

2022

ANNUAL REPORT



Khaled bin Sultan
Living Oceans
Foundation



MESSAGE FROM H.R.H. PRINCESS HALA

I was merely nine years old when my father first taught me how to scuba dive. We were in Jeddah early one morning for an advanced shark dive. My father noticed my nervous demeanor ahead of my plunge. With his usual poise, he reached over and told me, “Be calm and be safe.” Through diving, I started a deep bond with my father, Prince Khaled bin Sultan, who was known for his contagious passion for exploring and conserving the ocean. It is this passion and legacy I am honored to carry with me on my conservation journey.

Sadly, my fascination with the breathtaking scenes underwater were met with the emerging reality of deteriorating oceans. Over the past 30 years, we have lost 1/2 of our coral reefs and 1/3 of our mangrove forests. Coastal development, pollution, overfishing, disease, and a rapidly changing climate are all taking their toll. These ecosystems are not only important to the plants and animals that live there, but they provide food, income, and coastal protection to billions of people worldwide. While scientists estimate that one out of every six people on Earth depend upon these ecosystems for food or income, every person benefits from their existence.

Over the past three decades, Prince Khaled bin Sultan has committed to several ocean preservation projects through the concept of “Science Without Borders®.” A series of research and exploration projects executed by dozens of conscientious committed professionals culminated in the formation of the Khaled bin Sultan Living Oceans Foundation in the year 2000. Our mission is to protect and restore the oceans through science, education, and outreach.

I now work with a dedicated team of scientists, educators, and communications professionals to tackle some of the most pressing issues facing our ocean. If nothing is done to save them, coral reefs as we know them today could be gone by the end of the century. Given the importance of this ecosystem to people, the oceans, and the environment, the foundation has worked tirelessly to provide countries with science-based solutions to protect and conserve their reefs.

Ocean conservation efforts defy borders and individual institutions and affect people’s quality of life. As my father wisely stated many years ago, “We do not hope to stop human development – only to ensure it is sustainable for future generations to benefit from healthy oceans.”

Let us continue working and supporting this ecosystem –before it is too late.

Her Royal Highness Princess Hala bint Khaled bin Sultan
Director

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SCIENCE

The Khaled bin Sultan Living Oceans Foundation's (KSLOF's) science team has achieved a great deal in the past year, due in no small part to our ability to capitalize on the data and expertise we gathered on the Global Reef Expedition (GRE). We forged new collaborations, published papers, and conducted work in the field to assess the state of corals and reef fish.

MAPPING REEFS IN HAWAII

Earlier this year, the foundation's science team joined the University of Miami's Rosenstiel School of Marine, Atmospheric, and Earth Science's Aircraft Center for Earth Studies (ACES) to map the reefs of Lanai, Hawaii. We utilized a new approach to mapping reefs honed by NASA, using drones equipped with fluid lensing sensors to see beneath the waves and map reefs at a centimeter scale. To ground-truth the accuracy of the airborne surveys, the foundation's science team used their expertise in traditional underwater benthic and fish survey methods. This research mission was supported by a grant from the National Fish and Wildlife Foundation in partnership with Pulama Lana'i.

AUTOMATING CORAL REEF TRANSECT ANALYSIS

The Khaled bin Sultan Living Oceans Foundation continues to work with the Pacific Blue Foundation and the CoralNet team to automate the analysis of coral transect photos. CoralNet is a free software program that harnesses the power of machine learning to identify corals, substrate, and algae in coral reef transect photos, doing in seconds what it would otherwise take a highly-trained expert days to do on their own. The foundation is helping to bolster the annotation algorithm and is using our experience annotating tens of thousands of photos by hand to bring new ideas and perspectives to the project.

This year we entered the second phase of the project, and we are training the CoralNet algorithm on annotated images from the foundation's work in the Lau Province of Fiji, using an updated label set and images from Lau and Beqa Lagoon. We are now evaluating the outputs to see if CoralNet returns high accuracy of benthic point identification. Our intention of building upon the

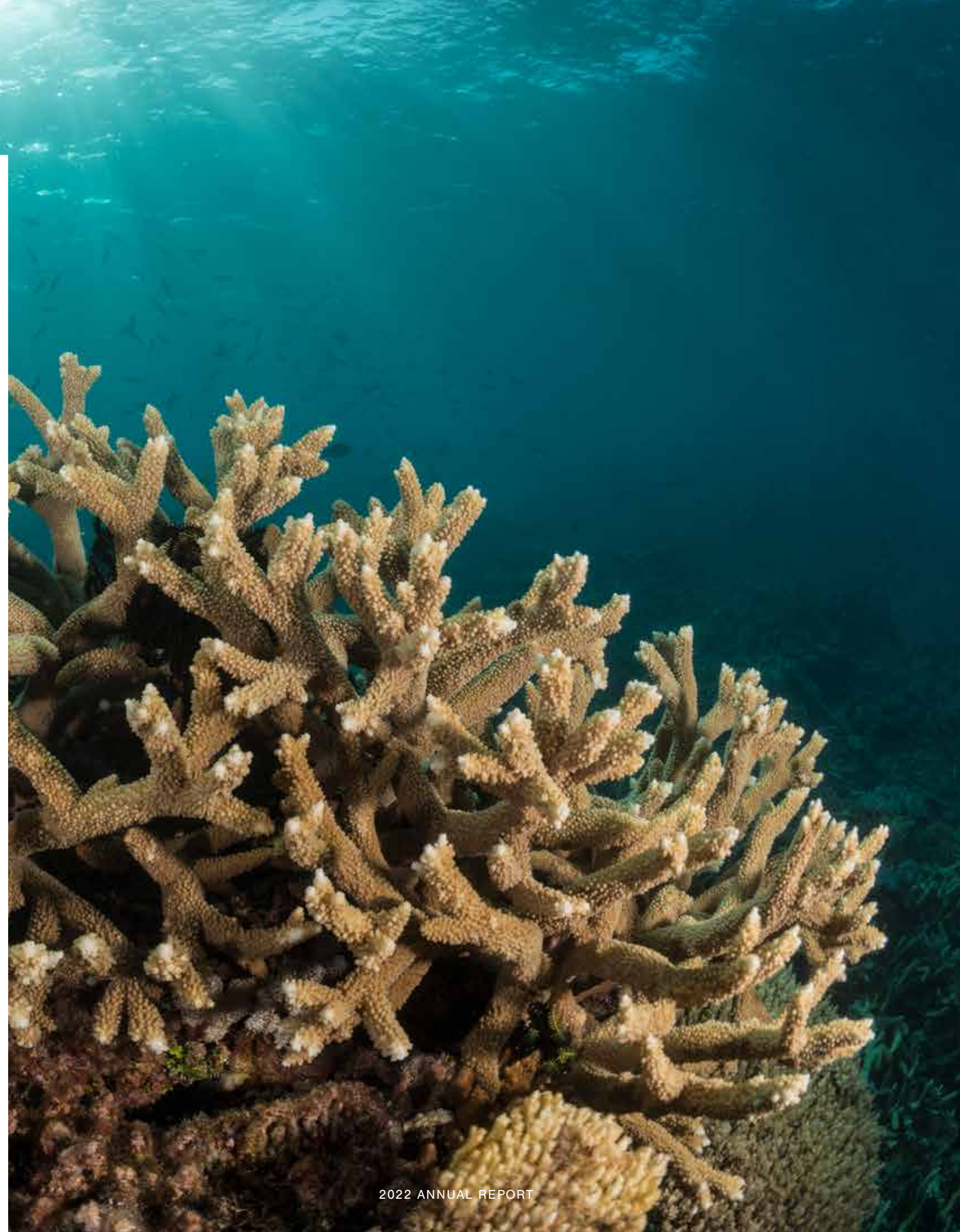
KSLOF continues to work with partners to **survey and map coral reefs** and assess their **health**.

robustness of the CoralNet machine learning platform is to enable low-skilled indigenous communities to cheaply and easily assess the state of their reefs. They can collect digital images at low cost, link to the internet, upload the images to the cloud, and have the images processed and analyzed in a way that provides data that can be used for coral reef management and scientific studies.

SUPPORTING CONSERVATION EFFORTS IN SAUDI ARABIA

Based on the foundation's expertise and vast historical database of the coral reef environment of the Red Sea, the foundation forged a new relationship with the National Center for Wildlife (NCW) in Saudi Arabia. This new partnership included data and knowledge sharing with the government agency, which they intend to use to create protected areas along the Saudi Arabian Red Sea coast.

This year, KSLOF was invited to share our work at several conferences in the Kingdom. In May, the United Nations invited KSLOF to speak at the Riyadh Blue Talk about data sharing and providing science-based solutions for conservation. The Minister of the Environment asked KSLOF to talk about threats and solutions for the sustainability of marine ecosystems on World Oceans Day. This winter, NCW welcomed us to Riyadh to speak on our experience creating management protocols for combating crown-of-thorns starfish (COTS) outbreaks and addressing the harmful effects they cause on coral reefs. These new collaborations help solidify the foundation's engagement with the new marine environmental initiatives in the region.



SCIENCE

MEASURING CORAL REEF HEALTH FROM SPACE

Our partners at the University of Miami (UM) utilized the Living Oceans Foundation's Global Reef Expedition field dataset to build a model that can predict coral cover and other metrics of coral reef health using open-source satellite data. Recently published in the journal *Coral Reefs*, the model was able to accurately predict coral and algal cover, as well as fish biomass, on islands in the South Pacific. Next year, our partners at UM plan to use the foundation's field data from the Caribbean to adapt the model for use in that region.

OCEANX RESEARCH MISSION

The foundation's Chief Scientist participated in a three-week expedition in the northern Red Sea and Gulf of Aqaba with OceanX. The OceanX research mission complemented the foundation's earlier work in the region, which we conducted 15 years ago. Whereas in 2007, the foundation focused on mapping the shallow-water reef systems of the northern Red Sea and setting a baseline for their health and vitality, the focus of the latest expedition was on the deep-water system, which extends from the mesophotic zone down to the abyssal plains of the Red Sea. This new focus allowed the underpinnings of the shallow-water reefs to be examined, and sheds light on the incredibly high diversity of reef morphology observed in the waters offshore Saudi Arabia.

CORAL REEF HEALTH INDEX

We continue to work with our partners at the University of Miami on a project that uses sediment samples collected on the Global Reef Expedition to assess the long-term health of coral reefs. This project, *Protist Prophets – Foraminifera as Global Bioindicators for Past and Present Coral Reef Health*, is funded by the National Science Foundation. Certain types of foraminifera thrive in the warm, clear waters of coral reefs, while others are more abundant in nutrient-rich waters. By looking at the types of benthic foraminifera present in the sand surrounding coral reefs, scientists can get an idea of what the conditions were like in the reef over a very long period of time.

This method could help inform conservation measures by telling us if the quality of the reef environment has changed recently, or if it has remained relatively similar for decades, centuries, or even millennia. This year, the team at UM picked through thousands of sand samples looking for the remains of foraminifera. By examining samples collected from different types of reefs in locations around the world, we will eventually be able to use this method to assess the long-term health of any tropical coral reef.

HELPING NASA MAP ALL THE CORAL REEFS IN THE WORLD

In 2021, KSLOF signed a Space Act Agreement with NASA to streamline the exchange of data and ideas between the two organizations. This agreement gave NASA access to all the foundation's coral reef maps from the Global Reef Expedition. NASA is now using KSLOF's ground-truthed coral reef maps as training data, feeding it into their NeMO-Net neural network running on the Pleiades supercomputer at NASA Ames. This system uses a combination of satellite imagery and next-generation underwater imaging technology to create detailed maps of coral reefs. This year NASA fully incorporated all of our maps into their neural network, helping to make their maps more accurate. When NASA completes its work and releases a map of all of the world's coral reefs, it will provide researchers and environmental managers with much needed information about what is happening to coral reefs and how to protect them at a time when they are experiencing unprecedented anthropogenic pressures.



2022 PUBLICATIONS

Bakker AC, Gleason ACR, Mantero A, Dempsey AC, Andréfouët S, Harborne AR, Purkis SJ (2022). "[Heat, human, hydrodynamic, and habitat drivers measured from space correlate with metrics of reef health across the South Pacific.](#)" *Coral Reefs*, 1-20.

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COMMUNICATIONS

This year, the Living Oceans Foundation made great strides in sharing the knowledge we gained on the Global Reef Expedition, presenting our work at international conferences, holding workshops, and expanding our online presence. We also formed new partnerships with like-minded organizations and worked across borders and scientific disciplines to improve the health of our oceans.

BLUE & GREEN SECURITY

This year the foundation took a more active role in promoting conservation that benefits nature and people. H.R.H. Princess Hala bint Khaled bin Sultan spoke about the importance of marine conservation for sustainable development at The Global Diwan's Blue & Green Security Forum in Nice, France. This high-level event brought together business leaders, experts, and decision-makers from Europe and the Middle East to tackle some of tomorrow's most important challenges: the environment and food security. Princess Hala spoke eloquently about her own journey into marine conservation and the foundation's work to preserve healthy oceans for current and future generations. She also called upon the global community to support efforts to conserve coral reefs and other coastal marine ecosystems before it is too late.

2ND FOUNDATIONS DIALOGUE

The Living Oceans Foundation participated in the Second Foundations Dialogue Meeting in Morocco, coming together with other ocean-focused foundations from around the world to address the major challenges facing our oceans. Organized by the Intergovernmental Oceanographic Commission of UNESCO, the Foundations Dialogue Group provides a platform for the philanthropic community to collaborate and work together to move the needle towards ocean conservation. The group seeks to address how foundations can align their efforts to achieve the bold ambitions of the United Nations Ocean Decade for Sustainable Development ('Ocean Decade'). At the meeting, KSLOF participated in a plenary session, "Uptake of Ocean Science," and spoke about how we can ensure that issues of usability and uptake are built into initiatives from the outset when we are working with local communities and managers on ocean conservation.

THE BOUKNADEL STATEMENT

KSLOF was proud to be one of 17 foundations that signed on to The Bouknadel Statement. This joint statement was launched at the 2022 United Nations Ocean Conference in Lisbon, Portugal to raise awareness of the need to increase investment in ocean science to support sustainable development. The members of the Foundations Dialogue launched The Bouknadel Statement to affirm their commitment to invest in transformative ocean science. It recognizes the central role of the ocean in human health, safety, and wellbeing, and encourages the philanthropic community to increase their support of marine science and conservation. It also calls for foundations to recognize their unique role in supporting the co-design and communication of ocean science and urges them to help meet the ambitious goals of the Ocean Decade.

PROFESSIONAL PRACTICE

This year, the foundation partnered with the International Master of Science in Marine Biological Resources (IMBRSea) program to help students gain real-world experience in marine science communications. This program connects master's students from 11 European universities with organizations working in marine science and conservation. The communications team hosted two professional practice students in 2022. One created ESRI StoryMaps to showcase our mapping products from the Global Reef Expedition, while the other made compelling and engaging content for KSLOF's social media channels.



2021 United Nations Decade
2030 of Ocean Science
for Sustainable Development

COMMUNICATIONS

INTERNATIONAL CORAL REEF SYMPOSIUM

In July 2022, the Khaled bin Sultan Living Oceans Foundation presented our work at the [International Coral Reef Symposium \(ICRS\)](#). ICRS only happens once every four years and brings together coral reef scientists and managers from around the world to share the latest coral reef science, technology, and outreach efforts. Due to the highly competitive nature of the conference, having presentations accepted from all of our staff and partners at the University of Miami was a major accomplishment. It highlights the importance and value of the work the foundation has been doing for the past several years.

The foundation presented on the following topics:

- **Exploring the extremes - unexpected findings from the world's largest coral reef surveying effort** highlighted the unique discoveries made on the Global Reef Expedition and the significant scientific findings presented in the Global Reef Expedition Final Report.
- **The importance of educating youth to inspire the next generation of coral reef stewards** covered the many educational programs KSLOF developed to improve ocean literacy and teach students about coral reefs and mangrove forests.

- **World Reef Map: A high-resolution mapping tool for marine spatial planning in remote regions of the world** shared the online mapping portal KSLOF developed to showcase our coral reef maps from the Global Reef Expedition and the many tools it has available for scientists and managers to use in marine spatial planning.
- **Lessons learned from ten years communicating coral reef science around the world** discussed the different ways the foundation communicates science to make it understandable and reach audiences beyond the academic community.
- **Modelling and mapping local-to-regional scale coral reef health and resilience in the South Pacific** explained the development a coral reef resilience model using data KSLOF collected on the Global Reef Expedition.
- **High-resolution habitat and bathymetry maps for 65,000 km² of Earth's remotest coral reefs** shared the methodology used to create KSLOF's coral reef maps on our World Reef Map and the value of producing high-resolution habitat maps.
- **Global-scale evidence for human impacts on coral reefs** showcased how data collected on the Global Reef Expedition is being used to identify the magnitude of human impacts on coral reefs worldwide.
- **Amphistegina foraminifera are excellent bioindicators of long-term heat stress on tropical and high latitude reefs** covered what benthic foraminifera can tell us about the past, present, and future of coral reefs.

This conference was a huge success and provided the foundation with the opportunity to connect with colleagues, learn about new coral science and outreach initiatives, and share our work with the global coral reef community. Conferences like ICRS are highly beneficial for creating new partnerships as we work toward our larger goals of coral reef conservation.



EDUCATION

SCIENCE WITHOUT BORDERS® CHALLENGE

The *Science without Borders® Challenge* 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 10th annual Science Without Borders® Challenge. The theme for this year's Challenge was "Ridge to Reef." Everything is interconnected from the land to the sea. For this year's theme, students were asked to create a piece of art that illustrates one or more actions that governments, non-profits, park managers, and indigenous communities can take to preserve coral reefs using a 'ridge to reef' approach to conservation.

The Challenge is judged in two categories, one for students ages 11-14, and another for students ages 15-19. Overall, the foundation received 510 submissions from 49 different countries. This was the first time the foundation received submissions from students in The Bahamas, Guatemala, Honduras, Myanmar, Serbia, and Turkmenistan.

First place in the category for students 11-14 years old went to 12-year-old Amy Hyobin Pyo from New Jersey, United States of America. Her piece, *Coral Reef in the*

Bosom of Their Mother, shows how coral nurseries can be an important tool in coral reef conservation. Amy said she wanted to use her artwork to "send a message to the world that corals are in danger, and how people are saving them." She hopes her artwork inspires people to help coral reefs in their daily lives.

Yeon Jae Lee won first place in the category for 15-19 year old students for her stunning artwork, *Rooted in the Ocean*. A 16-year old from Korea, Yeon's artwork illustrates how planting trees helps to provide clean, clear water to coral reefs, allowing them to thrive. Yeonjae said that she learned a great deal about the connection between the land and the sea by participating in this contest. "It made me realize that without physically going to the ocean, there are countless ways that we can take action on land," she said.

For the first time, the foundation implemented a new prize category for the contest called the People's Choice Award. Anyone could vote for their favorite images on the foundation's Facebook page. A winner was chosen from each of the age groups, 11-14 and 15-19, and awarded a \$50 prize.

This competition introduced students around the world to ridge-to-reef conservation that can be used to preserve critical coastal marine ecosystems. 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.

First Place, ages 11-14:



"CORAL REEF IN THE BOSOM OF THEIR MOTHER"

by Amy Hyobin Pyo
Age 12
New Jersey, USA

First Place, ages 15-19:



"ROOTED IN THE OCEAN"

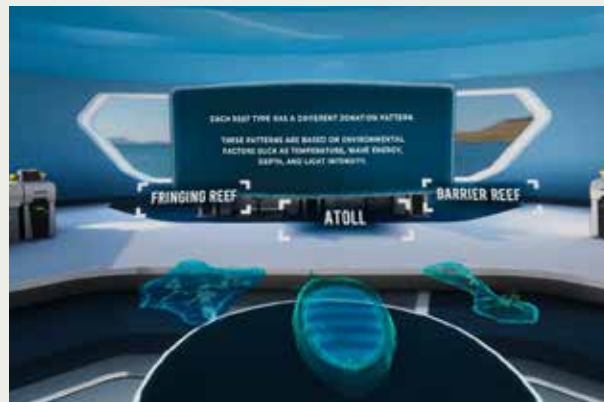
by Yeonjae Lee
Age 16
Republic of Korea

EDUCATION

MANGROVE EDUCATION & RESTORATION

The foundation's [Mangrove Education and Restoration Programs](#) were halted due to the COVID-19 pandemic. Thankfully, after a two-year postponement, we were able to resume our [Jamaica Awareness of Mangrove in Nature \(J.A.M.I.N.\)](#) program this year. KSLOF continued to partner with Alligator Head Foundation and the University of the West Indies Discovery Bay Marine Lab to bring this immersive, experiential education program to high school science students in Jamaica. J.A.M.I.N. is being implemented again in Port Antonio and William Knibb High Schools, and Happy Grove High School entered the program for the first time since its inception. This year KSLOF also welcomed Saskia Schmöle from the University of Bremen, who is conducting her master's thesis on the effectiveness of the J.A.M.I.N. program

This year the foundation completed the Mangrove Development, Education, Awareness, and Livelihoods ([Mangrove DEALs](#)) grant with our partners at the Alligator Head Foundation. This program expanded our mangrove education and outreach efforts in Jamaica by providing workshops to key stakeholders including students, 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.



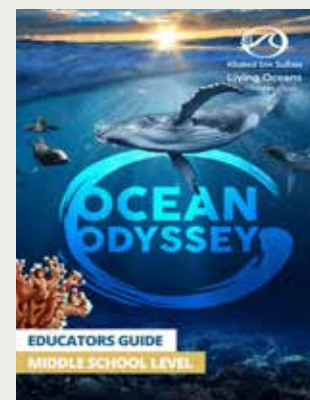
OCEAN LITERACY

In an effort to increase ocean literacy, the foundation continued to develop educational resources for our [Education Portal](#), which hosts our robust *Coral Reef Ecology Curriculum*. The foundation launched two new units this year: [Food Webs](#) and [Conservation](#). The Jerome S. & Grace H. Murray Foundation generously supported the foundation in this endeavor.

The foundation, along with our partners Dr. Ryann Rossi and the Bahamas Marine Mammal Research Organisation (BMMRO), received a grant from the [National Geographic Society](#) to develop curriculum on the impact of the COVID-19 pandemic on wildlife. The curriculum contains teacher lesson plans, activities, and short videos which focus on the effect of marine noise pollution on sperm whales. This curriculum will be housed in the *Coral Reef Ecology Curriculum's Behavior* unit which will be released in 2023.

With our partners at the University of Miami (UM), and support from the UM Magic Leap grant, we created a virtual reality (VR) application that takes users on a [virtual field trip](#) to learn about coral reef types and their zonation patterns. This immersive educational experience is the first of its kind for the foundation, adding an innovative learning technology to our *Coral Reef Ecology Curriculum*. The VR application will be available for the public to use in early 2023.

This year the foundation developed an educator's guide called "[Little Creatures with a Big Message](#)," with support from a grant from the National Science Foundation, which we received with our partners at UM. These lesson plans amplify math and science skills among middle and high school students, use real-world contexts and problem-based learning to increase ocean literacy, and support teachers integrating STEM (science, technology, engineering, and math) into their classrooms using UM's important research on a type of plankton called foraminifera. In the next two years of the grant, these educational resources will be vetted with students and teachers and shared with classrooms around the world.



OCEAN ODYSSEY EDUCATOR'S GUIDE

This year the foundation released an educator's guide for middle school students (grades 6-8) in partnership with K2 Studios to accompany their IMAX® film, [Ocean Odyssey](#). The film is narrated by legendary oceanographer and conservation icon Dr. Sylvia Earle. The free guide contains lesson plans, worksheets, and grading rubrics that teachers can use in their classes to delve into important educational and conservation topics in the film.

CONSERVATION

UN OCEAN DECADE PROJECT

This year, the foundation's newest project, [Science Without Borders®: Conserving the Tropics](#), was endorsed by the United Nations (UN) as an official Ocean Decade Action. This prestigious endorsement from the Executive Secretary of UNESCO's Intergovernmental Oceanographic Commission (IOC) highlights the value of our work to help communities protect and restore ocean health.

Our *Science Without Borders®* project aims to help communities leverage scientific data, resources, and technologies to conserve their tropical marine ecosystems and resources. Through applied science, outreach, and education, the project will provide science-based solutions to help communities protect coral reefs, mangrove forests, and seagrass beds. We will also work with communities to establish best practices for management plans, train community members to collect scientific data, improve ocean literacy, and expand our existing education and restoration programs to more communities and schools around the world.

This project expands upon our work on the Global Reef Expedition, taking what we learned and using it for conservation. It will tie in the close partnerships we have developed over the past several years with the University of Miami, the Pacific Blue Foundation,

and NASA to advance science, as well as the Alligator Head Foundation in Jamaica to advance ocean literacy. Combined, the project will allow us to use the science and technology we developed on the Global Reef Expedition and teach communities how to apply this to their conservation efforts. We will also help to improve ocean literacy at a community level, not just focusing on kids but instead providing knowledge and skills to the communities on how to take an active role in the monitoring and conservation process. This project will work with local governments, NGOs, universities, community leaders, and the public to create low-cost sustainable marine conservation plans that can be implemented at a local level.

The project was one of several dozen projects that were endorsed this year at the United Nations Ocean Conference, which was a huge accomplishment. We are very excited to be part of such a prestigious group. Since the endorsement was announced, we have held meetings with potential partners and funders, and have applied for several grants to get seed funding. We are actively looking for partners and funders interested in bringing this program to your community.

GLOBAL REEF EXPEDITION WEBINAR SERIES

In 2022 the Living Oceans Foundation launched a new webinar series to share our knowledge from the Global Reef Expedition directly with organizations that could use it for coral reef conservation.

We held the first webinar in August in partnership with SPREP, the Secretariat of the Pacific Regional Environmental Programme. We presented our findings from the Global Reef Expedition, shared the maps and data resources we have available, and discussed the conservation implications of our work with scientists and marine managers from several countries we visited on the GRE. This webinar not only allowed us to share our findings from the GRE directly with people influencing conservation decisions, but it also allowed us to reestablish ourselves in the South Pacific region.



FINANCIAL STATEMENT

KHALED BIN SULTAN LIVING OCEANS FOUNDATION

STATEMENT OF FINANCIAL POSITION

As of December 31, 2022

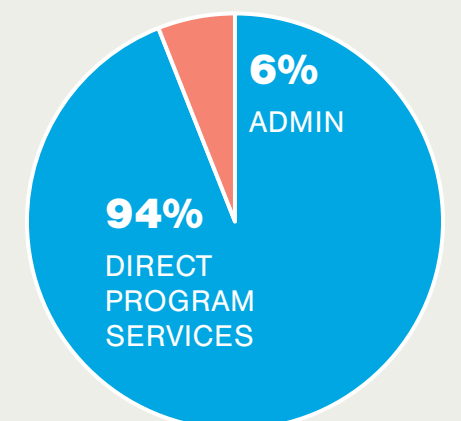
	TOTAL
ASSETS	
Current Assets	
Cash and cash equivalents	\$350,299
Prepaid expenses	\$1,868
Receivables - other	\$1,581
Total Current Assets	\$353,747
Furniture and Equipment	
Furniture and equipment, net	\$6,117
TOTAL ASSETS	\$359,865
LIABILITIES AND NET ASSETS	
Current Liabilities	
Accounts payable and accrued expenses	\$152,242
Grants payable	-
Total Current Liabilities	\$152,242
TOTAL LIABILITIES	\$152,242
Net Assets	
Without donor restrictions	\$207,623
TOTAL NET ASSETS	\$207,623
TOTAL LIABILITIES AND NET ASSETS	\$359,865



MANY THANKS TO OUR DONORS

PRINCE KHALED BIN SULTAN
 DR. MOHAMED FAISAL
 JEROME S. & GRACE H. MURRAY FOUNDATION
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 THE NATIONAL GEOGRAPHIC SOCIETY
 THE NATIONAL SCIENCE FOUNDATION
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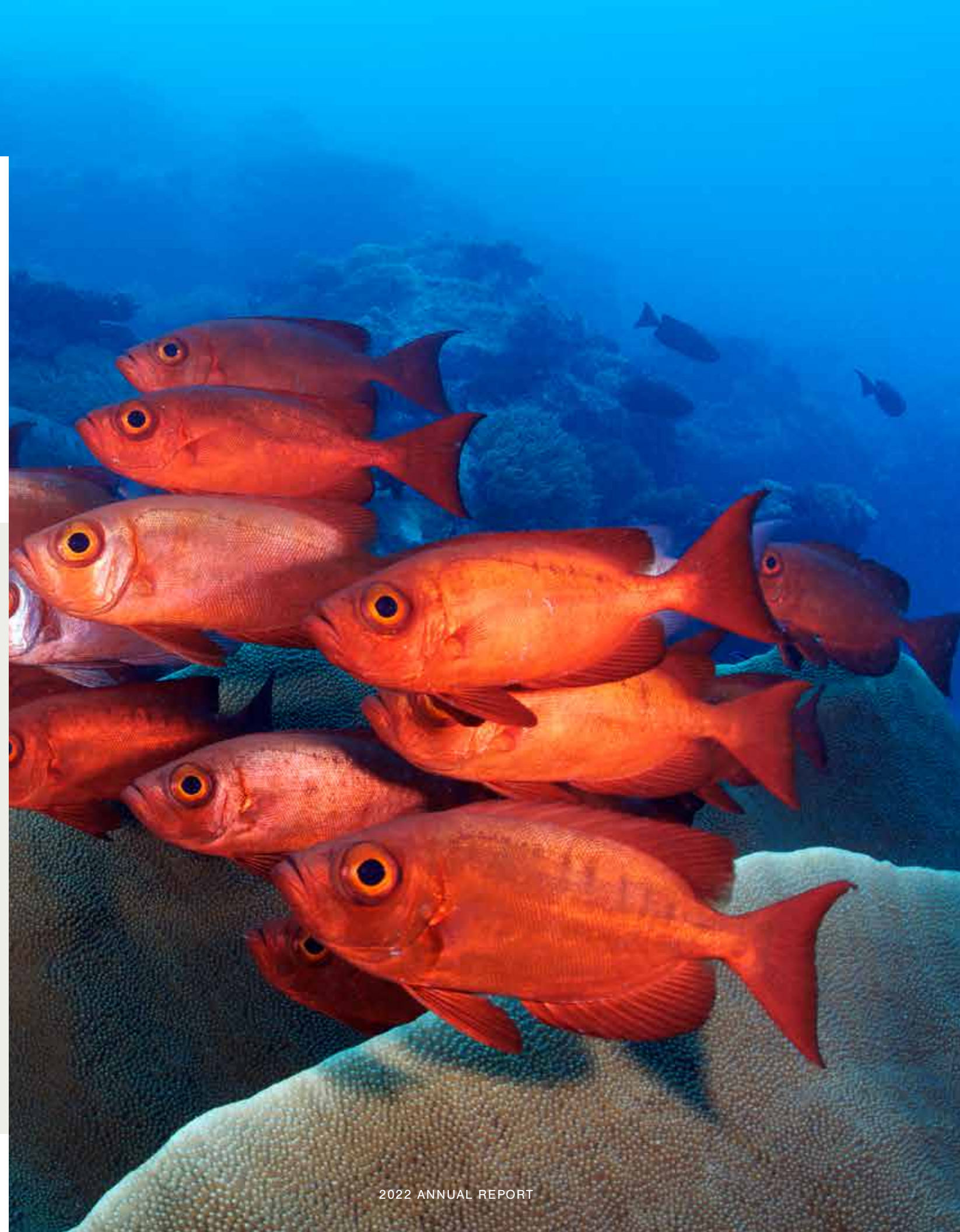
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STAFF

STAFF



SAM PURKIS, PH.D.
Chief Scientist



ALEXANDRA DEMPSEY
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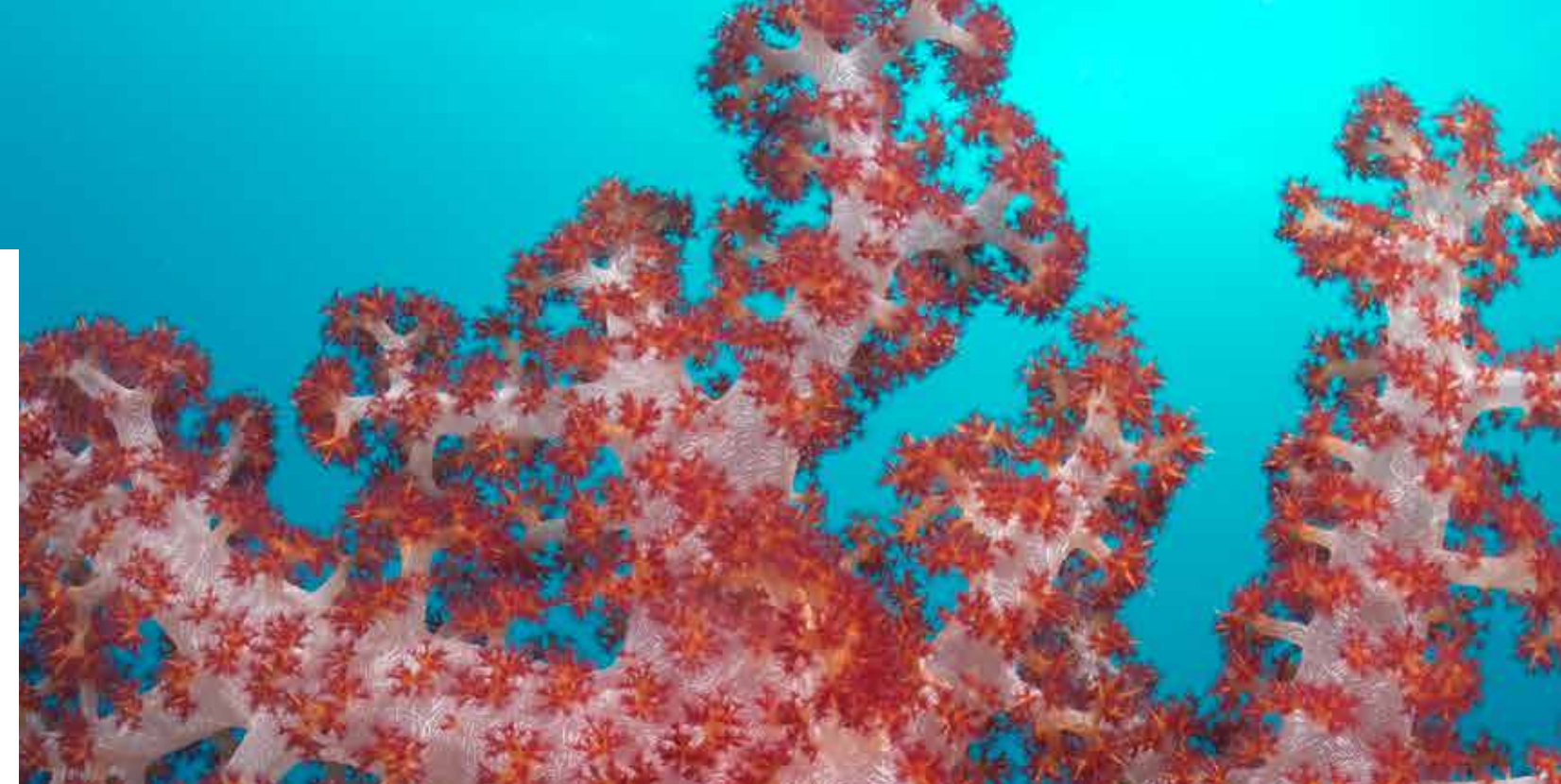
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Director of Education



RENÉE CARLTON
Marine Ecologist



LIZ THOMPSON
Director of Communications



2022 BY THE NUMBERS

- 357,000** SOCIAL MEDIA REACH
- 147,000** WEBSITE VISITORS
- 30,000** EDUCATION PORTAL USERS
FROM **130** COUNTRIES
- 1750** WORLD REEF MAP USERS
- 861** SAND SAMPLES PICKED
- 650** MANGROVES PLANTED
- 510** SWB CHALLENGE STUDENTS
FROM **49** COUNTRIES
- 168** J.A.M.I.N. & B.A.M. STUDENTS
- 107** REEF TRANSECTS ANALYZED
- 21** NEMO-NET GENERATED HABITAT MAPS
- 14** NEW CURRICULUM RESOURCES
- 12** TALKS & PRESENTATIONS
- 11** MANGROVE WORKSHOPS
- 10** KM² OF REEFS MAPPED
- 8** SCIENTIFIC PAPERS
- 1** PROJECT ENDORSED BY THE UN

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