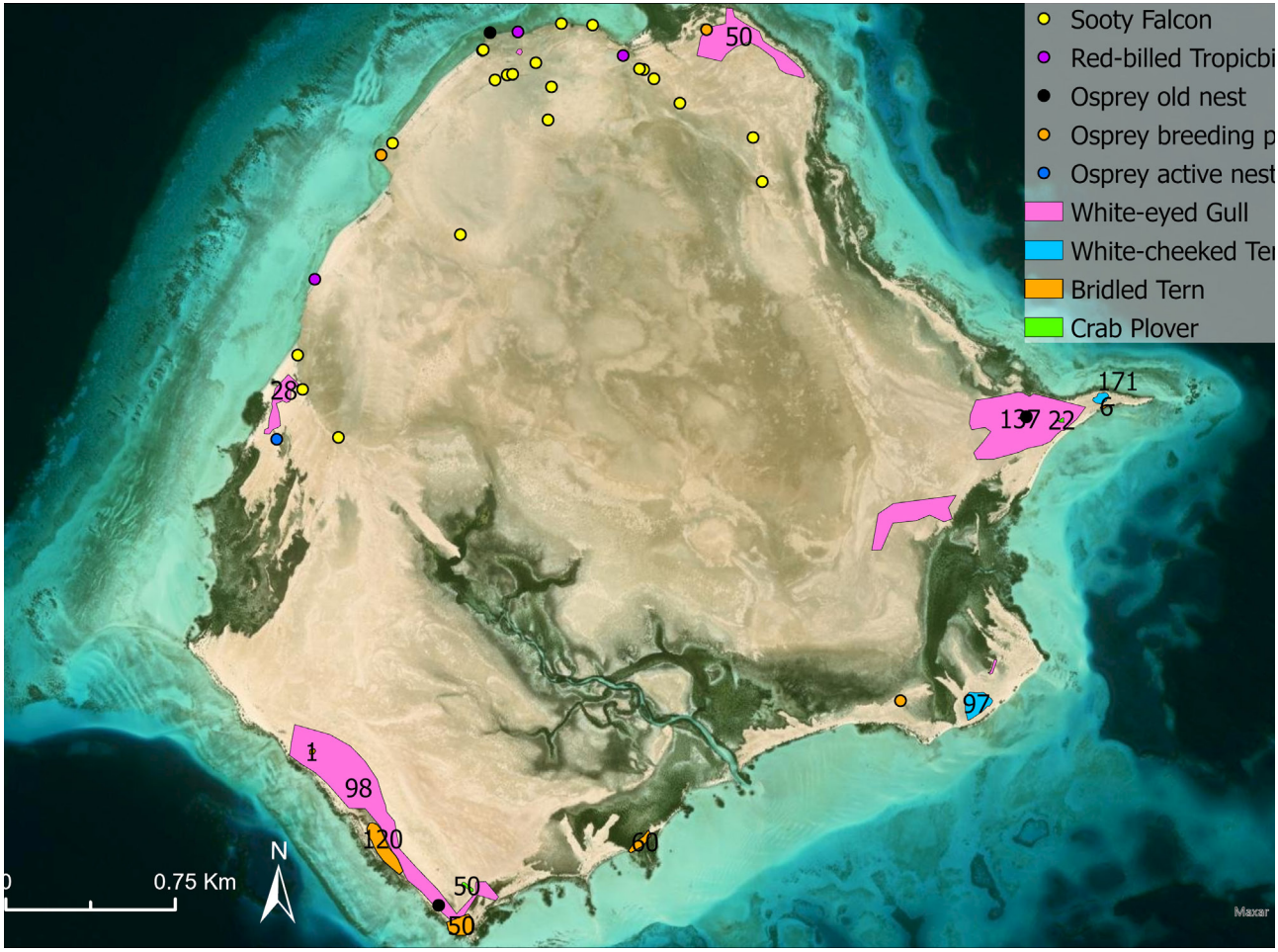
Methods

The study took place on 92 islands suitable for bird nesting. Surveys were timed to take place during each species' breeding periods.

Surveys were separately conducted across 4 breeding periods: winter (December to March); spring (April to May); summer (July); and Autumn (early September).

To assess bird populations, we estimated the number of breeding pairs by counting nests. Two different counting methods were used depending on the species. For strictly colonial species, the perimeter of the colony was marked with GPS and the number of eggs, chicks and scrapes found in each colony were counted. For loosely colonial and single nest species, every nest was photographed and linked to its location, and the content recorded.

Example distribution of nests and colonies is shown below for Quman Island, based on surveys conducted in 2021. Observations at the islands and nest contents were used to determine the seasonality of the breeding cycle for each species.



Distribution of nests and colonies recorded on Quman Island. Similar maps produced for all 92 islands.

The sooty falcon is a high conservation priority species (considered regionally vulnerable), so it is crucial to understand how the population is doing during different stages of its life cycle. Different breeding parameters can indicate at which stage the population is more vulnerable and identify any threats that need to be addressed. Assessment of sooty falcon breeding success was done in September to October, by recording not only the number of nests, but also the number of eggs per nest, the number that hatched, and the number of checks successfully fledged (i.e., survived through the breeding season and departed with other falcons to their winter-feeding area in Madagascar). Breeding outcomes were assessed by visual inspection in periodic visits to the nest to check the status of eggs or chicks in nests. The team is testing the use of cameras systems that would be able to remotely gather information on the timing and cause of any egg or chick failures while minimizing any potential disturbance

Red-billed tropicbird with chick in nest.

Results: Life Cycle, Abundance & Distribution

- Nearly 25,000 breeding pairs belonging to 14 species recorded, breeding birds were found on 75 islands, and colonies on 57 islands
- The most abundant and widespread species was the white-cheeked tern, with 11,758 breeding pairs present on 47 islands. The osprey was equally widespread, but with only 71 breeding pairs in total. The lesser-crested tern had the highest colony density, with 4,453 breeding pairs on 10 islands.
- 41 breeding pairs of sooty falcons were recorded in 2021, about 2-3 percent of the estimated global population. The island of Quman alone had 20 breeding pairs.
- Timing of breeding cycle was identified for all species: the pre-breeding phase (breeding pairs inspect the area and build nests); the incubation phase (adults incubating eggs); and the chick-rearing phase, that lasts from the hatching to the fledging of the chicks. A species is most susceptible to disturbance during incubation and chick-rearing phases, while disturbance during the pre-breeding phase can lead to the abandonment of the breeding site completely.

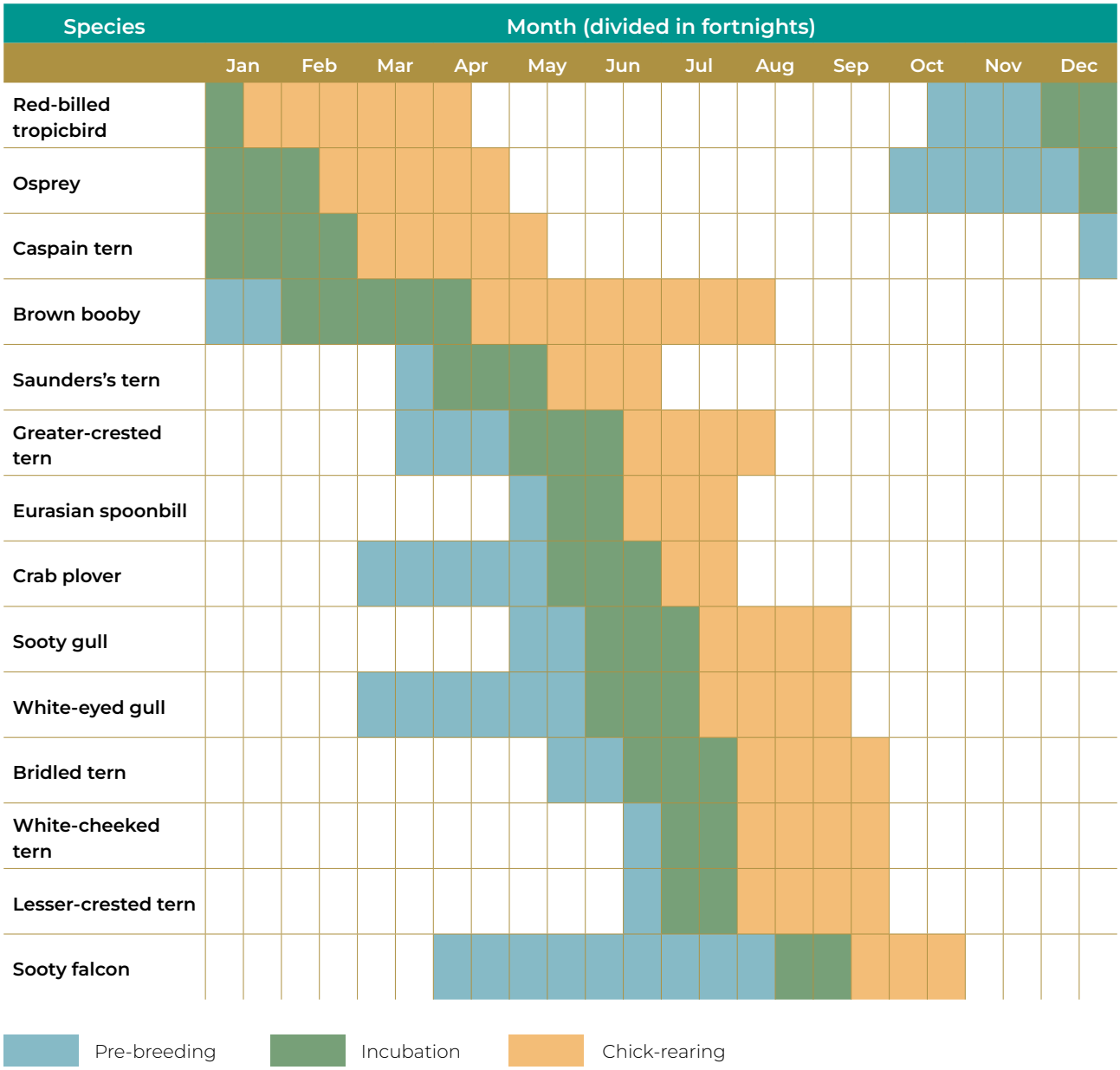


Table. Seasonality of breeding stages of main breeding species on TRSP islands. Blue indicates the pre-breeding phase, when birds inspect the area and, when a good spot is selected, they build a nest. Green is the incubation phase, when adults are incubating eggs. Pink is the chick-rearing phase, that lasts from the hatching to the fledging of the chicks.

Sooty Falcon Breeding Success

39 nests were monitored to assess sooty falcon breeding success. Overall, 76 percent of the monitored breeding attempts fledged at least one chick, with an average of 1.5 chicks fledged per breeding pair (37 total). The most successful islands (with more than one nest) in terms of fledglings were Quman and Ghawar where 80 percent and 71 percent of the nests fledged at least one chick. Quman hosts the highest number of breeding pairs and has the highest breeding success – marking it out as a particularly important conservation spot.

Island	# Breeding pairs	# Eggs	# Eggs Hatched	# Fledged chicks	% Eggs successfully reared[1]
Quman	20	43	36	31	72%
Breem	5	10	6	5	50%
Ghawar	7	16	13	12	75%
Swayhill	2	6	6	-	
Swayhill Islet	1	3	3	2	67%
Al Numaniat 3	1	2	1	1	50%
Al-Numaniat 2	1	3	3	-	
Sheybarah South	3	5	3	3	60%

1. Fledging represents successful rearing of a chick through to the stage of developing wing feathers and being capable of flight, at which stage the fledgling is largely independent.
2. One additional breeding pair observed at Mardunah Island, but breeding success not tracked

Given the significance of our area as a sooty falcon breeding site, TRSDC is currently testing ways to improve this species' habitat and breeding success. Foremost among those, we are trialing a variety of prototype nest boxes constructed form different materials. A key goal is to ensure that nest box designs can replicate conditions within natural nests that are typically in cracks and crevices in small cliffs.

Young sooty falcon chicks at Quman

Young Sooty Falcon

This is an elegant bird of prey, 32–37 cm long with a 78–90 cm wingspan. It is shaped like a large hobby or a small Eleonora's falcon, with its long pointed wings, long tail and slim body. The adults are blue-grey, and lack the black underwing coverts of the Eleonora's falcon. The young bird is like a large juvenile hobby, or small juvenile Eleanora's falcon.

3. Priority Megafauna

Priority megafauna species are large, generally mobile, species that are frequently quite rare or vulnerable, including sea turtles, dugongs, cetaceans (dolphins and whales), and elasmobranchs (sharks and rays). In addition to their conservation value, these species serve as symbols and rallying points to stimulate conservation awareness and action, with many of these species in the Red Sea region being both of conservation concern and of interest for future sustainable tourism activities. A detailed knowledge base on these species can help prevent potential disturbance from development, inform planning for navigation routes, and provide information to benefit future ecotourism. To understand these species – and any impacts resulting from future conservation efforts– it's important to have baseline data such as population size, connectivity of individuals and essential habitats.

Two species of sea turtle were recorded during surveys in the area: green turtles, listed as endangered, and hawksbill, critically endangered. Identifying areas of high use for turtles is essential to reduce impacts of development or tourism on nesting beaches and so that inter-nesting, foraging and high-use habitats can be properly managed and protected.

Although it has been some time since the results of region-wide survey have been available, the most recent data available suggest that the Red Sea hosts the third largest population of dugongs behind Australia and the Arabian Gulf. However, this vulnerable species is listed as 'data deficient' for the Red Sea on the IUCN Red List, emphasizing the importance of improving information on their abundance and trends in the Red Sea Project Area and beyond. As dugong feed on seagrasses, and prefer shallow habitats that are sheltered from rough winds and heavy waves, it is likely that the Al Wajh lagoon, and some of its surrounding areas, contain regionally important habitat for this speces.

Eight species of cetacean regularly occur in the Red Sea: Bryde's whale, Risso's dolphin, false killer whale, Indian Ocean humpback dolphin, pantropical spotted dolphin, spinner dolphin, Indo-Pacific bottlenose dolphin and common bottlenose dolphin. Among those, the Indian Ocean humpback dolphin is endangered. Understanding the presence and movements of these species can help prevent potential disturbance from further development, inform planning for navigation routes, and benefit future ecotourism activity plans. Cetaceans are particularly sensitive to underwater noise from various construction methodologies, so planning mitigation measures to prevent impacts during construction will be key.

The Red Sea is host to 32 shark species, 23 of which are considered. threatened. Two species of hammerhead shark, the scalloped and great hammerhead, occur in the Red Sea, both of which are critically endangered. It is also home to approximately 28 species of ray, with 18 considered threatened. Given how significant proactive management, including large MPAs can be for many of these species, reliable population baseline data, are essential to assess future changes in population following conservation efforts.

Surveys were conducted between March and November 2021.

Notable Findings

- 318 green turtle nests and tracks recorded at 19 islands: 187 hawksbill turtle nests and tracks at 22 islands. These included the first evidence of hawksbill nesting at Mardunah Island; and the first reports of green turtle nesting activity at Al Dahra.
- 10 sightings of dugongs (including a female with calf).
- 50 reports of cetaceans, including seven of the endangered Indian Ocean humpback dolphin (including two calves).
- Eight species of shark and seven species of ray were observed – including two critically endangered species: a hammerhead shark and the Halavi guitarfish. In total 142 Halavi guitarfish were encountered around 26 different islands.
- Many Halavi guitarfish, as well as other sharks and rays sighted were young individuals, suggesting that there are important nurseries for these species in the Al Wajh lagoon.

A hawksbill turtle dives following a brief visit to the surface

Methods

Sea Turtles

92 islands were surveyed by walking perimeters to look for evidence of nesting such as pits from previous seasons' nests or fresh tracks along the waterline. The location and status of each track and nest was recorded. Surveys took place from early March until late November 2021, to encompass hawksbill and green nesting seasons. Each island was visited between one and four times, so that in total there were 168 survey visits to different islands over the year. With a few exceptions, visits involved walking and surveying every nesting beach on the island. Because the main nesting beaches were visited on multiple occasions through the hawksbill and green nesting seasons, we can be confident that the great majority of nesting activity in our area was surveyed.

Sightings of turtles in shallow waters around the islands were also reported, with, when possible, waypoints, number of individuals and species information collected.

Other Priority Megafauna: dugong, dolphins and whales, sharks and rays including guitarfish

Dugong and other marine mammal sightings were recorded by any team working in the project area. Information recorded included location, date, and time, and species ID. Some dolphin species are difficult to differentiate from above the water or at a distance, so several sightings could not be reliably distinguished to species level.

A dugong foraging site suitability map was created using sighting locations, known earlier sightings (from earlier reports), observed feeding trails, and presence of suitable feeding areas - seagrass presence in 1-9m depths. This map is being used to identify areas that should be monitored more closely for the presence of dugongs, and where specific protection measures may be justified due to their importance to this species.

Teams visiting islands to conduct turtle nesting surveys -which involve walking round large portions of most islands – would also generally look for sharks and rays in nearshore waters. It was during those visits, that large numbers of Halavi guitarfish and juvenile sharks were recorded.

Hawksbill turtle

Risso's dolphin

Dugong

Results

Sea Turtles

- 131 green turtle nests and 187 tracks were recorded across 19 islands. Breem had the highest recorded nesting, with 222 tracks and nests recorded on the island. Waqadi and Ataweel had 23 and 22 nests and tracks, respectively. The remaining 16 islands all had 10 or fewer nests and tracks – including first reports of nesting activity at Al Dahra.
- 96 hawksbill nests and 90 tracks were recorded on 22 islands. Waqadi had 96 nests and tracks, Breem had 26 nests and tracks. The remaining 20 islands recorded 10 or fewer nests and tracks. Six nests and tracks were recorded at Mardunah, the first evidence of hawksbill nesting there.

Dugongs

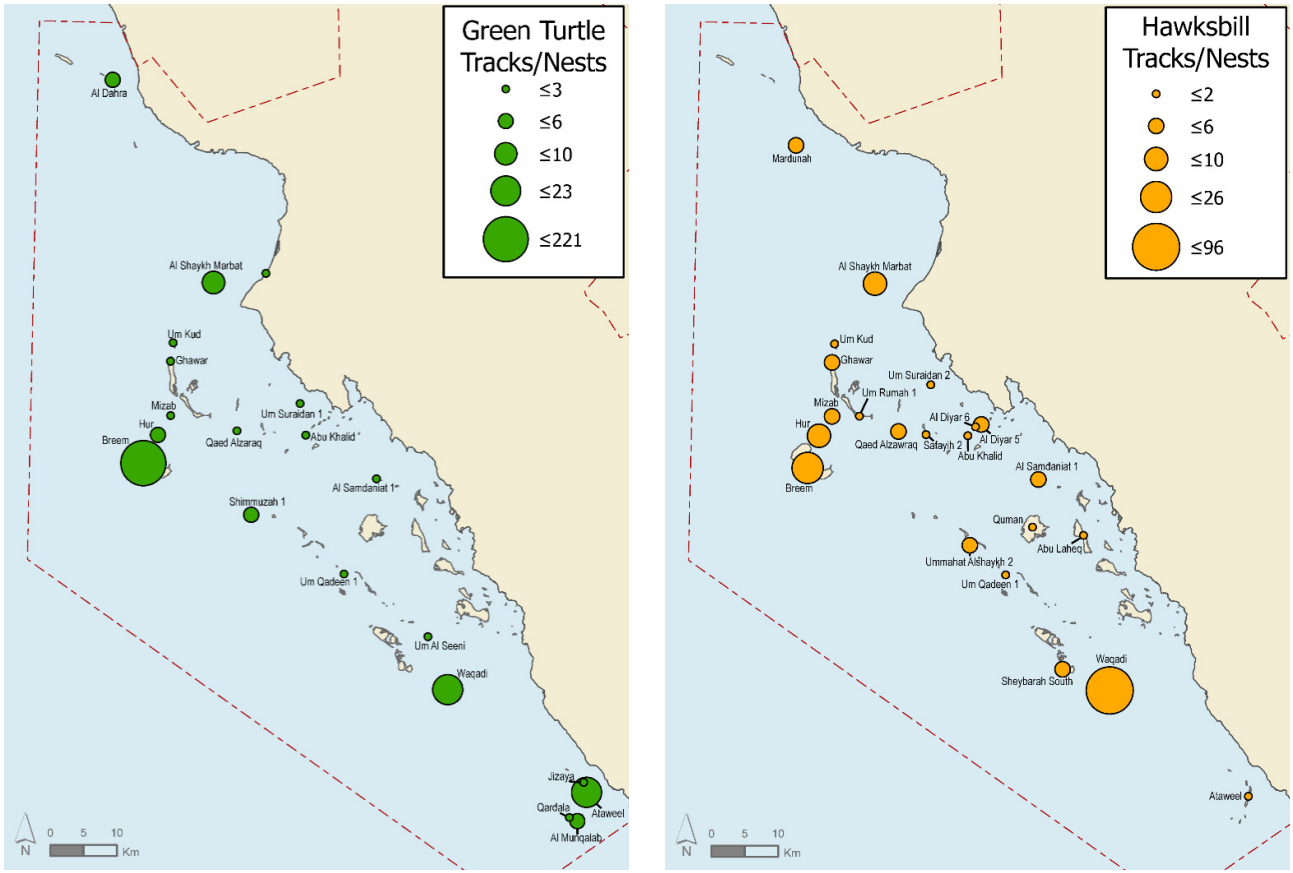
- Ten sightings were reported in 2021, mainly of single individuals, though one was of an adult with a calf.

Cetaceans

- In total, there were 50 distinct sightings of cetaceans - either as individuals or in pods including occasionally with calves. Four species were confidently identified: Indo-Pacific bottlenose, the endangered Indian Ocean humpback, Risso's and spinner dolphins.
- There were also seven encounters with endangered Indian Ocean humpback dolphins, and four spinner dolphins – mostly seen in pods of multiple individuals.

Sharks and Rays

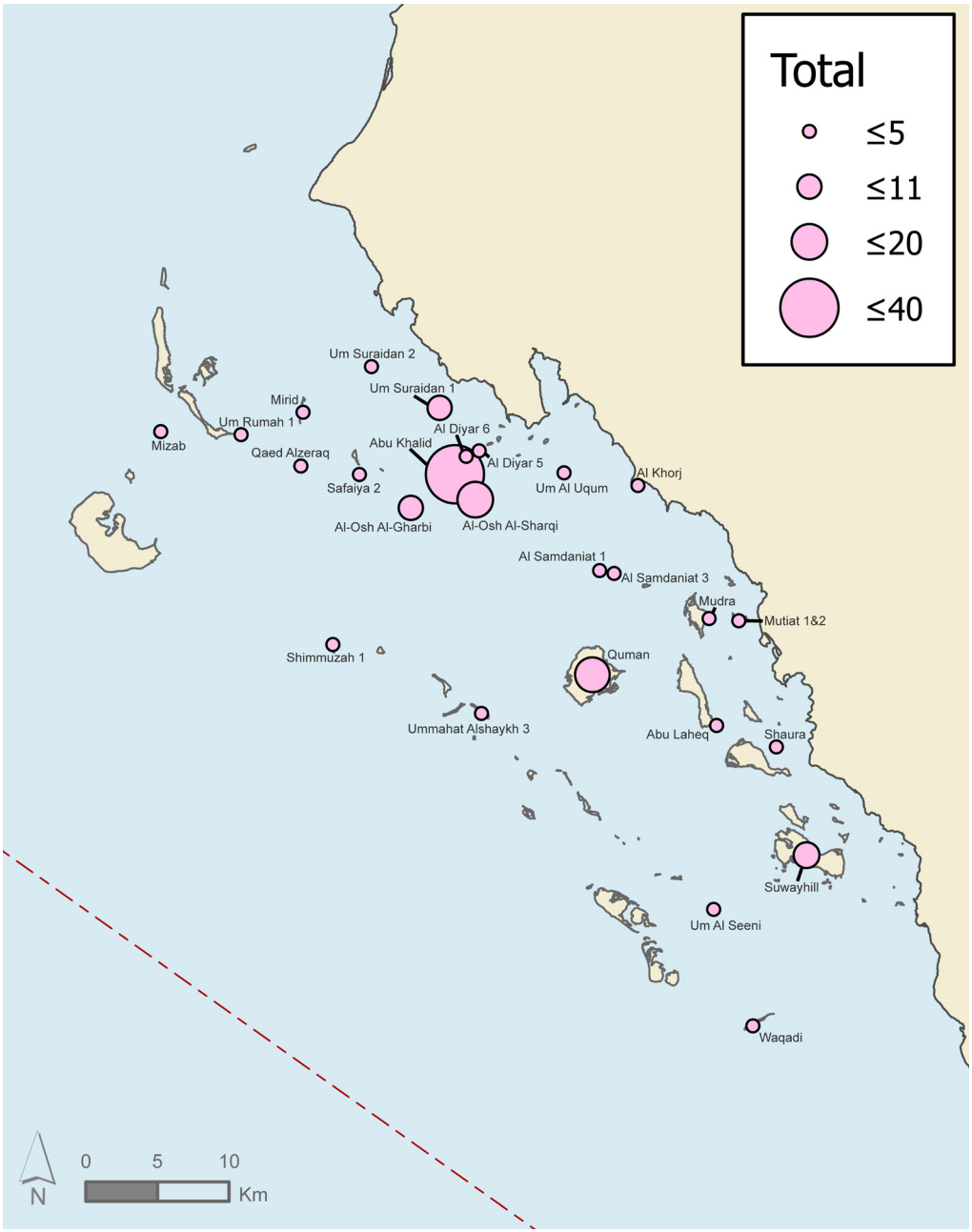
- At least eight species of sharks and seven species of rays were observed during the surveys. In total, 261 sharks and rays were recorded.
- 76 sharks were observed, the majority on reefs outside the main lagoon. Whitetip reef sharks were most common, while a single hammerhead shark was sighted. At both Waqadi and Breem, small blacktip reef sharks were observed, likely juveniles, suggesting the presence of nurseries. At one location, close to what we believe to be an important fish spawning area, tiger sharks have been repeatedly seen at certain times of the year, coincident with peaks of spawning aggregation.
- There were reports of 179 rays – the most frequently observed being the bluespotted stingray, a common species throughout the Red Sea. Five other species of ray were observed: the whitetail stingray, spotted eagle ray, fantail ray, reticulate whipray and Baraka's whipray.
- The Al Wajh lagoon appears very strongly to be an important area for the halavi guitarfish – a critically endangered species endemic to the Arabian Seas region. In total, 142 halavi guitarfish were observed. Large numbers of young halavi were sighted at some islands, including Abu Khalid, Al Osh Al Sharqi, Quman and Suwayhill, indicating some are likely to be nurseries. As they are critically endangered, it is vital to identify and protect their nursery areas throughout the region.



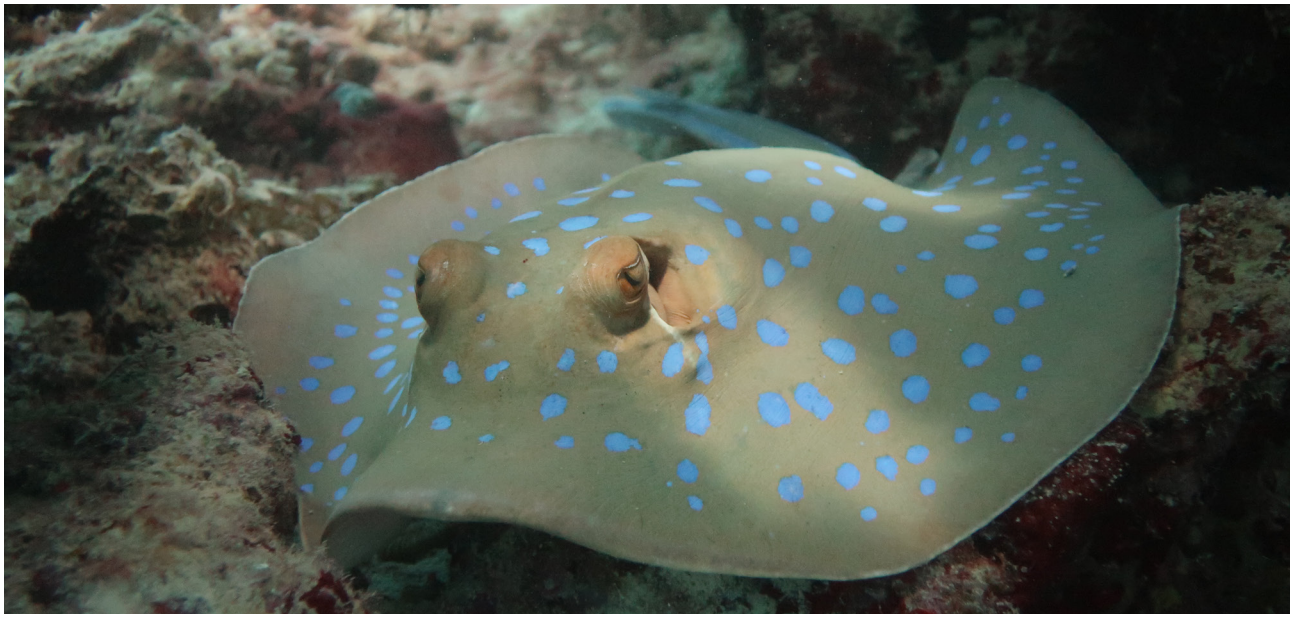
Distribution of green (left) and hawksbill (right) sea turtle nesting evidence from March through November 2021. Number of both nests and tracks at each island represented through graduated symbols

Tiger shark observed at tip of Waqadi Reef, around time of major fish spawning aggregation.

Common name	Scientific name	# Observations	# Individuals
SHARKS			
Tiger Shark	*Galeocerdo cuvier*	4	6
Zebra Shark	*Stegostoma fasciatum*	1	1
Whale Shark	*Rhincodon typus*	2	2
Blacktip Reef Shark	*Carcharhinus melanopterus*	9	13
White Tip Reef Shark	*Triaenodon obesus*	26	48
Sandbar Shark	*Carcharhinus plumbeus*	1	2
Tawny Nurse Shark	*Nebrius ferrugineus*	3	3
Hammerhead shark	*Sphyrna spp*	1	1
	TOTAL	**47**	**76**
RAYS			
Bluespotted Stingray	Taeniura lymma	67	95
Whitetail Stingray	Urogymnus granulatus	7	9
Spotted Eagle Ray	Aetobatus ocellatus	22	29
Fantail Ray	Pastinachus sephen	17	18
Reticulate Whipray	Himantura uarnak	19	27
Baraka's whipray	Maculabatis ambigua	1	1
	Total	**133**	**179**



Distribution of Halavi guitarfish observations from March through November 2021. Number of individuals sighted at each island represented through graduated symbols



Blue-spotted stingray

Hawksbill turtle

4. Advanced Technology & Additional Monitoring Efforts

Our team is committed to utilizing cutting edge advanced technology to extend and expand our monitoring efforts and is establishing an integrated interdisciplinary ecosystem observation system to continually monitor coral reefs and their communities, with the key goals of detecting trends early and establishing new global standards for environmentally sustainable tourism development.

The Systematic Marine Monitoring Strategy (SMMS) gathers comprehensive and meaningful data, especially around areas near development, to record the functioning of coral reefs and changes in the environment. It monitors:

- The benthos – flora and fauna at the bottom of the sea (coverage, coral growth rates, mortality)
- Microbial communities – benthic and pelagic (open sea)
- Environmental conditions – temperature, salinity, turbidity (opacity).

Here we describe some of the approaches used and progress to date.

Achievements and Highlights

- Training and validation of a CoralNet machine learning 'robot' for automated analysis of coral reef survey imagery.
- Application and development of Structure from Motion photogrammetry (SfM) to survey and analyze high resolution 2D and 3D models of fixed coral reef plots.
- Development of environmental DNA tools to provide rapid and reliable biodiversity assessments.

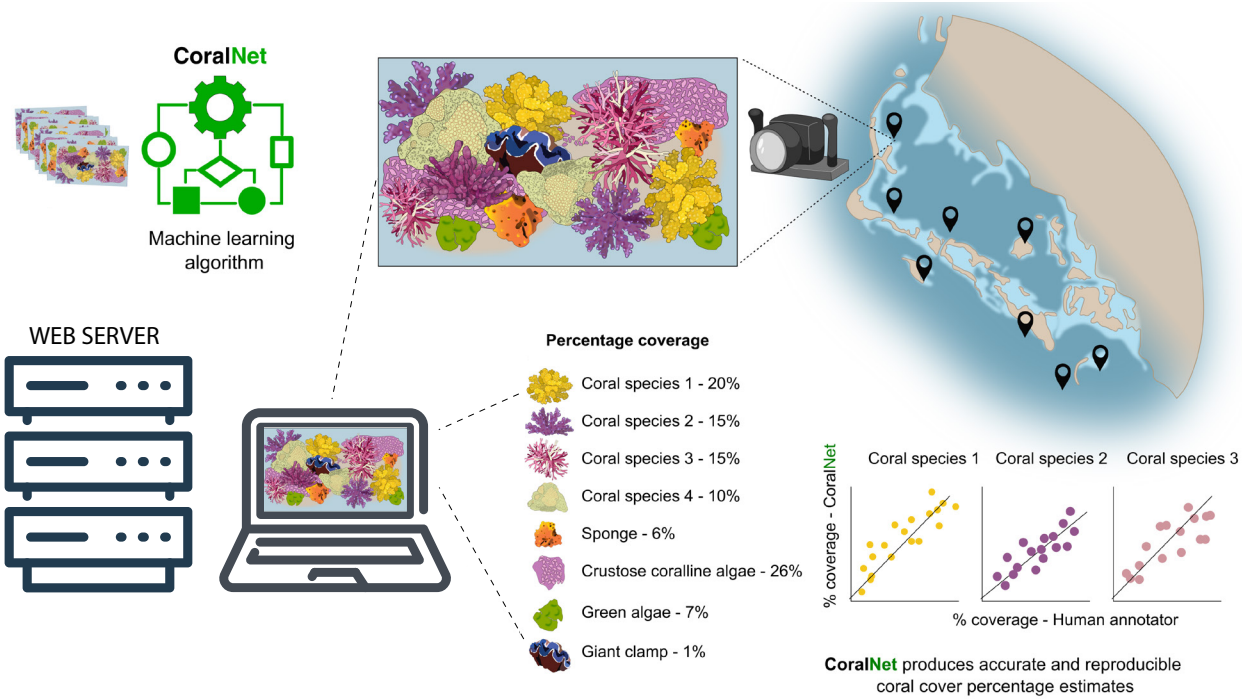
Methods

Machine Learning for Analysis of Photo-quadrats.

Photo-quadrats are photos in which organisms are counted and identified. They provide fine-scale information and are analyzed using the machine-learning image analysis tool CoralNet mentioned above.

When properly trained with data from human experts - CoralNet can automatically analyze coral reef photo survey imagery. To train our Coral Net system, an expert in coral and benthic identification manually annotated 500 images from our surveys, and those were used as a training dataset. We then tested the ability of the trained system to automatically analyze the same imagery, then made some refinements to the training set and the analysis levels, until we were satisfied that we had a system capable of very reliably analyzing survey imagery.

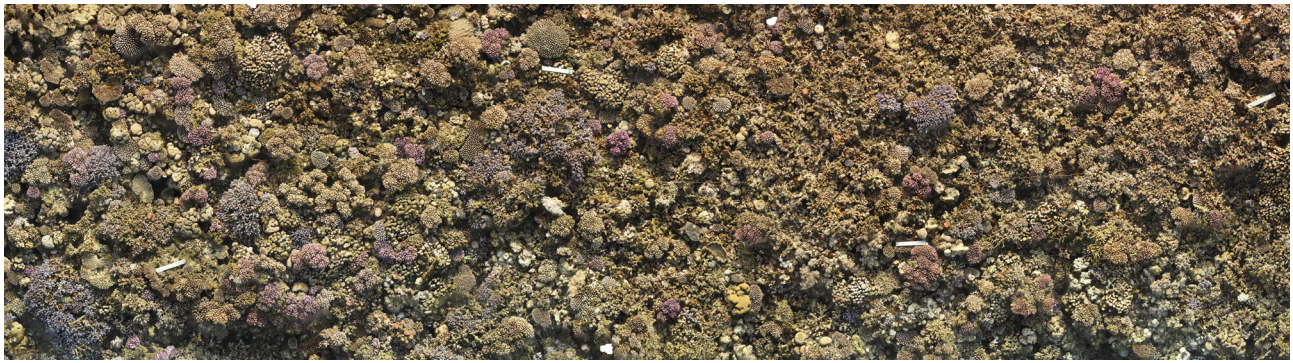
Utliization of machine learning dramatically reduces the time it takes to process and generate survey results - by >95% - yet still produces estimates of hard coral cover that are highly comparable to those produced by human experts. Without utilizing this tool, it would have been impossible for us to survey as extensively as we have.

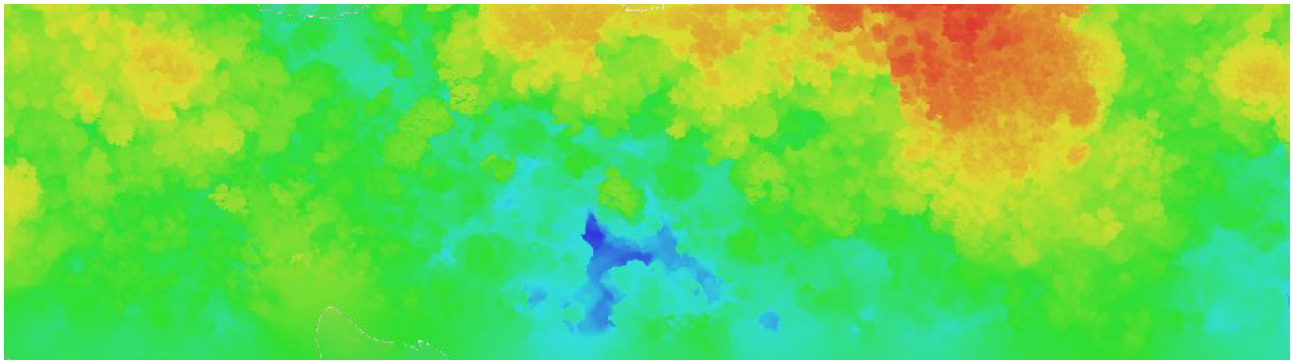


Structure from Motion Photogrammetry

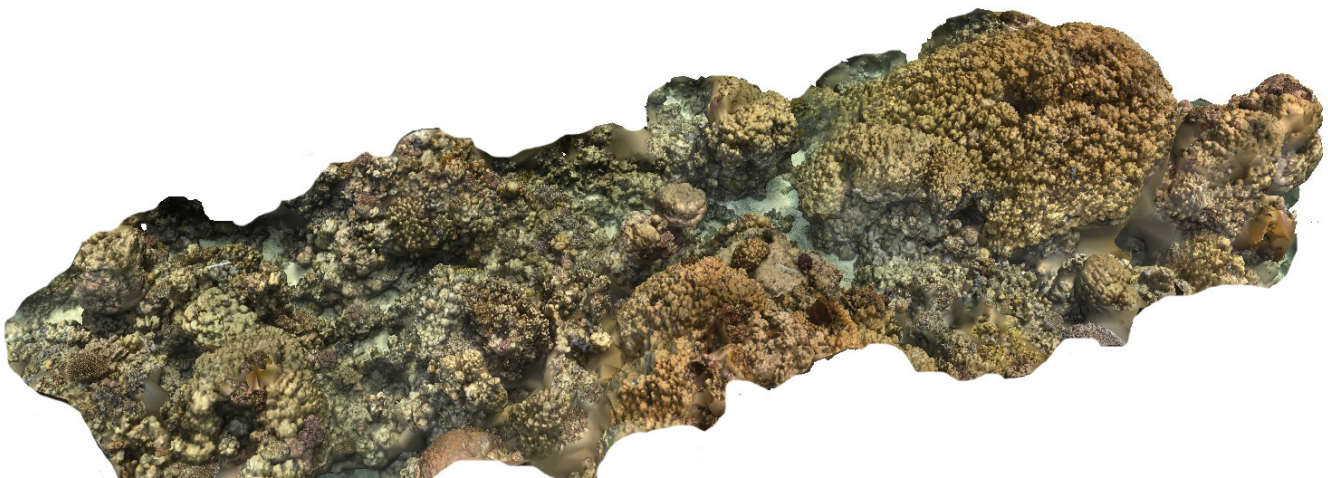
Structure from Motion (SfM) is a photogrammetry technique used to generate 2D and 3D digital scaled models of the coral reef from thousands of overlapping underwater photographs.

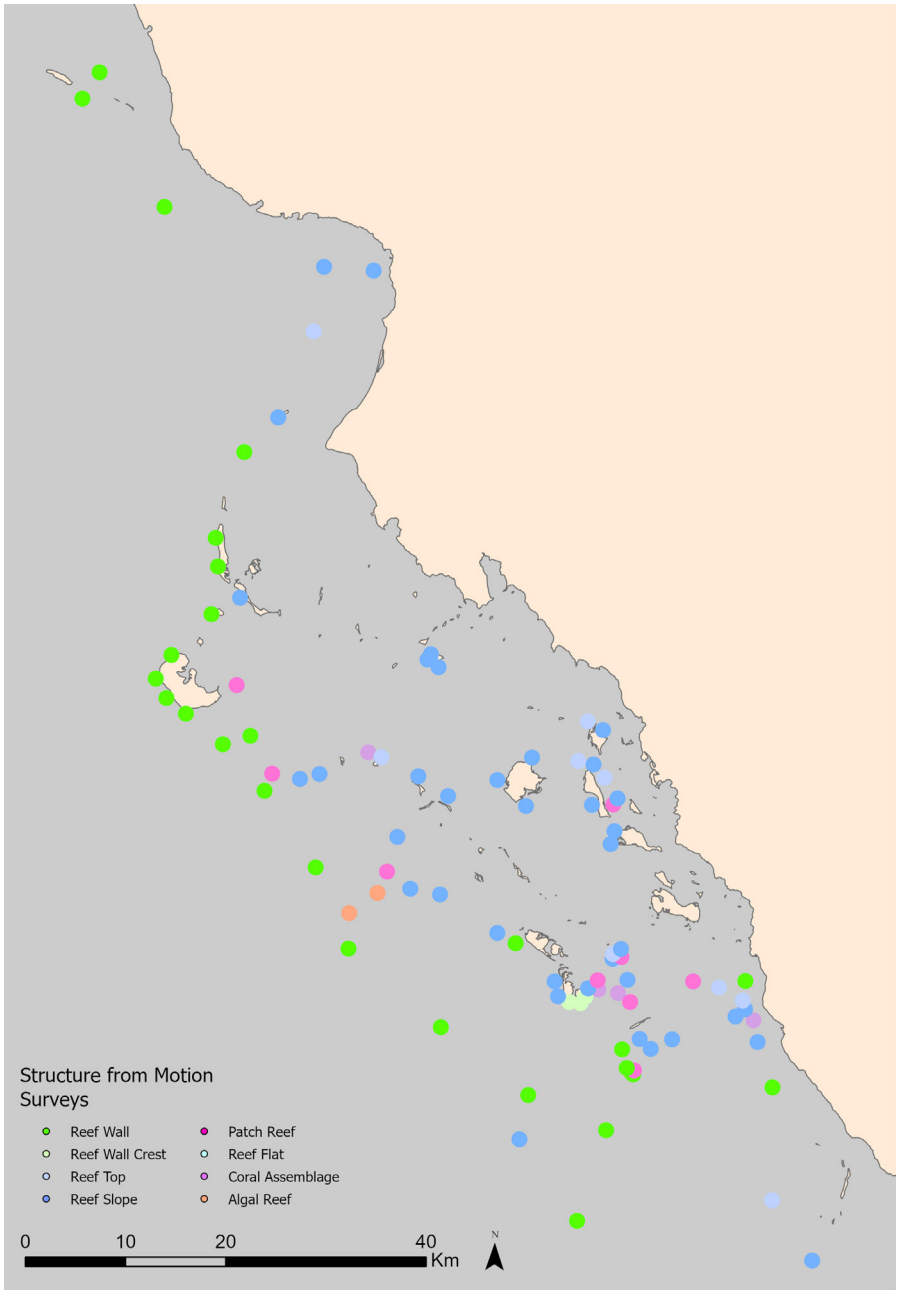
SfM will become our primary method for surveying changes in coral communities. Already the team has established more than 100 permanent monitoring sites across the TRSP area and conducted one more baseline SfM surveys at each of those sites.





Outputs from the SfM process include: an ‘orthomosaic’ showing the entire 20m*5m plot in 2D; a ‘digital elevation model’ which shows the relative heights of the reef (red represents high points and blue are cracks and crevices - low points); and a 3D visual representation of the reef.





As the analytical tools that work with SfM develop, it will become possible to track the fate of individual colonies over time. Use of SFM is very computer intensive, and TRSDC is installing high powered computer servers to support this need.

As SfM technology improves, we will use it to:

- Track and measure individual coral colonies over time to determine change
- Track coral recruitment (coral larvae growing into adult coral) to determine success and growth rates
- Measure the complexity (or roughness) of the reef to assess changes in structure from growth, erosion, or damage
- Evaluate the condition of corals to track disease, predation, bleaching or other changes to health
- Monitor invertebrates to gain understanding about grazing and predation in the coral community.

Location of SfM surveys conducted in 2021. At each dot, at least one 20m * 5m SfM permanent plot has been established and surveyed.

Environmental DNA to detect cryptic biodiversity, identify ecosystem change, and understand distribution of rare species

Environmental DNA are traces of DNA left by organisms that are present in or move across an area. By collecting water and sediment samples from areas, it is possible to understand what species use the area and potentially also to have some indications of their relative abundance. It is particularly useful for cryptic, rare, and microbial organisms that are challenging to survey with more traditional methods. Use of eDNA has amazing potential to rapidly and reliably identify subtle shifts in communities - enabling alerting and mitigation before any more dramatic change can occur.

Therefore, at some of our sites, water and sediment samples were collected for DNA analysis, and we are working with partners at KAUST and elsewhere to fully develop the potential of these approaches.

Bacterial Indicators of Environmental Change

Our first efforts regarding eDNA approaches have been focused on the definition of bacterial indicators of environmental change, identifying bacterial groups and considering variables (such as depth, temperature, nutrients, and organic matter content) of the sites where the samples were taken.

For this work, sediment and water samples for DNA analysis have been collected from a total of 70 sites, across a range of habitats – coral reef, seagrass, soft-bottom sediments. An initial round of sample processing has been completed, and the results are currently being analyzed.

Associated physio-chemical Monitoring Effort

Water and sediment samples were also collected at these sites to monitor variables such as temperature, salinity, dissolved oxygen and nutrient supply. At a subset of sites, temperature loggers, sensors for pH and dissolved oxygen, and current meters have been installed.

eDNA for Detection of Marine Mammals including Dugong

A second use of eDNA by our team is to improve our understanding of the distribution of dugong. Specifically, we take water samples from areas which we believe may be important for dugong, and test for traces of their DNA to help us confirm which areas are most used by this species. This information will help us design and implement an efficient long-term monitoring program for these often shy and elusive creatures.

Very young Humphead wrasse

Concluding Remarks

by Dr. Omar Al-Attas,
Head of Environmental
Sustainability - SEZ

This report is a starting point. A benchmark.

Our initial survey has not only provided us with an essential baseline understanding of the rich diversity of wildlife in our area of the Red Sea region of Saudi Arabia but has unearthed fascinating findings of real importance. It has made clear that a large number of threatened and endangered species call the area their home, from the critically endangered hawksbill turtle and Halavi guitarfish, to the threatened dugong and Indian Ocean humpback dolphin – our research has served to highlight the importance of the region to these majestic animals.

As the next phases of development for both TRSP and AMAALA move forward, concern for environmental protection, conservation and enhancement is being embedded across every aspect, from destination planning all the way through to welcoming guests. The data in this report provide both inspiration and accountability. Inspiration, in that the knowledge already gained will influence decisions across all aspects of TRSDC, and accountability in that it acts as a baseline against which it can be seen whether TRSDC is meeting its stringent sustainability commitments, and achieving our ambitious conservation goals.

Achieving our conservation, enhancement and management goals requires high quality information and continuous monitoring efforts, and we are firm in our belief that these monitoring efforts can now be refined and further developed using the data recorded as we continuously seek to learn and grow.

Surveying efforts from this point will continue to increase as TRSDC grows, and as we strive to do something truly unique and remarkable – create sustainable, even regenerative, luxury tourist destinations where visitors can share space with some of the most beautiful and precious life on the planet, while trusting that it is protected and nurtured.

Tourism, properly harnessed, can and must serve the needs of the environment if it is to be sustainable in the long term. Scientific surveys, and the technology used within them, can be a huge asset, monitoring and thus protecting the environment.

Our aim is to set new standards in sustainable development, respecting the natural world, creating opportunities for the local communities and protecting the destination for the future. Where the technology does not yet exist to realize our ambitions, we will work with innovators to develop it.

Knowledge gained and lessons learned will be shared with the rest of the world, inspiring other destinations and supporting the conservation of multiple coral reef ecosystems globally.

As this report shows, significant planning and effort is underway to set a new benchmark in environmental conservation – but we do not intend to stop here. As a flagship organization of the Kingdom of Saudi Arabia, it is our duty and privilege to continue pushing boundaries and showcasing an unwavering commitment to progress. TRSDC will continue to assess, monitor, and act in the most responsible and sustainable ways possible – from initial development, through to opening where we are aiming for 100 percent reliance on renewable energy, zero single use plastics, zero waste to landfill, and zero discharge to the sea. All underpinned by our alignment with all 17 of the UN Sustainable Development Goals (SDGs).

Working closely with our partners across the private and public sectors has been, and will continue to be, key to our success. Collaboration across sectors and across borders brings a diversity of thought and resources, and leads to better, more efficient innovations. Together, TRSDC and its partners are pioneering the future of sustainable development, creating a regenerative approach to tourism for the betterment of both people and planet.

Contributors

TRSDC Scientists Leading Monitoring Efforts

- Dr. Licia Calabrese, Senior Bird Science Manager
- Dr. Royale Hardenstine, Protected Species Science Manager
- Dr. Cecilia Martin, Habitat Enhancement Science Manager
- Dr. Eva Martinez, Senior Coral Science Manager
- Dr. Susann Rossbach, Environmental Chemical Science Manager
- Dr. Luis Silva, Reef Fish Science Manager
- Rhonda Suka MSc., Benthic Surveying Science Manager
- Dr. Ivor Williams, Marine Ecosystem Monitoring Director

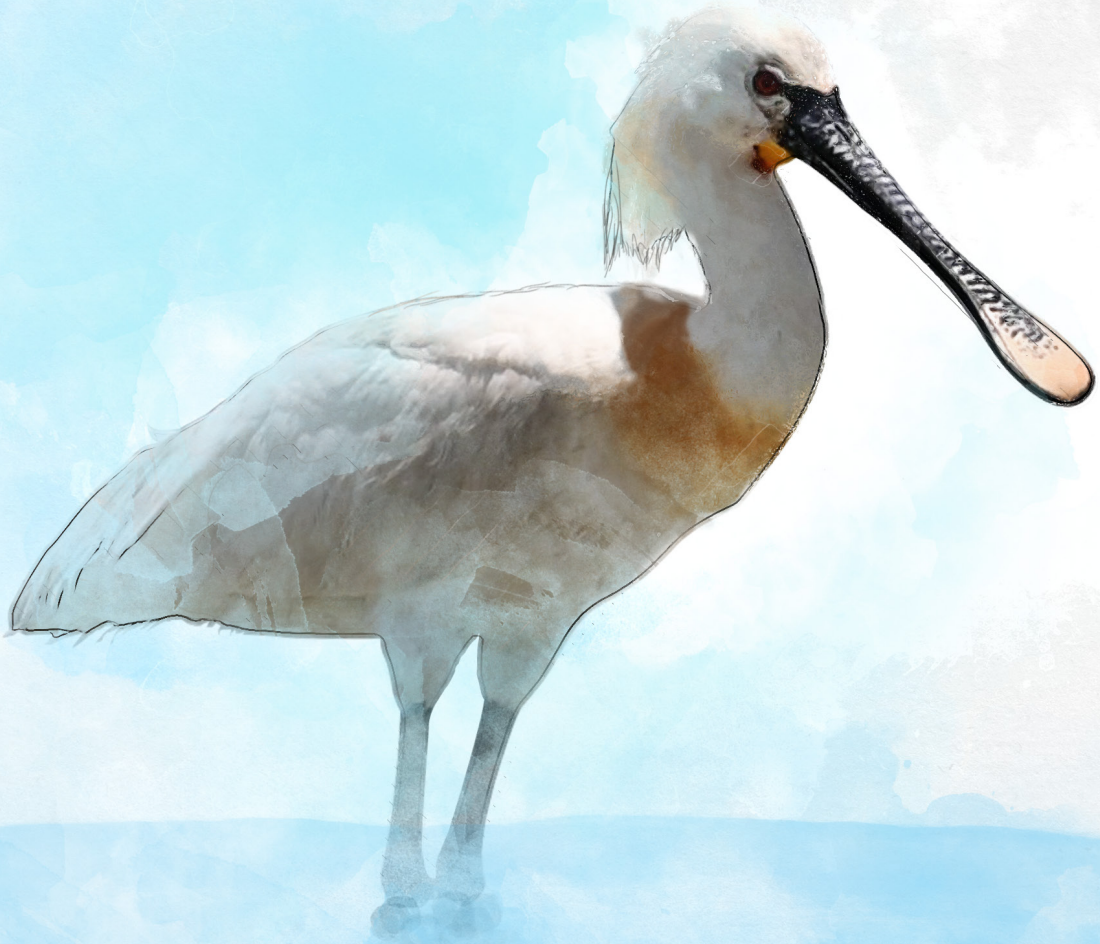
Considerable field and other support provided by:

TRSDC: Dr. Michael Campbell, Dr. Zac Forsman, Dr. Sander den Haring, Dr. Jacob Asher, Ahmed Alghanmi, Abdullah Al-Juhani, Ibrahim Alhamad, Dr. Raul Vilela, Katharina English, Dr. Rusty Brainard, Ahmed Alghanami, Abdullah Salman Alhamdi, Yasir Wusayl Aljohani, Eisa Ali Alhamidi, Eissa Awadh Aljohani, Abdullah Ahmad Alrefayl, Saber Abduallah Zaki, Kayid Abdulelah Aljohani, Mohammed Oudah Aljohani, Zyad Ahmad Alhemidi, Mohammed Dakhel Aljohani, Abdullah Mohammed Alhamdi, Saleh Dakhel Aljuhani, Abdulrahman Swalim Alard, Sakar Mohammad Alfaidi, Vera Costa, Maram Alrashid, Carol Buitrago-Lopez.

Staff and students of KAUST including:

Dr. Michael Berumen, Dr. Francesca Benzoni, Dr. Alison Green, Alex Kattan, Karla Gonzalez-Martinez, Dr. Darren Coker, Dr. Tullia Terraneo, Alexa Foster, Dr. Fabio Marchese, Dr. Jesse Cochran, Dr. Susana Carvalho, Carolina Bocanegra, Dr. Antony Chakkiath, Areen Nasif, Kaitlyn O'Toole, Stephania Palacios, Viktor Peinermann, Gloria Gil Ramos, Gabriel Duarte-Rosado, Irene Salinas Akhmadeeva, Hailey Shchepanik, Lyndsey Tanabe, Matthew Tietbohl, Marta Ezeta Watts.

Spoonbill



"Eurasian Spoonbills got their name because of their spoon shaped bills. They hunt by foraging in shallow water and they sweep the bill from side to side to catch small fish, crustaceans, and insects. When their prey touches the sides of the bill, spoonbills snap them up. On the red sea project islands, they breed in small numbers building about 40 cm nests onside mangrove forests."

Dr. Licia Calabrese

About The Red Sea Development Company

TRSDC was established in 2018 as a Closed Joint Stock Company wholly owned by the Public Investment Fund (PIF) of Saudi Arabia to develop a regenerative tourism destination along Saudi Arabia's west coast. The company is the master developer of two landmark destinations in the Red Sea – The Red Sea Project and AMAALA.

TRSDC aims to set pioneering standards to develop truly global destinations, embracing visitors from around the world. These aspirations are guided in every aspect by the vision, mission, and values to conduct business responsibly, collaboratively, and passionately while respecting stakeholders, the environment and the Kingdom of Saudi Arabia's culture and heritage.

Sustainability lies at the core of TRSDC's values and is fully integrated into operations and planning. This integration positions TRSDC as a driver of long-term value creation in the Kingdom of Saudi Arabia.

The Red Sea Project (TRSP) is a development area that includes a marine area of 7,000 km2 (with the Al Wajh lagoon as the core), including 90 islands and 4,600 m^2 of coral reefs. 150 km north of the TRSP is AMAALA, a development encompassing 4,155 km^2 and sitting within the Prince Mohammad Bin Salman Natural Reserve.

Both TRSP and AMAALA are set to be located within a semi-autonomous Special Economic Zone (SEZ), regulated by a unique and independent set of laws, complementary to Saudi base economy and in line with international standards. The SEZ will provide competitive financial incentives and a regulatory framework conducive to attracting business and investment. The SEZ will develop environmental regulatory standards to ensure the ambitious goals for environmental sustainability and enhancement are achieved.

Lion Fish

Glossary / Appendix

Specialist terms identified and used throughout this report:

TRSDC – The Red Sea Development Company: the organization responsible for the development and execution of the environmental baseline surveys, and the master developer of two landmark destinations in the Red Sea – The Red Sea Project and AMAALA.

TRSP – The Red Sea Project: a 28,000km2 luxury, regenerative tourism destination that will set new standards in sustainable development and position Saudi Arabia on the global tourism map

AMAALA – A 4,500km2 ultra-luxury destination, and the first global integrated family wellness destination, set to curate transformative personal journeys inspired by arts, wellness, and the purity of the Red Sea

SEZ – Special Economic Zone: a semi-autonomous zone governed by independent laws and a regulatory framework on par with international standards

No-Take Marine Protected Area (MPA) – a specific type of marine protected area. no-take MPAs totally prohibit the extraction or significant destruction of natural or cultural resources

SfM – Structure from Motion: photogrammetry software allowing you to generate great 3D models from a series of photographs

CoralNet - a machine learning tool that is capable of automating the analysis of coral reef survey images

Locations mentioned: Specialist terms identified and used throughout this report:

TRSDC Scientists Leading Monitoring Efforts

Dr. Licia Calabrese, Senior Bird Science Manager

PhD Avian Ecology and Conservation (2015, Marie Curie University, Paris)
MSc Nature Conservation (University of Parma)

BSc Natural Science (University of Parma)

Dr. Calabrese has more than a decade of experience in a variety of conservation, monitoring and science roles involving seabirds, as well as terrestrial animals and ecosystems. Her expertise in species assessments, habitat selection and mapping, and species recovery planning provide an ideal basis for conserving and enhancing the bird populations within The Red Sea Project area.

Dr. Royale Hardenstine, Protected Species Science Manager

PhD Marine Science (2020, KAUST)
MSc Marine Science (2015, KAUST)
BSc Marine Biology (2013, University of New England)

Dr. Hardenstine first worked with protected species during her BSc, when she volunteered at the University of New England's Marine Animal Rehabilitation Center, helping to rehabilitate sick and injured seals and sea turtles. She then worked in outreach and animal care at a nature center and aquarium.

In 2014, Dr. Hardenstine joined the Reef Ecology Lab at KAUST where she completed both her MSc and PhD focused on Red Sea whale shark ecology and population genetics. Part of this work used citizen science contributions and photo-identification to identify movements of whale sharks throughout the Red Sea.

Dr. Hardenstine also led the Red Sea deployments of baited remote underwater video systems to understand shark and ray presence, as part of the Global FinPrint Project. Alongside her research interests, she has a commitment to outreach and community education.

She joined TRSDC in 2021, where her work is focused on assessing population sizes and essential habitats of turtles, dugongs, and other marine mammals in The Red Sea Project area. She also coordinates the response, rehabilitation, and release of injured sea turtles (3 turtles recovered and were released back into The Red Sea Project waters in 2021).

Dr. Cecilia Martin, Habitat Enhancement Science Manager

PhD Marine Science (2020, KAUST)
MSc Biology (2015, University of Milano-Bicocca)
MSc Marine Science for Sustainable Development (2012, University of Milano-Bicocca)
BSc Biology (2011 University of Milano-Bicocca)

Dr. Martin received her BSc and MSc in Biology at the University of Milano-Bicocca. She completed a 1-year MSc in Marine Sciences for Sustainable Development at the Marine Research and High Education (MaRHE)

center in the Maldives, and she earned a PhD in Marine Science at the King Abdullah University of Science and Technology (KAUST) in Saudi Arabia. Her MSc thesis was in coral reef ecology, focusing on the distribution of mushroom corals in the Maldives, while for her PhD dissertation she investigated the fate of marine plastic pollution in the Red Sea.

Her work on the use of drones to quantify beached anthropogenic marine litter was pioneering and her research on mangroves has demonstrated their importance as permanent sinks of microplastics (sequestered indefinitely in their sediments), showing why mangroves should be protected.

Her job at The Red Sea Development Company aims to provide the scientific knowledge and support to enhance habitats like mangroves and seagrass. She is currently involved in mapping the habitats within the project area, identifying areas suitable for enhancement and conducting pilot mangrove plantation projects.

Dr. Eva Martinez, Senior Coral Science Manager

PhD Molecular Ecology (2017, University of the Basque Country)
MSc Marine Environmental Management (2012, University of the Basque Country)
MSc Biomedicine and Biotechnology (2010, University of Tenerife)
BSc Biology (2009, University of Tenerife)

Dr. Martinez completed her PhD in 2017 in Spain. Her work focused on the application of molecular approaches (in particular a technique called DNA metabarcoding) to monitor marine biodiversity. Her efforts resulted in the development of DNA-based biotic indices to quantify changes in the environment due to anthropogenic pressures with application for managers and scientists in environmental impact assessments.

In 2017, she moved to KAUST where she continued the investigation of the response of marine organisms to anthropogenic impacts, such as aquaculture activities, oil and gas extraction or coastal development. She has also conducted extensive research on the application of metabarcoding to describe small cryptic species associated to coral reefs using Autonomous Reef Monitoring Structures (ARMS) across the Red Sea.

Eva joined TRSDC in 2021, where she is developing and applying novel methodologies (e.g., high resolution imagery, machine learning tools and molecular approaches) to describe and monitor changes in coral reef associated communities.

Dr. Susann Rossbach, Environmental Chemical Science Manager

PhD Marine Science (2020, KAUST)
MSc Biological Oceanography (2016, University of Kiel)
BSc Biology (2013, University of Kiel)

Dr. Susann Rossbach holds a doctorate degree (2020) in Marine Science from King Abdullah University of Science and Technology (KAUST) and is also a certified / professional scientific diver (2014) and a SCUBA instructor.

In her previous work as a researcher, she worked with cold-water and deep-sea corals from the North Atlantic and the Patagonian Fjord region, on

different benthic communities of the Mediterranean Sea, as well as coral reefs, and in particular on Red Sea giant clams. She has also been previously involved in a range of other projects, from marine archaeology to geology.

Susann is an avid underwater photographer with a passion for science communication and environmental education.

Susann joined TRSDC in February 2021, as the Environmental Chemical Science Manager. In that role, she works on topics ranging from carbon sequestration in mangrove forests and seagrass beds, to assessment of water quality and water chemistry as part of the SEZ Coral Reef Impact and Baseline Monitoring projects. Her work helps The Red Sea Project gain a better understanding of the environmental factors that shape the unique ecosystems found there

Dr. Luis Silva, Reef Fish Science Manager

PhD Marine Science (2020, KAUST)
MSc Marine Biology (2012, University of Algarve)
BSc Aquatic Sciences (2010, Institute of Biomedical Sciences Abel Salazar, University of Porto)

Dr. Luis Silva's initial scientific career focused on aquaculture and fisheries. During his master studies in collaboration with the Lisbon Oceanarium (Portugal), he gained experience in rearing fish larvae and adults, as well as zooplankton and microalgae. He was also involved in other national and international research projects where he assisted setting-up aquaria tanks for fish larvae experiments.

In 2014, he started working as environmental consultant and later, research assistant in the north of Portugal, where he contributed to understanding the potential impacts of floating wind turbine and ghost fishing on marine biota.

In 2015, Luis joined KAUST – Red Sea Research Center as a PhD student. His research focused on microbial oceanography and ecology. By assessing marine bacteria's potential to grow in different ecosystems in the Red Sea, Luis contributed to better understand the role of planktonic microbes in pelagic food webs and biogeochemical cycling.

At The Red Sea Development Company, Luis used his cross-field expertise evaluating the potential impacts on benthic, fish, and microbial communities of the ongoing development plan.

Rhonda Suka MSc., Benthic Surveying Science Manager

MA Geography (2013, University of Hawaii)
BA Geography (2011, University of Hawaii)

Rhonda Suka has more than 20 years of experience in coral reef monitoring and habitat mapping. Her work spans the tropical Pacific and the southern Mediterranean Sea, working with the National Oceanic and Atmospheric Administration (NOAA) and the University of Hawaii.

While at NOAA, Rhonda led the development and implementation of photogrammetry surveys (Structure from Motion - SfM). SfM is a monitoring approach that is now the standard tool used for all monitoring teams within the NOAA Coral Reef

Ecosystem Division in Hawaii. Rhonda has also implemented SfM techniques to document and digitally preserve architectural and geomorphological seafloor features at archaeological sites in the Aegean Sea.

Her work with The Red Sea Development Company is helping achieve goals to use SfM and other leading edge techniques to provide high resolution imagery and precise data to monitor and measure changes in coral reef communities.

Dr. Ivor Williams, Marine Ecosystem Monitoring Director

PhD Coral Reef Ecology (2000, University of Newcastle)
MSc Tropic Coastal Management (1994, University of Newcastle)
PGD Software Development (1988, Newcastle Polytechnic)
BSc Mathematics & Philosophy (1986, University of Manchester)

Dr. Williams has more than 20 years of experience in coral reef research, conservation, and management, primarily with US state and federal government agencies and with The Nature Conservancy. He led the reef fish ecology and monitoring team at NOAA's Coral Reef Ecosystem Division in Hawaii between 2010 and 2020. While there, he helped to design and implement one of the world's

largest coral reef monitoring programs – the Pacific Reef Assessment and Monitoring Program, which surveys coral reef ecosystems on 40 islands in US and US-territorial waters of the Pacific Ocean.

Dr. Williams has published more than 60 peer reviewed scientific papers, mostly on coral reef fisheries and marine protected areas, coral reef macro-ecology, and monitoring approaches.


Lesser
Crested
Tern