

# 2021

# ANNUAL REPORT



Khaled bin Sultan  
Living Oceans  
Foundation



## MESSAGE FROM THE CHAIRMAN

This year I had the pleasure of announcing the conclusion of the Global Reef Expedition (GRE), the largest coral reef survey and mapping expedition ever conducted in the history of mankind.

Thirteen years ago at the 2008 IUCN World Conservation Congress in Barcelona, I assured the conservation community that an era of new knowledge about coral reefs and the challenges they face is about to emerge, one that requires a gigantic translocation of resources, cutting-edge technology, and bringing expertise to the most remote coral reefs in the world.

In 2021, we completed that mission. We circumnavigated the globe, conducting tens of thousands of underwater surveys and produced maps of over 65,000 square kilometers of coral reefs—the largest collection of ground-truthed, high-resolution coral reef habitat maps ever made. The GRE's treasure-trove of scientific data was freely shared by a wide range of end-users, from marine managers to government officials, to NGOs. Data collected on the GRE has already been used to enact new conservation measures in several parts of the world.

Without the dedication of hundreds of scientists, conservationists, educators, students, and sailors, the foundation would not have been able to collect this valuable data on coral reefs, or create its award-winning classroom curricula and documentary films. Our coral reef studies are now being taken to the next level, for we are partnering with the National Aeronautics and Space Administration (NASA), permitting the use of information collected on the GRE as a guide for mapping coral reefs from space.

I am proud of the achievements of each and every one of the past and present affiliates of the foundation. Now, with the Global Reef Expedition complete, we have the knowledge we need to address the coral reef crisis. As we move forward, we strive to leave a legacy of ocean conservation, so our children, and our children's children, can also experience the beauty and wonder of a coral reef.

**His Royal Highness Prince Khaled bin Sultan**  
Chairman & President

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# CONCLUDING THE GLOBAL REEF EXPEDITION

For over a decade, the foundation has worked hard to complete the world's largest coral reef mapping and survey effort, the Global Reef Expedition (GRE). This year, the foundation is proud to announce the conclusion of this pioneering effort to survey and map coral reefs around the world. Prince Khaled formally announced the conclusion of the GRE this past September at the IUCN World Conservation Congress. He specifically chose to share the news at this prestigious conference, as it was the same one where he announced his intention to launch the Global Reef Expedition in 2008.

The GRE is one of the biggest accomplishments in the foundation's history. The Expedition circumnavigated the globe, traveling over 53,000 km and spending over 20,000 hours underwater surveying the reefs to collect baseline data on the status of corals and reef fish around the world.

The GRE took place at a critical time, as the coral reef crisis continues to worsen. While the science team was conducting surveys, our education and outreach teams shared the foundation's knowledge about coral reefs with community members, local and traditional leaders, teachers, and schoolchildren. They also created award-winning films to bring our research into people's homes, and brought back valuable information to the scientists from the communities who relied on the coral reefs for their lives and livelihood. This collaborative effort allowed the foundation to have lasting impacts on the communities we worked with, helping us provide science-based conservation recommendations catered to the reefs we studied.

This year we also completed the [Global Reef Expedition Final Report](#), which looks at global trends in the data from this extensive Expedition. The report highlights the pressing need for the conservation of the world's reefs. In particular, we found that overfishing was a global problem, and by swiftly addressing acute disturbances on coral reefs, we have a better chance of preserving our precious

marine resources. This, combined with the worsening impacts of climate change, is why strict conservation efforts will need to be implemented to protect this precious and fragile ecosystem.

Our findings from the GRE have been shared widely and received with great accolades. Copies of the report were sent to government officials, conservation organizations, and marine managers in every country we surveyed. News of the Expedition appeared in over 150 radio, TV, news, and magazine stories worldwide. Our findings were also presented at two major international conferences this year, the [International Coral Reef Symposium \(ICRS\)](#) and the [IUCN World Conservation Congress](#). Now, our colleagues at the University of Miami are using data collected on the GRE to develop a resilience model for reefs so that it can be applied and used in conservation management plans worldwide.

Our work on the GRE has led to many successful partnerships where we have been able to collaboratively establish management plans. These partnerships have led to the creation of marine protected areas in The Bahamas, Cook Islands, Jamaica, and Fiji, and we continue to work with partners in other countries visited on the GRE to help them conserve their reefs.

Going forward, all three of the foundation's departments look forward to using our wealth of data to continue our work to preserve the world's oceans. The high-resolution habitat maps we created as a result of the GRE have led to one of our most exciting partnerships to date, a partnership with NASA. The foundation is working closely with NASA scientists to map the remainder of the world's reefs and develop state-of-the-art technology that can be used by coastal communities worldwide. Currently, over 100-peer reviewed scientific papers, reports, and management plans have been published using data collected on the GRE, and we have plans to continue publishing and sharing our data in the near future.



## GLOBAL REEF EXPEDITION FINAL REPORT

The Khaled bin Sultan Living Oceans Foundation circumnavigated the globe studying the health and resiliency of coral reefs. The [Global Reef Expedition Final Report](#) summarizes our findings from that research mission, provides valuable baseline data on the status of the world's reefs at a critical point in time, and offers key insights into how to save coral reefs in a rapidly changing world.

# SCIENCE

This year has been an eventful and exciting year for the science team at the Khaled bin Sultan Living Oceans Foundation. In 2021, the science team was hard at work focusing on addressing the plight of coral reefs. In addition to concluding the Global Reef Expedition, the foundation partnered with NASA, presented at prestigious conferences, and launched new projects to map coral reefs.

## NASA SPACE ACT AGREEMENT

This year, KSLOF partnered with NASA's Ames Research Center in California's Silicon Valley to use the foundation's extensive high-resolution data about reefs to expand NASA's coral mapping capabilities. This partnership will allow NASA to create maps of all the coral reefs in the world and track how reefs are changing through time, giving scientists around the world the insight needed to address the coral reef crisis.

The Space Act Agreement between NASA and KSLOF gives NASA access to data from the foundation's Global Reef Expedition, one of the largest surveys of coral reefs ever completed. The partnership will use the ground-truthed coral reef maps from the GRE as training data, feeding it into NASA's NeMO-Net neural network and the Pleiades supercomputer at NASA Ames. This system uses a combination of satellite imagery and ground-breaking underwater imaging technology to create detailed maps of coral reefs.

With the information from the GRE, NeMO-Net's maps will become more accurate, giving researchers and environmental managers better information about what's happening to coral reefs and how to protect them at a time when they are experiencing unprecedented anthropogenic pressures.

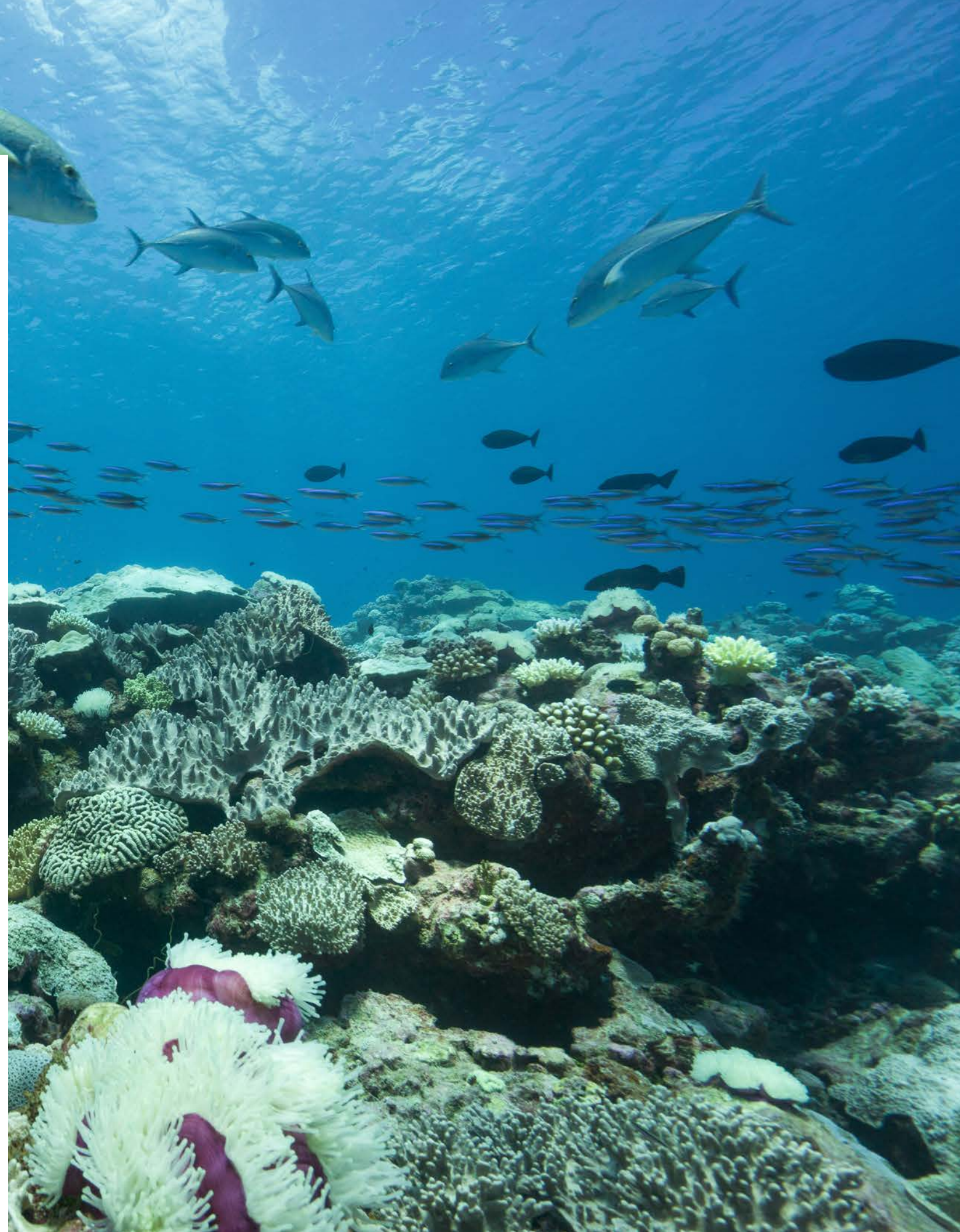
Enabled by the recently-executed Space Act Agreement with NASA, KSLOF and NASA are now embarking on additional research projects together. A new multi-year study mapping reef biodiversity entitled 'The Marine Biodiversity and Scaling Project' (MarineVERSE) was just launched at the end of the year.

KSLOF signed  
a **space act**  
collaboration agreement  
with **NASA.**

## CORALNET MACHINE LEARNING

In 2021 KSLOF was awarded a grant to work on a new project with The Pacific Blue Foundation and CoralNet. The project uses KSLOF's large repository of annotated and unannotated images from Lau Province, Fiji, and our expertise in benthic photo transects, to improve the CoralNet machine learning platform. The project aims to train the CoralNet algorithm on the foundation's annotated images from Lau Province to automate image analysis from benthic transects and evaluate if CoralNet returns high accuracy of benthic point identification.

By improving the robustness of the CoralNet machine learning platform, we can enable low-skilled indigenous communities to collect digital images at low cost, link to the cloud, and have the images processed and data delivered back that is relevant for indigenous community reef management as well as to provide data for scientific studies and government management. This technology could be globally transformative, allowing for very large-scale collection of images at low cost with strong objective analysis using the CoralNet machine annotator platform. Once the CoralNet algorithm is properly trained, the machine can annotate an image more than 1,000 times faster than a human.



# SCIENCE

## IUCN WORLD CONSERVATION CONGRESS

In the summer of 2021, KSLOF had the prestigious opportunity to present our findings from the GRE at the International Union for the Conservation of Nature's (IUCN) World Conservation Congress in Marseille, France. The presentation, entitled "[The Global Reef Expedition: Circumnavigating the Globe to Address the Coral Reef Crisis](#)," focused on the plight of coral reefs and how the GRE was conducted to assess the state of coral reefs around the world. Held once every four years, the IUCN World Conservation Congress brings together "several thousand leaders and decision-makers from government, civil society, indigenous peoples, business, and academia, with the goal of conserving the environment and harnessing the solutions nature offers to global challenges."

As coral reefs are rapidly declining globally due to a host of different stressors such as climate change and overfishing, they are a key example of a critical habitat in need of global awareness and protection using a multifaceted approach of conservation disciplines and stakeholder involvement. The presentation highlighted how the GRE was meticulously planned under the framework of [Science Without Borders®](#), and the foundation's three-pronged approach of using scientific research, education, and outreach to address the coral reef crisis.



## CHAGOS FINAL REPORT

For the duration of the Global Reef Expedition, the foundation has provided individual final country reports to the governments, managers, and communities with detailed information regarding our findings from each location. In March 2020, the foundation published the final report for the Chagos Archipelago, the last territory visited on the GRE. We spent over two months at sea in Chagos, conducting thousands of surveys of the benthic and reef fish at over one hundred locations across the archipelago. [The Global Reef Expedition: Chagos Archipelago Final Report](#) summarizes the findings from this research mission and includes valuable baseline information on the status of the reefs at that point in time.

The Chagos Archipelago was the most remote and well-protected location surveyed on the GRE, and it boasted some of the most beautiful and healthy reefs we had seen. However, even in what may be the most remote and well-protected reefs on Earth, there were signs of human impacts. We were the first to witness what would become one of the largest and most catastrophic global bleaching events, which reduced live coral cover to just 5-15% in this archipelago.

## EXPANDING CORAL REEF RESEARCH & TECHNOLOGY

The foundation's team at the University of Miami has been working on a broad range of initiatives in the last year. First, funded by the National Science Foundation, a three-year study to improve the use of bioindicators to audit reef vitality over timescales of centuries to millennia. This project heavily leverages data collected on the Global Reef Expedition. Next, work continues on the upscaling of diver measurements of reef condition using remote sensing data. A pilot study in the South Pacific is now complete, and the strategy will shortly be applied more broadly across the Indian and Atlantic Oceans. The development of new technology remains important, and the team recently published a paper that expands the use of ICESat, a satellite, to measure the topography of submerged reefs.

## PUBLICATIONS

Global Reef Expedition Final Report. Carlton, R., Dempsey, A., Thompson, L., Heemsoth, A., Lubarsky, K., Faisal, M., and Purkis, S. Khaled bin Sultan Living Oceans Foundation, Annapolis, MD. Vol 15.

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Mingyue Wu, Virginie K.E. Duvat, & Sam J. Purkis. Multi-decadal atoll-island dynamics in the Indian Ocean Chagos Archipelago. *Global and Planetary Change*. Vol. 202.

Manzello D. P., Enochs I. C., Carlton R., Bruckner A., Kolodziej G., Dempsey A. & Renaud P. Pacific-wide pH snapshots reveal that high coral cover correlates with low, but variable pH. *Bulletin of Marine Science*. Volume 97, Number 1, January 2021, pp. 239-256(18).

Desbiens, Amelia A., Roff, George, et al. 2021. Revisiting the paradigm of shark-driven trophic cascades in coral reef ecosystems. *Ecology*. 102(4):e03303.

Global Reef Expedition: Chagos Archipelago. Final Report. Carlton, R., Dempsey, A., Lubarsky, K., Faisal, M., and Purkis, S. Khaled bin Sultan Living Oceans Foundation, Annapolis, MD. Vol 13.

Winrow, N., et al. Empowering and Inspiring Young Girls a STEM at a Time: Using Place-Based Learning to Cultivate STEM Identities. *Current: The Journal of Marine Education*, 35(1), pp. 6-15



# COMMUNICATIONS

Despite the restraints imposed by the ongoing pandemic, 2021 was a banner year for the communications team at the Khaled bin Sultan Living Oceans Foundation. This year, we focused on communicating our overarching findings from the Global Reef Expedition, publishing the last of the GRE Final Reports, announcing the conclusion of the Global Reef Expedition, and producing a new TV show with EarthxTV.

## SHARING FINDINGS FROM THE GLOBAL REEF EXPEDITION

Early in the year, the foundation published the *Global Reef Expedition: Chagos Archipelago Final Report* and shared the news widely with conservation organizations and news media worldwide. News of our findings was shared on TV, radio, and printed media around the world, including on PBS, BBC news and radio, Alekhbariya TV, *Scuba Diver Magazine*, *ECO Magazine*, *Chagos News*, and many more. In total, more than 50 news stories were published on this research alone.

This summer, KSLOF participated in the IUCN World Conservation Congress, where in addition to presenting our scientific findings, we organized a press conference for H.R.H. Prince Khaled bin Sultan to announce the conclusion of the GRE. The press conference and release resulted in great international press coverage. IUCN helped to share the news with the global conservation community, and invited KSLOF to join the IUCN-US Communications Subcommittee this year.

One of the biggest successes for the foundation this year was publishing the *Global Reef Expedition Final Report*. This report summarizes all of our findings from the GRE and is the first report we published that combines research from all the countries studied on the GRE. The communications team worked closely with the science team to publish this report, producing a legacy document on the state of coral reefs around the world. In addition to scientific research, the report highlights the outreach and education components of the GRE, showcasing the 3-pronged approach we took to complete the largest coral reef survey and mapping expedition in history.

## “OUR LIVING OCEANS” TV SHOW

This year the foundation partnered with EarthxTV to produce *Our Living Oceans*, a 6-part documentary series now playing on EarthxTV. Each episode takes viewers on a journey of discovery, educating viewers on the health of our living oceans, the threats they face, and what is being done to save them through conversations with scientists, conservationists, and local leaders from around the world.

KSLOF is heavily featured in all the episodes, which showcase our findings from the Global Reef Expedition and includes interviews with H.R.H. Princess Khaled bin Sultan as well as the foundation’s staff, partners, and fellows. Hosted by submarine pilot Erika Bergman, the series also interviews world-renowned marine scientists and conservationists including Sylvia Earle, Nancy Knowlton, Ben Halpern, Pete Mumby, Daniel Pauly, and President Tommy Remengesau.

This season of *Our Living Oceans* focuses on coral reef conservation. The first episode covers the Global Reef Expedition and our journey to collect baseline data on the state of coral reefs. The following episodes cover our coral reef maps, our work to assess the health and resiliency of coral reefs, threats to reefs, coral reef conservation, and why there is still reason to have hope for the future.

*Our Living Oceans* is now playing on EarthxTV and streaming on the EarthxTV app.



## “OUR LIVING OCEANS” TV SHOW

Produced in collaboration with EarthxTV, “Our Living Oceans” is a documentary TV series that explores the health of our living oceans, the threats they face, and what is being done to save them through conversations with scientists, conservationists, and local leaders from around the world.

[Watch “Our Living Oceans” on EarthxTV!](#)

# EDUCATION

## SCIENCE WITHOUT BORDERS® CHALLENGE

The *Science without Borders® Challenge* contest was developed to get students and teachers around the world more involved and interested in ocean conservation through various forms of art. This annual international contest inspires students to be creative while using different types of media to promote public awareness of the need to preserve, protect, and restore the world's oceans and aquatic resources; thus, contributing to the overarching motto of the Foundation—**Science without Borders®**.

This year the foundation completed its 9<sup>th</sup> annual Science Without Borders® Challenge. The theme for this year's Challenge was "*The Magic of Mangroves*." Students were asked to use their artistic talents to create a piece of art that illustrates the importance of mangroves. This is the first time that mangroves were used for the contest theme.

The *Challenge* is judged in two categories, one for students ages 11-14, and another for students ages 15-19. Overall, the foundation received 680 submissions from 63 different countries, which is the greatest number of countries that we have ever received submissions from in any year. This was the first time the foundation received submissions from students in Afghanistan, Brazil, Cameroon, Cayman Islands, Czech Republic, Dominica, Ghana,

Iran, Kuwait, Maldives, North Macedonia, Palestine, Panama, Senegal, and Zambia.

First place in the category for students 11-14 years old went to 13-year-old Dana Chung from Korea. Her piece, *Shelter*, shows how mangroves create habitat for other organisms and shelters them from storms. Dana said that she wanted to show that "mangrove trees are valuable, not just to people, but also for the Earth."

Sharon Choi won first place in the category for 15-19 year old students for her stunning artwork, *The Guardians of the Sea*. A 16-year old from California, Sharon created a piece of art that illustrates how mangrove forests provide a refuge for marine species, particularly in their early stages of life. "I really liked the idea of mangroves being a safe-haven for young fish, like a kindergarten, so that is what I wanted to portray in my piece," she said.

This competition introduced students around the world to mangrove forests and encouraged them to learn more about this critical coastal marine ecosystem. Each of the first place [winners](#) received \$500 scholarships from the Khaled bin Sultan Living Oceans Foundation to help them continue to pursue their interests in art and ocean conservation.

**Science Without Borders®** is the motto of the **Khaled bin Sultan Living Oceans Foundation**. It guides all of our work as we pursue our mission to **preserve, protect, and restore** the world's **oceans** and **aquatic resources**.

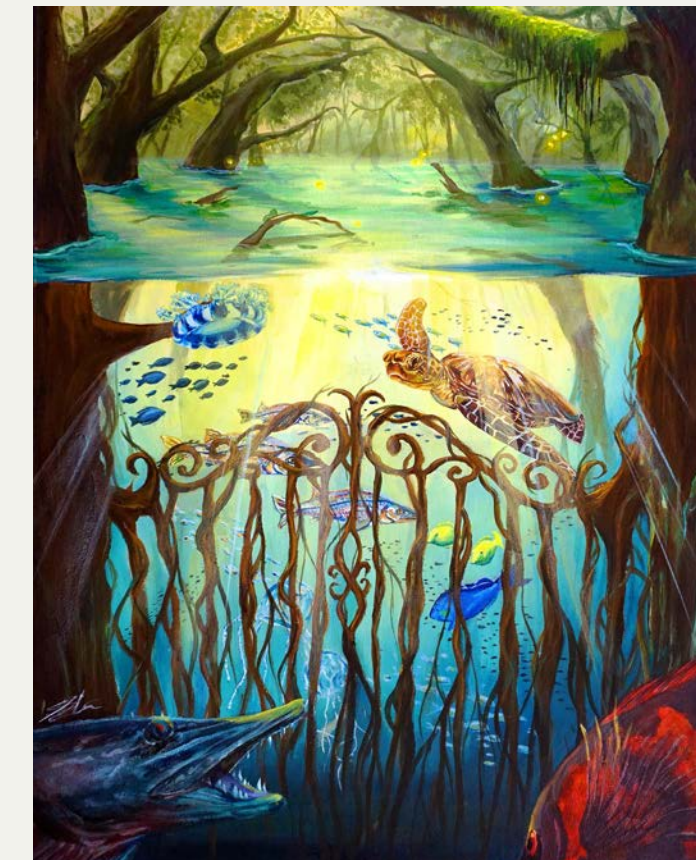
### First Place, ages 11-14:



#### SHELTER

by Dana Chung  
Age 13  
Seoul, South Korea

### First Place, ages 15-19:



#### THE GUARDIANS OF THE SEA

by Sharon Choi  
Age 16  
California, United States

# EDUCATION

## MANGROVE EDUCATION & RESTORATION PROGRAMS

Our [Mangrove Education and Restoration Program](#) is a two-year immersive, experiential education program that engages high school students and teachers in the Caribbean to learn about, restore, and monitor mangroves through project-based learning. Due to continued concerns of COVID-19, face-to-face learning was postponed during the 2021-2022 academic year.

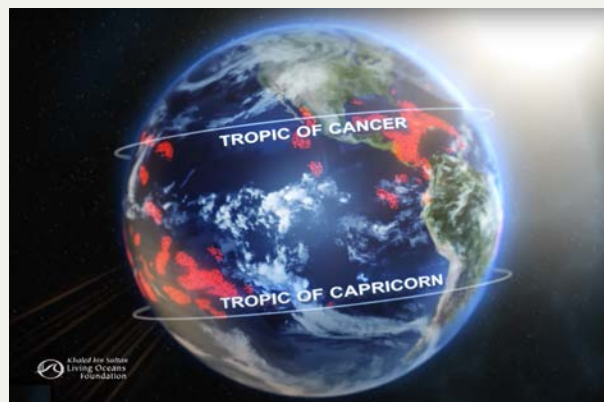
Despite these setbacks, the foundation remotely worked with Alligator Head Foundation to launch a new program called the Mangrove Development, Education, Awareness, and Livelihoods ([Mangrove DEALs](#)). The program's goal is to increase awareness and appreciation of mangroves and advocate for greater preservation of wetland ecosystems. This program allows the foundation to expand its existing mangrove education and outreach efforts in Jamaica by providing workshops to key stakeholders including educators, community members, and government officials. These efforts wouldn't have been possible without the gracious support from the National Conservation Trust Fund of Jamaica.

## EDUCATION PORTAL

Schools around the world continued remote learning throughout the pandemic. The foundation's Education Portal, which hosts their *Coral Reef Ecology Curriculum*, continued to be a useful resource, especially for those learning remotely. With the postponement of face-to-face learning opportunities, the foundation was able to focus on creating additional content for the Education Portal.

Some of these education resources were created with funds received from grants. With generous grant funding from the Jerome S. & Grace H. Murray Foundation, the foundation was able to create additional resources on the Education Portal. The foundation, and partners at the Bahamas Marine Mammal Research Organisation (BMMRO) and Dr. Ryann Rossi, were also awarded a National Geographic grant to develop curriculum about how marine mammals are affected by sound pollution before and during the pandemic. Finally, the foundation received a joint grant with the University of Miami (UM) to create a virtual reality (VR) educational tool that allows students to explore a 3-dimensional environment to learn about different types of reefs and their zones. This new VR technology is the first of its kind for the foundation, and support was provided by the UM Magic Leap grant. All these education materials will be available in 2022.

The foundation also partnered with K2 Studios to develop a curriculum for their IMAX film called *Ocean Odyssey*, which features world-renowned conservationist and scientist, Dr. Sylvia Earle. The curriculum was developed to expand on concepts introduced in the film, including food webs and Sylvia Earle's Hope Spots, areas of the ocean that need protection. The target audience for the curriculum is middle school students (grades 6-8). The curriculum will be available on the film's website, and it will be incorporated into corresponding units in the foundation's *Coral Reef Ecology Curriculum*.





# FINANCIAL STATEMENT

## KHALED BIN SULTAN LIVING OCEANS FOUNDATION

### STATEMENT OF FINANCIAL POSITION

As of December 31, 2021

	TOTAL
<b>ASSETS</b>	
<b>Current Assets</b>	
Cash and cash equivalents	\$379,262
Prepaid expenses	\$2,630
<b>Total Current Assets</b>	<b>\$381,892</b>
<b>Furniture and Equipment</b>	
Furniture and equipment, net	\$6,827
<b>TOTAL ASSETS</b>	<b>\$388,719</b>
<b>LIABILITIES AND NET ASSETS</b>	
<b>Current Liabilities</b>	
Accounts payable and accrued expenses	\$145,542
Grants payable	-
<b>Total Current Liabilities</b>	<b>\$145,542</b>
<b>TOTAL LIABILITIES</b>	<b>\$145,542</b>
<b>Net Assets</b>	
Without donor restrictions	\$243,177
<b>TOTAL NET ASSETS</b>	<b>\$243,177</b>
<b>TOTAL LIABILITIES AND NET ASSETS</b>	<b>\$388,719</b>

## MANY THANKS TO OUR DONORS

PRINCE KHALED BIN SULTAN  
 THE JEROME & GRACE MURRAY FOUNDATION  
 THE PACIFIC BLUE FOUNDATION  
 UNIVERSITY OF MIAMI - MAGIC LEAP GRANT  
 RUTH D. MITCHELL



# BOARD & ADVISORS

## BOARD OF DIRECTORS



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PRINCE KHALED BIN SULTAN**  
Chairman and President

**HER ROYAL HIGHNESS  
HALA BINT KHALED**  
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**GENERAL CHARLES HORNER,  
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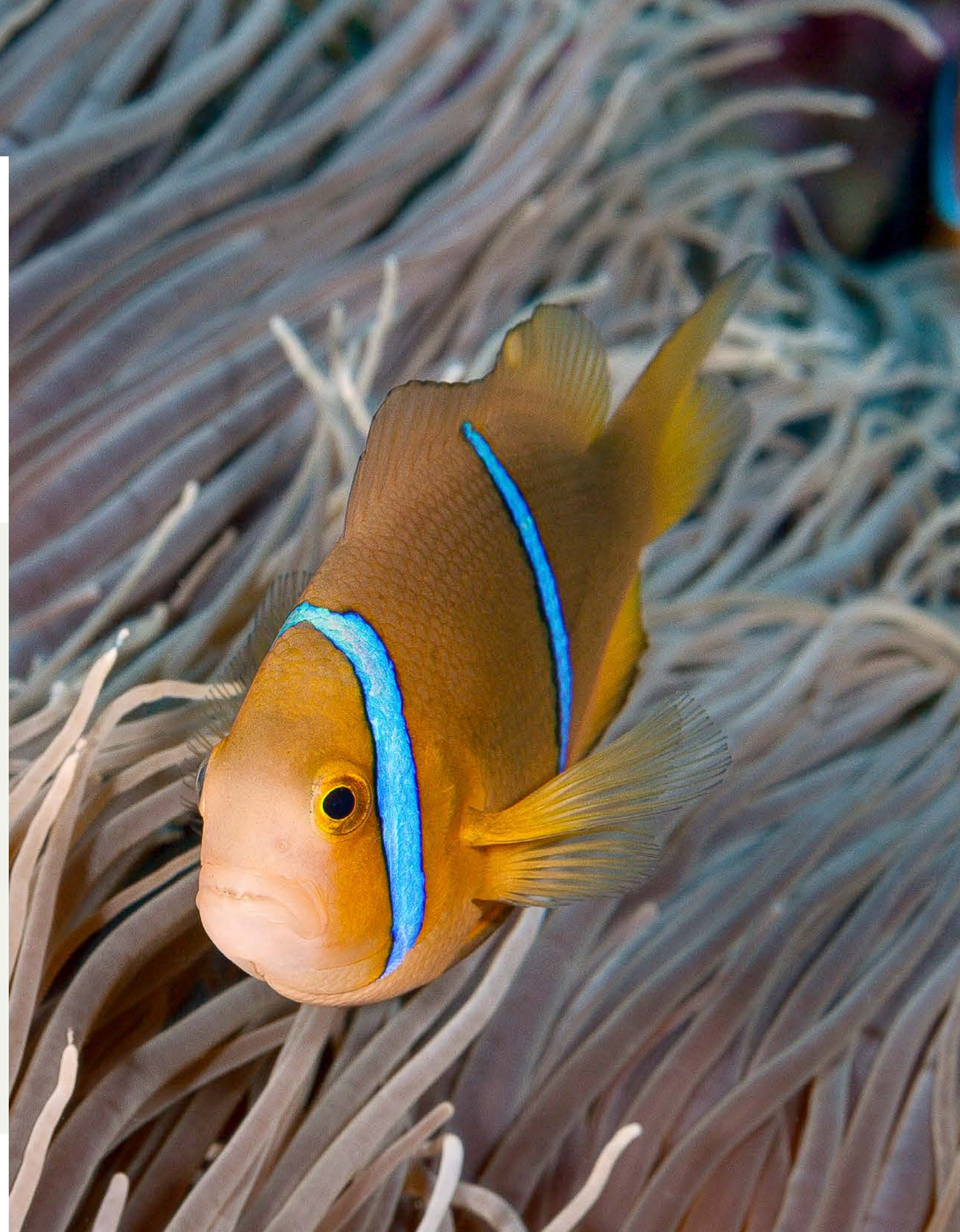
**MOHAMED FAISAL,  
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Lead Scientist

**SHAWN MCLAUGHLIN, PH.D.**  
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**PROFESSOR ABDULAZIZ  
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- SAM PURKIS, PH.D.



# STAFF

## STAFF



**SAM PURKIS, PH.D.**  
Chief Scientist



**ALEXANDRA DEMPSEY**  
Director of Science Management



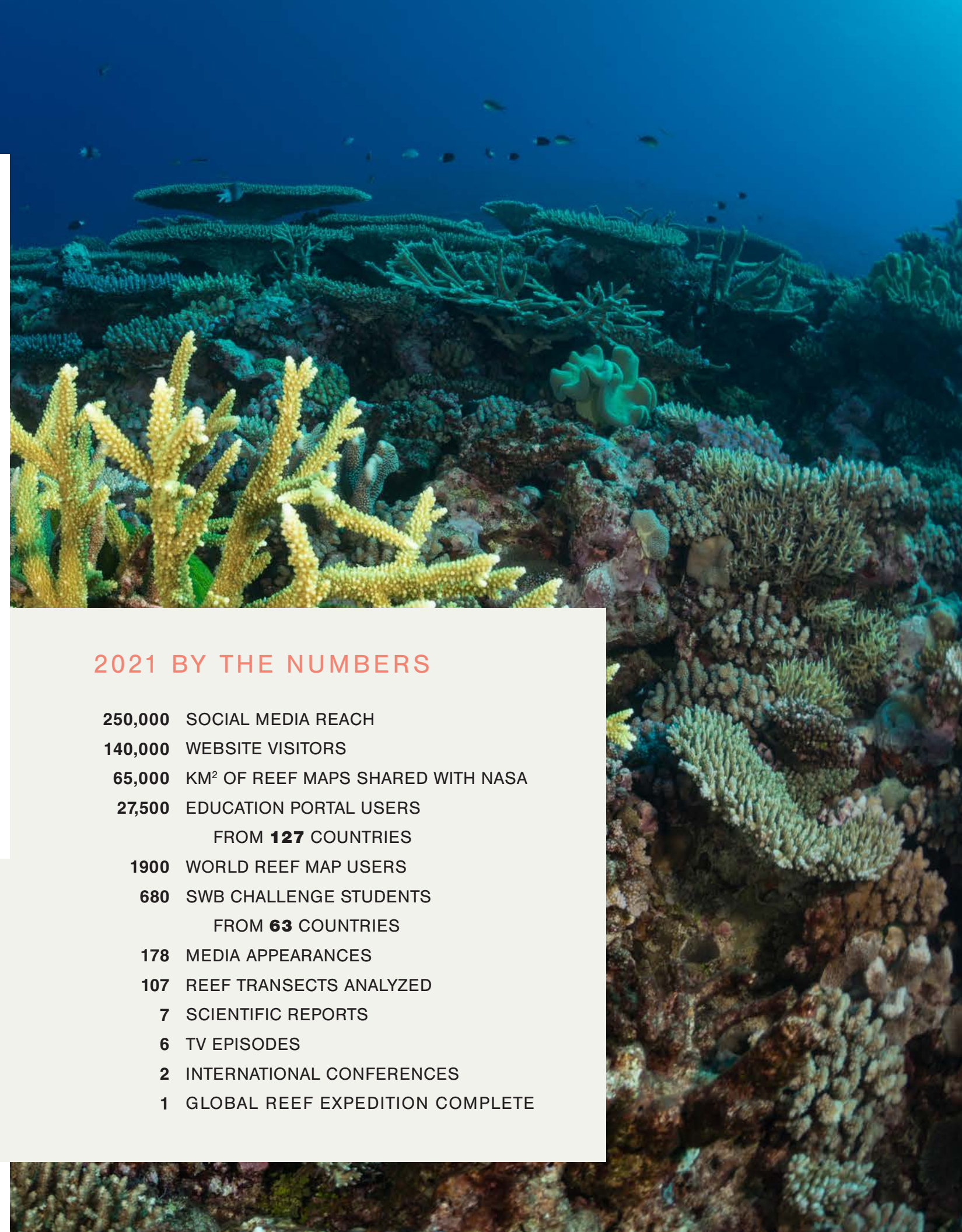
**AMY HEEMSOTH**  
Director of Education



**RENÉE CARLTON**  
Marine Ecologist



**LIZ THOMPSON**  
Director of Communications



## 2021 BY THE NUMBERS

- 250,000** SOCIAL MEDIA REACH
- 140,000** WEBSITE VISITORS
- 65,000** KM<sup>2</sup> OF REEF MAPS SHARED WITH NASA
- 27,500** EDUCATION PORTAL USERS  
FROM **127** COUNTRIES
- 1900** WORLD REEF MAP USERS
- 680** SWB CHALLENGE STUDENTS  
FROM **63** COUNTRIES
- 178** MEDIA APPEARANCES
- 107** REEF TRANSECTS ANALYZED
- 7** SCIENTIFIC REPORTS
- 6** TV EPISODES
- 2** INTERNATIONAL CONFERENCES
- 1** GLOBAL REEF EXPEDITION COMPLETE



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Living Oceans  
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