SOLUTIONS

As a frequent participant of international ocean conferences, I have always marveled at the intelligence and commitment of fellow delegates—dedicated to posing the most critical questions and pursuing the most complicated concepts and ideas about how to understand and address the critical issues facing the world ocean. It has been always humbling, so much talent focused on such a big problem.

What has been the outcome of this focus? Certainly, the ocean sciences have advanced, specifically through expanded research, a global system of observation—underwater, on the surface, and from space. The accumulation of data has expanded exponentially. Ocean policy has also advanced, at least in theory and design. The implementation of these creative efforts has been sporadic and prolonged by a need for consensus, political buy-in, and confrontation with vested interests that would prefer to see things remain just as they are.

As an impatient type, my reaction to these events has become more frustrated by the prolongation of the discussion, the endurance of problems left unaddressed by solutions. Again and again, it might seem as if the conversation and good intent was to be the best we could do, and the critical issues were to be left to aspiration and hope that we would soon turn from word to deed.

The focus of this volume of World Ocean Journal is *solutions*: real

ideas and inventions that are being developed and applied around the world by entrepreneurs and innovators, to direct action through enterprise and commitment to transformational change *now* —in spite of the awkward and unresolved delays by theorists and bureaucrats. What is happening here is the work of *change*, the project-by-project application of data, imagination, energy, and action directly in, on, and by the ocean as an expression of new values and determined commitment to a future that works.

I find true optimism in these specific endeavors. Each of the individuals, organizations, and projects described in this volume are a true expression of dedication to the viability and utility of the ocean as a global resource for the benefit of all mankind.

On the following pages you will find examples of the application of the wisdom in Nature to mimic processes and products; of world economic leaders enabling start-ups and alternative financing models; of fresh ideas generated

by young people—some still in high school—dedicated to building their future if no one else will; and effective tools for observation, measurement, analysis, visualization, and communication of data in novel formats to enable new value propositions and practical strategies for response to changing environmental conditions and to engage public awareness. Most of these examples exist in an information vacuum, mostly unknown, but driven by the enthusiasm of their inventors. Gathering them here has been an exhilarating task, and we trust you will share our regard and support for each one as unique progress forward to the conservation, sustainability, and future value of the ocean for human survival.

And here is the best news: we found so much of this creative thinking and so many of these fresh ideas and actions that we are already assembling Part 2 of *Solutions* to be published in the first quarter of 2021.

Let's celebrate invention!

Peter Neill is founder and director of the World Ocean Observatory. His latest book, *Aqua / Terra: Reflections on the World Ocean* is scheduled to be released in Spring 2021.

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PART 2 OF THE *SOLUTIONS* SERIES

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SUSTAINABLE SOLUTIONS FOR A BALANCED ECOSYSTEM

Examples of problem-solving, nature-inspired designs

from the Biomimicry Institute

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How marine habitats are informing new concrete designs

WEREWOOL
Protein structures found in nature creating textiles without dyes, finishes and synthetics

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Developing lighter, stronger, and more impact resistant composites based on the mantis shrimp

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Soft robotics inspired by marine species--providing infinite range of motion

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Developing plastic pollution capture technology by mimicking ocean filter feeders

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INSTABUFF
Mitigating nutrient loading blue-green algae to capture water and encourage plant growth

YOUTH DESIGN CHALLENGE

TIDAL KITE: PASSIVE CONTROL SYSTEMS FOR ENERGY GENERATION
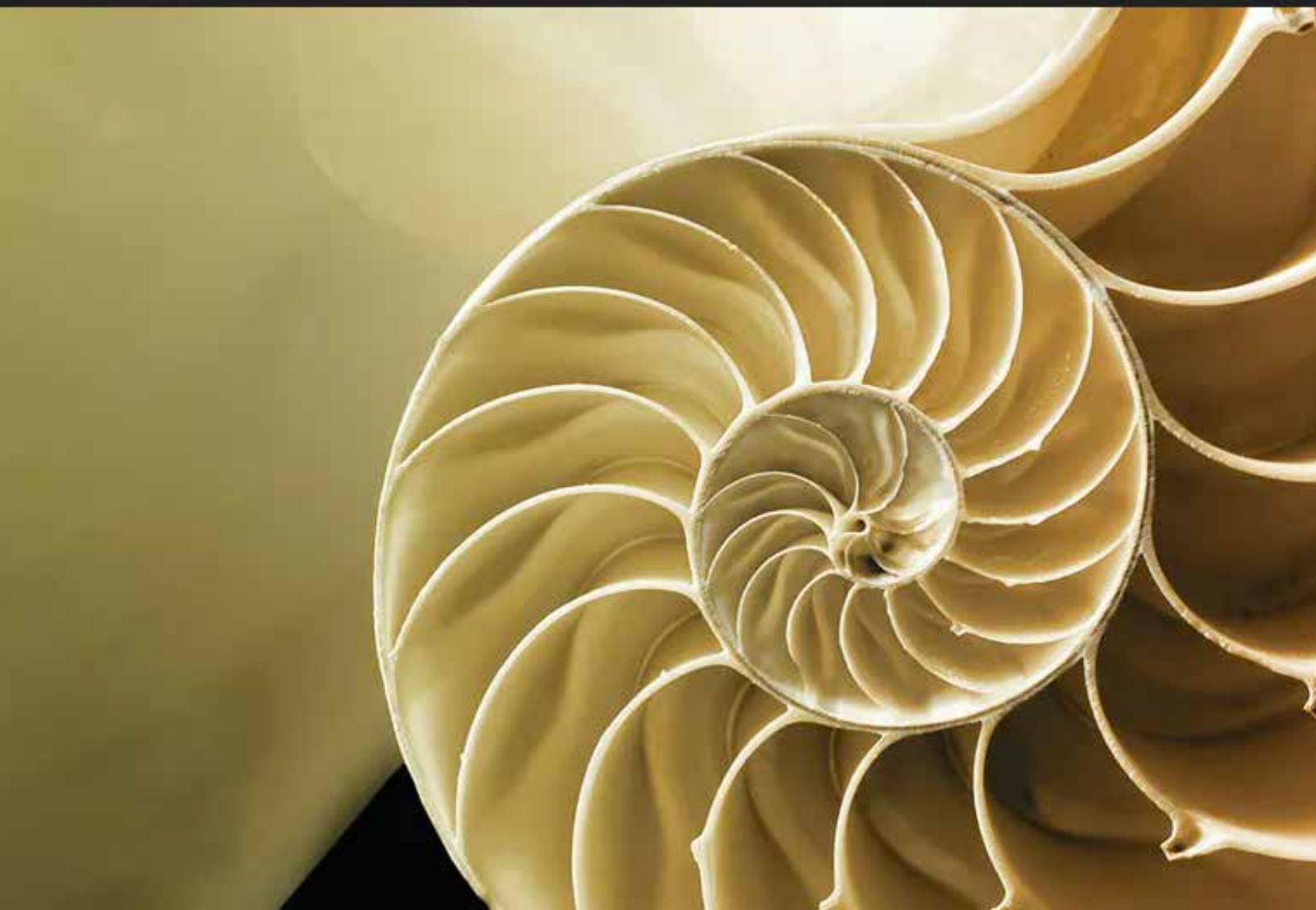Looking to nature to design tidal kites for reducing greenhouse gasses worldwide

THE BAYPROTECTOR
Removing nitrogen from stormwater using ion exchange resin beads

REEF GUARD
Protecting coral reefs using webs inspired by the Orb Weaver spider

WHAT IS BIOMIMICRY?

BIOMIMICRY INSTITUTE

ECOncrete: How marine habitats are informing new concrete designs

ECOncrete offers products that facilitate the growth and regeneration of local marine species and strengthen structures over time through a process known as bioprotection. Inspired by beach rock formations, coral polyps, oyster shells, mangrove roots, and other marine habitats and life forms, ECOncrete embodies biomimicry's design intention: to learn from and mimic forms and processes found in nature to create regenerative solutions.

PROBLEM AND OPPORTUNITY

With more than 50% of the world's population concentrating along coastlines, accelerated coastal development inflicting severe stress on natural ecosystems is inevitable. Combined with growing threats of sea level rise and increased extreme weather events, coastlines worldwide require development, retrofitting and intensive maintenance, generating a multibillion dollar market for ECOncrete's products

SOLUTION

ECOncrete's patented technology is based on three science-based elements that work in synergy to mimic nature and create habitats for native marine organisms: concrete composition, surface texture & 3D design. Bio-enhancing admix and designs induce a layer of biogenic

buildup that makes the concrete stronger and more durable in a process called *Bioprotection*. This technology can be used to create different structures like seawalls, breakwaters, bridge foundations and urban waterfronts.

BIOMIMICRY IN PRACTICE

ECOncrete's vision is to change the way future coastlines look and function minimizing destruction of local habitats. They draw inspiration from marine habitats and life forms, harnessing natural processes for the benefit of coastal ecosystems and infrastructures, mimicking forms, textures and chemical properties from beach rock formations, rocky reefs, tide pools, mangrove roots, and ecosystem engineering species like oysters, corals and tube worms.
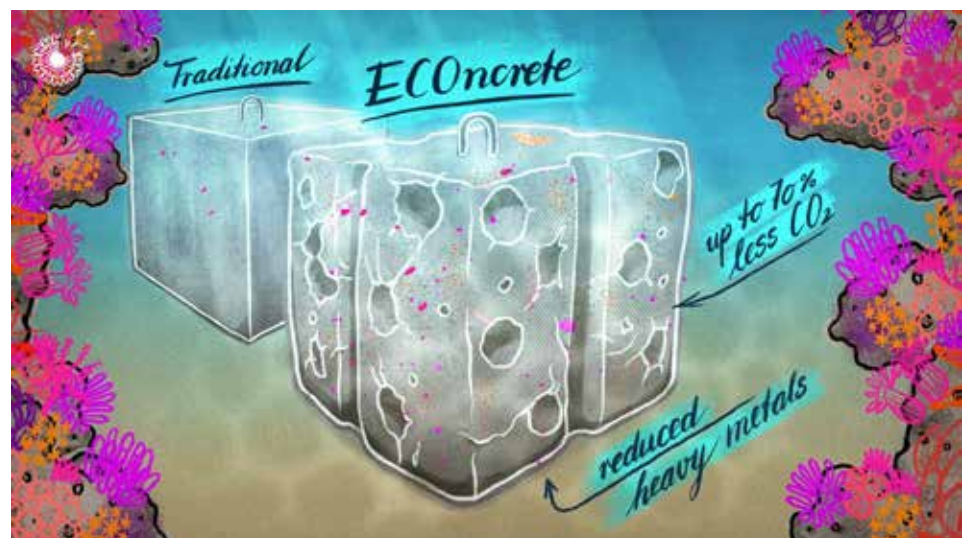
FMI about ECOncrete visit econcretetech.com

Werewool: Redesigning textiles for a circular economy

*Inspired by nature, and utilizing the tools of biotechnology, **Werewool** is developing a platform to design fibers at the DNA level for sustainable textiles with inherent properties such as color, moisture management, and stretch, that meet the demands of today's consumers.*

PROBLEM AND OPPORTUNITY

The global textile market, worth $925.3 billion, produces 1.2 billion tons of CO_2 equivalent per year, and uses textile dyes that are responsible for 20% of global wastewater. The industry depends on petroleum based synthetic fibers that account for 35% of global microplastic pollution.

SOLUTION

Werewool fibers minimize a brand's environmental footprint throughout their supply chain, decreasing water, land and energy use, and end of life impacts of their products. Werewool has filed a provisional patent on their prototype fibers – vibrant, and naturally fluorescent protein composite fibers that rely on structural proteins instead of dyes and pigments. Still early in the development stage, Werewool is optimizing their fiber composition to ensure scalability of the fiber production process that prioritizes the environment, while meeting the demands of today's consumer.

BIOMIMICRY IN PRACTICE

Nature's organisms have evolved structural proteins to support their ability to survive. For example, the Discosoma Coral depends on the structure of RFP (red fluorescent protein) as a source of colorant to support a symbiotic relationship with an algae to survive. Werewool is emulating proteins found in nature to create natural color, and apply it to create textiles without the use of dyes or pigments.

FMI about Werewool visit werewool.bio

BIOMIMICRY INSTITUTE

Helicoid Industries is making lighter, stronger and more impact resistant composites based on the mantis shrimp.

Helicoid composites apply the same internal architecture found in the mantis shrimp's extremely durable club, reducing raw material use while creating lighter, more energy efficient components at an overall lower production cost.

PROBLEM AND OPPORTUNITY

The composite industry is constantly looking for ways to increase performance, reduce consumption of expensive raw materials and make lightweight, tougher products. For example, doubling the length of a wind turbine blade will quadruple the energy output; reducing the weight of automobiles by 10% can result in 6-8% fuel economy improvement; and lighter aircrafts result in reduced fuel costs and a lower carbon footprint. Lightweight, stronger and more impact resistant composite materials will revolutionize the industry and provide meaningful benefits.

SOLUTION

Using the Helicoid architecture in any composite material or product provides numerous benefits, including reduced weight, increased strength, increased toughness, improved impact resistance, and reduced material costs. Helicoid works seamlessly with existing manufacturing processes, allowing any composite industry to use less material, while making a stronger product.

BIOMIMICRY IN PRACTICE

The "smasher" Mantis shrimp evolved an internal architecture to protect the hammer-like club it uses to pulverize prey with incredible speed and force. The unique architecture, called a helicoid, protects the mantis shrimp from self-inflicted damage as it crushes hard-shelled prey. The architecture prevents cracks from expanding, minimizes damage propagation and ultimately dissipates significant amounts of energy from strikes to avoid catastrophic failure.

The "smasher" Mantis shrimp evolved an internal architecture to protect the hammer-like club it uses to pulverize prey with incredible speed and force.

Watertower Robotics

are bringing soft robotics to the world to reduce the water currently lost through deteriorating municipal water pipe infrastructure.

PROBLEM AND OPPORTUNITY
Water loss threatens every part of the planet. It is a global problem requiring a new approach. WaterTower Robotics aims to make water distributions safer and more efficient. Their soft body and tether-less robots find leaks in water distribution pipes and can run inspections without interruption to water service at the municiple level.

SOLUTION
Through their cloud-based analytics, Watertower has created a "google maps of pipes" highlighting leaks, informing pipe operators of the location and size of leaks, and the likelihood of catastrophic failure.

BIOMIMICRY IN PRACTICE
Watching how octopus and jellyfish move and behave has inspired the design of soft robotics.

OCTOPUS
Inspired by their strength and flexibility

HOW IT WORKS IN NATURE
As invertebrate, the absense of bone structure and shell allows them almost infinite range of motion.

HOW IT WORKS FOR ROBOTICS
Watertower Robotics has created a robot flexible and adaptable enough to maneuver complex pipe networks, and stays in contact with pipe walls to more easily identify leaks in a similar way to how octopus tentacles leverage their suckers.

MOON JELLYFISH
Inspired by their swimming efficiency

HOW IT WORKS IN NATURE
Able to propel itself through water by contracting and relaxing its umbrella-shaped bell, creating its own current. Moon jellyfish use 48% less energy than any other swimming animal.

HOW IT WORKS FOR ROBOTICS
Watertower robots leverage the current created by a pipe's operational flow to propel itself with its umbrella-shaped connection without a need to expend any energy as it travels.

Cephalopod, Lisbon, Portugal
credit: Isabel Galvez

GLOBAL DESIGN CHALLENGE

BIOMIMICRY INSTITUTE

The Biomimicry Global Design Challenge is an annual competition that asks teams of students and professionals to address critical global issues with nature-inspired solutions.

Floating Coconet aims to capture plastic pollution in rivers before it has the chance to enter the oceans.

By mimicking the way organisms like manta rays and basking sharks filter food from water, Floating Coconet of The Hague University of Applied Sciences in Hague, Netherlands, is able to collect and direct free-flowing plastics, small and large in size, in rivers for safer capture.

WHAT PROBLEM DOES THIS SOLVE?

The primary goal of Coconet is to prevent plastics from entering the ocean. This is achieved by both collecting the plastics from the rivers and preventing them from polluting the rivers at all.

WHAT IS THE TECH AND HOW DOES IT WORK?

Coconet is a filtration system mimicked from (primarily) the Manta Ray. This mechanism consists of rows of adjustable fins at an angle that are able to direct water flow in a certain direction, based on the position of the fins. The natural flow of the river is being used to deliver a consistent run of water through these fins. This water flow, combined with the angle of the fins, will create a turbulence. This turbulence will then be used to capture and trap the plastics in the water.

Biomimetic Land-Ocean Treatment System (BLOTS)

looks to marine organisms for water management inspiration

As sea levels rise, coastal regions and cities are experiencing more and more flooding. It is estimated that by 2100, sea levels could rise by a foot. BLOTS looks to numerous organisms for water management inspiration in order to find an adaptable and resilient way to deal with infrastructure being inundated with water. The BLOTS system absorbs, redirects, filters, and stores flood water. The system is adaptable to any situation, whether it be a flooded street, playground, or building, and can be utilized by anyone.

WHAT PROBLEM DOES THIS SOLVE?

As climate change progresses, coastal regions and cities will further feel the effects of sea-level rise caused by the melting glaciers and ice caps. These regions are experiencing "sunny day flooding", where the sea-level rise regularly pushes high tide levels past the point that coastal infrastructure was designed to accommodate. It is estimated that by 2100, sea levels could rise by a foot.
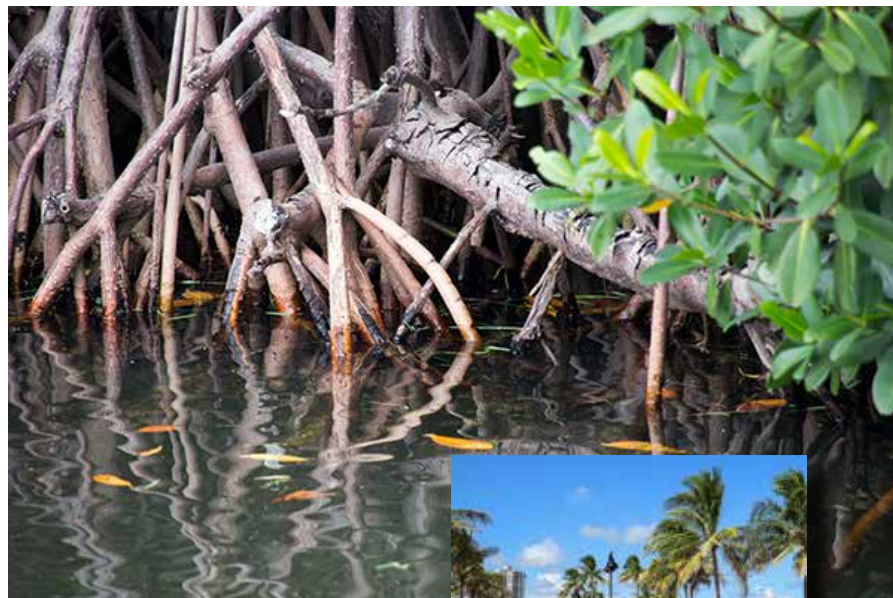
WHAT IS THE TECH AND HOW DOES IT WORK?

BLOTS is based on our observations of organisms that are experts in absorbing, directing, filtering, and storing liquid. The system is adaptable to any situation, whether it be a flooded street, playground, or building and can be utilized by anyone. The design is accompanied by a mobile app that alerts residents to areas that are flooding and directs people (via GPS embedded in the components) to where available units are located. In this way, residents are empowered and able to self-organize. After capturing the water, it is passively directed away from the flooded area and then has the capability of being filtered and/or stored locally or directed to waste/stormwater facilities for future use. An unintended consequence of the shoreline moving further inland is that water treatment facilities and water lines can be compromised, making useable water in demand. BLOTS has the capability to attach filter components to the system in order to remove particulates. Human's effect on the planet has caused disturbances that our way of life is not prepared for, leaving many people feeling helpless. It can be part of a solution that allows communities to adapt to these climate change impacts.

BIOMIMICRY INSTITUTE

Instabuff

Mitigating nutrient loading in water bodies that lead to blue-green algae blooms

Blue-green algae blooms have been occurring in reservoirs, lakes, and oceans at increasing rates around the world. These blooms deplete oxygen in water bodies and can release liver and neurotoxins, as well as negatively impact ecosystems, health, recreation opportunities, and drinking water supplies. InstaBuff is a layered mat inspired by several organisms that filters nutrients, holds water, collects sediment and promotes plant growth.

WHAT PROBLEM DOES THIS SOLVE?

This innovation targets the mitigation of nutrient loading in water bodies, which leads to toxic blue-green algae blooms. One of the best existing strategies is the creation of riparian buffers, but the challenges of erosion control, installation costs, and time for ecological services to mature are major deterrents of its use on a larger scale. The strategy with the Instabuff will hopefully create a more robust riparian buffer that effectively prevents erosion and retains nutrient runoff immediately after installation, and is cost effective and easier to install.

WHAT IS THE TECH AND HOW DOES IT WORK?

The Instabuff is a biodegradable, roll-out mat with seeds incorporated into the fabric, along with phosphorus-absorbing and water-retaining compounds. The geometry of the material is formed specifically to capture water and nutrients to facilitate growth of riparian plants, and to biodegrade upon maturation of the buffer plants. It aims to be a cost-effective way to install a riparian buffer to mitigate erosion and nutrient loading.

The Biomimicry Global Design Challenge is an annual competition that asks teams of students and professionals to address critical global issues with nature-inspired solutions. The challenge is hosted by the Biomimicry Institute. Challenge finalist teams are invited to join the Biomimicry Institute's Launchpad for an opportunity to turn their idea into a reality.

The Earth is constantly changing, but the rapid climate and ecological changes humans have set in motion in the last century are like nothing any species has experienced before. Hungry for energy, food, and other resources, our growing populations are pushing Earth's systems toward a frightening and well-documented tipping point. The science is clear and so is our imperative. To reverse course, we need a new generation of innovators who know how to create human materials, products, and systems that are regenerative, circular, and generous to all species.

The challenge is this: Create a nature-inspired innovation (a product, service, or system) that aligns with one or more of the following Sustainable Development Goals, outlined by the United Nations. Do you think you have what it takes to create a winning biomimetic design? Rally your team and register for the next challenge:

challenge.biomimicry.org/en/challenge/global-design-challenge-2020

YOUTH DESIGN CHALLENGE

BIOMIMICRY INSTITUTE

About the Challenge

The Biomimicry Youth Design Challenge is a project-based learning experience that asks middle and high school teams to design bio-inspired ideas that can provide solutions to the climate crisis. It provides a framework for formal and informal educators to introduce biomimicry as an engineering design strategy, to integrate relevant purposeful STEM experiences, and to provide engaging instruction aligned to the Next Generation Science Standards.

Passive Control Systems for Tidal Kite Electricity Generation

First Place High School Winner

WHAT PROBLEM DOES THIS IDEA ADDRESS AND HOW IS IT RELATED TO CLIMATE CHANGE?

Electricity production is one of the largest contributors of greenhouse gasses worldwide. Many techniques for generating clean electricity have been devised including ocean-based systems such as tidal kites which, due to their ability to generate electricity from low-velocity currents, have the potential to revolutionize ocean-based energy generation. There are, however, several issues, particularly when it comes to reliable control systems, that must be addressed before these kites are ready for wide-scale deployment. For that reason, the team looked to nature in order to design a passive control system for tidal kites that maintains high levels of stability.

WHAT DOES THE SOLUTION DO, AND DOES IT SOLVE OR IMPROVE THE PROBLEM ADDRESSED?

This passive control system maintains kite stability while allowing the kite to achieve high-speed spirals when flown across a current. The spiral motion is created due to a small level of asymmetry between the wings of the kite which causes one side to produce less lift than the other. Stable flight is attained through several mechanisms including swept wings which allow for pitching stability, washout in order to prevent stalling and undesired spinning, and, perhaps most importantly, dihedral wing angle which brings considerable spiral stability.

HOW WAS THIS SOLUTION INSPIRED BY NATURE? WHAT ORGANISMS WERE STUDIED? WHAT WAS LEARNED AND HOW DID IT INFORM THE DESIGN?

This design is based very closely on the seeds of Alsomitra macrocarpa, a species of vine that grows high in the trees of Indonesian rainforests. Due to the advantages of spreading offspring far from the parent plant, Alsomitra seeds have evolved to utilize all of the characteristics discussed above—swept wings, washout, and dihedral wing angle—which makes them extremely well suited to long-distance gliding.
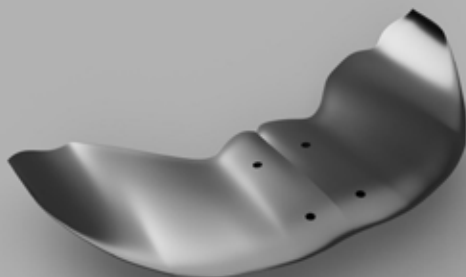
A note from the Biomimicry Institute: These Youth Design Challenge ideas are not proven or necessarily feasible for actual implementation.

BIOMIMICRY INSTITUTE

The BayProtector

Third Place High School Winner

This group of 9th graders sought to solve the issue of eutrophication caused by nutrient pollution (nitrogen) entering their local watershed and looked to nature to propose a solution that is inexpensive, compact, and versatile. Eutrophication occurs when excess nutrients within water bodies produce algae blooms, which then deplete oxygen levels in the water, harming aquatic life. Their design, the BayProtector, removes excess nitrogen from stormwater. The team looked first at villi, small structures found lining the small intestine, which assist with nutrient absorption. Next, they recognized the small intestine's high surface area and meandering shape as inspiration to further improve the design.

WHAT PROBLEM DOES THIS IDEA ADDRESS AND HOW IS IT RELATED TO CLIMATE CHANGE?

The project addressed the issue of algal blooms, which are becoming more frequent and severe due to climate change. Nutrient pollution is responsible for damaging many marine ecosystems and manifests in algal blooms and hypoxic "dead zones", or areas of the ocean devoid of life. The blooms' effects extend beyond the environment, harming human health and causing economic damage. As climate change continues, increasing global temperatures will provide ideal conditions for algal bloom growth. Recognizing that current solutions are too costly and require lots of land and infrastructure, this team set out to combat the growing issue of algal blooms.

WHAT DOES THE SOLUTION DO? DOES IT SOLVE OR IMPROVE THE PROBLEM ADDRESSED?

The BayProtector accomplishes the task of nitrogen removal from stormwater by using villi-inspired structures containing ion exchange resin beads that remove nitrogen from water and maximize the surface area of absorption, just as in the small intestine. By removing nitrogen from water sources flowing into a larger body of water, the BayProtector significantly reduces the nitrogen levels of that body of water. By significantly reducing nitrogen emissions into waterways in a more cost-effective and compact manner, this design will reduce the severity and frequency of algal blooms.

HOW WAS THIS SOLUTION INSPIRED BY NATURE? WHAT ORGANISMS WERE STUDIED?

Inspiration was taken from the villi, small structures found lining the small intestine which assist with nutrient absorption. With a characteristic high surface area, the villi optimize their ability to capture the nutrients flowing through the small intestine. In addition to the villi, this team team saw the small intestine's meandering shape as inspiration to further improve the design's absorption surface area, leading to the conception of the BayProtector prototype. The physical prototype was able to reduce the nitrate concentration of a solution by an astonishing 92%.
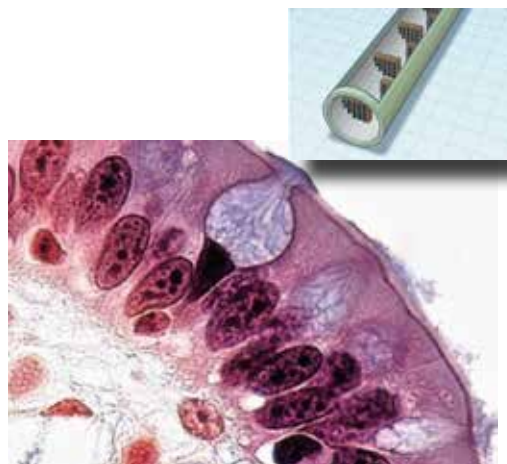
Reef Guard

Second Place Middle School Winner

The Reef Guard is a concept for protecting coral reefs from UV radiation and rising ocean temperatures that cause coral bleaching. This team created a floating underwater shade structure inspired by giant lily pads and the UV-reflecting properties of Orb Weaver spiders' webs. The team was commended by the judges for their strong engineering design process and testing and refinement of key components of the design.

WHAT PROBLEM DOES THIS IDEA ADDRESS AND HOW IS IT RELATED TO CLIMATE CHANGE?

The problem addressed is the warming of the oceans which is affecting the coral reefs and causing reefs to die due to global warming caused by greenhouse gasses in our atmosphere. Reefs are a big part of ocean life. 25% of marine life lives in the coral reefs, yet reefs only make up 1% of the ocean. Rising temperatures of the oceans are causing the algae to shed from the coral, leaving the coral exposed to direct radiation from the sun. This bleaching of the coral is destroying habitats for many marine animals.

WHAT DOES THE SOLUTION DO? DOES IT SOLVE OR IMPROVE THE PROBLEM ADDRESSED?

This solution attempts to lower the temperatures around the reefs, but still allow enough sunlight through for natural photosynthesis to occur in the algae. The Reef Guard design will reflect much of the sun's harmful radiation away from the coral reef and shade the reef area, much like leaves on a tree provide cool shade on hot days. This keeps the water temperature under the Reef Guard cooler and helps keep the algae in place reducing the bleaching effect on the coral and allowing the symbiotic relationship between algae and coral to thrive.

HOW WAS THIS SOLUTION INSPIRED BY NATURE? WHAT ORGANISMS WERE STUDIED?

The solution was inspired by the Orb Weaver, a spider that can spin UV reflective webs. Integrating this reflective property to reflect UV radiation away from the reef will keep the area under the Reef Guard cooler and protected. The sun's rays are comprised of white light: algae grows best with blue light as it penetrates the water at greater depths, so the Reef Guard's mostly translucent blue light can filter through to the coral/algae below.

WHAT IS BIOMIMICRY?

Biomimicry is a practice that learns from and mimics the strategies found in nature and used by species alive today. The goal of biomimicry is to create products, processes and policies that solve our greatest design challenges sustainably and in solidarity with all life on earth.

The practice:

• Brings relief to stressed natural systems and gives us hope

• Helps us design generously

• Gets us to sustainable solutions, faster

• Changes our lens on the world

• Values nature for what we can learn, not from what we can extract

The three essential elements are:

Emulate: learning from then replicating nature's forms, processes and ecosystems to create more regenerative designs

Ethos: the philosophy of understanding how life works and creating designs that continuously support and create conditions conducive to life

(Re)Connect: the concept that we are Nature and find value in connecting to our place on Earth as part of life's interconnected systems, encouraging us to observe and spend time in Nature to understand how life works so that we may have a better ethos to emulate biological strategies into design.

FOR ALL THE CHALLENGES
WE FACE, NATURE HAS
A SOLUTION.

Image credit: Shifaz Abdul Hakkim

WORLD ECONOMIC FORUM
UPLINK OCEAN SOLUTIONS SPRINT

INNOVATIVE AND SURPRISING SOLUTIONS
FOR SAVING OUR SEAS

In early 2020 World Economic Forum Uplink innovators presented their ideas to a panel of experts and judges at WEF's Virtual Ocean Dialogues. These solutions tackle challenges from freight shipping and illegal fishing to plastic pollution and the degradation of precious underwater reef habitats.

CUBEX GLOBAL
A more sustainable approach to ocean transport

OCEANIUM
Biopackaging from sustainably-farmed seaweed

RECYGLO
Tackling plastic pollution at the source in southeast Asia

MADIBA & NATURE
Recycling plastic waste in Cameroon

UNSEENLABS
Breaking new ground in the fight against illegal fishing

OLSPS
Preventing illegal fishing through data management

GLOBAL CORALITION
Using art to alleviate poverty and implement water and waste solutions

LIFE OUT OF PLASTIC
Empowering citizens to take action against plastic pollution

PLASTIC LOOP
Reducing plastic in dumpsites by formalizing waste picking

THE FLIPFLOPI PROJECT
A boat made of waste plastic bring attention to single-use plastic

PINOVO
Preventing paint-based microplastics on rigs from entering the ocean

HALONG BAY, THANH PHO HA LONG, QUANG NINH, VIETNAM

Credit: Lewis J Goetz

UPLINK

Sustainable Development Goal (SDG) 14: Life Below Water inspired the World Economic Forum's first Virtual Sprint in 2020 for entrepreneurs developing new innovations and solutions toward the SDGs. A cohort of Uplink innovators presented their ideas to a panel of experts and judges in May. The following solutions tackle challenges from freight shipping and illegal fishing to plastic pollution and the degradation of precious underwater reef habitats. While only three winners were chosen from the first Sprint, WEF and Uplink will work with all cohorts over the next months to scale innovators' impacts, highlight their work, and introduce them to experts and potential funders who can help accelerate their ideas into actionable solutions.

CUBEX GLOBAL
A more sustainable approach to global transport

This digital marketplace for sea freight can maximize empty shipping container space while simultaneously protecting the planet with a more sustainable approach to ocean transport. Shipping containers are classified into FCL and LCL shipments. FCL (full-container-load) means that one company or individual books the entire container space. And LCL (less-than-container-load) allows multiple entities to book space in a single container. The problem in the LCL sea freight industry is lack of space utilization. 100 million of these shipping containers go 25 to 40% empty from one port to the other. Every year $25 billion is lost in shipping empty space. This happens because freight forwarders for the past 40 years have been using phones, fax and emails to fill up empty space. They are operating on old methods in a digital era. Cubex Global has solved this $25 billion problem by creating an online marketplace where ocean freight forwarders can buy, sell and bid on empty container space in real-time, thus enabling them to recover as much as $25 billion in lost revenues on an annual basis on top of cutting down as much as 20% carbon emissions. The Cubex Global marketplace is built on blockchain, making it secure. All shipping documents are digital and free from human error making it cost efficient.

OCEANIUM
Biopackaging from sustainably-farmed seaweed

Oceanium is an innovative biotech start-up developing products from sustainably-farmed seaweed including a circular life-cycle bio packaging material: *Oceanware*. Oceanium is targeting packaging categories that currently have no end of life solution. Oceanware is designed to be disposed of with food waste and ultimately used as compost for soil health or anaerobic digestion for energy. It is ideal for closed-loop environments such as sports events, festivals and airlines. An important aspect of their mission is to enable the sustainable seaweed farming industry in the western hemisphere to mitigate climate change, provide environmentally friendly livelihoods and ensure food security. Seaweed sequesters carbon and helps ocean bioremediation as it absorbs excess nutrients which cause ocean eutrophication. Seaweed as a feedstock/food source does not need cleared land, freshwater, insecticide or fertilizer unlike competing bioplastic feedstocks such as corn. Oceanware will be produced using green chemistry and will be marine safe. Oceanium is based at the European Marine Science Park in Oban, Scotland with an office in London.

RECYGLO
Waste management and data analytics platform tackling plastic pollution at its source across southeast Asia

Recyglo is a zero waste and circular economy waste management & data analytics platform, providing innovative green technologies. This small startup is committed to providing environmentally-friendly recycling solutions in Myanmar and Malaysia. Founded in 2017, their mission is to process materials in a safe, non-hazardous manner with the aim of making the world cleaner and more environmentally sustainable. They believe in promoting smart recycling habits in order to achieve long-lasting results. Their goal is to become a leading waste management solution platform in Southeast Asia that produces zero waste, has a zero carbon footprint, and develops a waste management and recycling culture in Asia.

Recyglo connects with logistics and recycling facilities around the world to provide zero waste management solutions in addition to the traceability, data analytics and carbon footprint reporting. In addition, Recyglo also possesses the tech for waste-to-energy, waste-to-fertilizer & livestock, used cooking oil recycling, recycling of non-recyclable plastics waste, and more.

This innovative start-up from Myanmar is helping companies recycle in simple but clever ways

MADIBA & NATURE
Rcycling plastic waste and inspiring entrepreneurs in communities across Cameroon

Madiba & Nature was founded to help preserve the livelihoods of fishermen while also addressing the issue of marine plastic pollution. Plastic waste is collected through beach cleanups and is used to create Ecoboats for fishermen. Their strategy includes the use of Ecobins at beaches to encourage cleanup and waste management in coastal areas. With more than 150 Ecobins in place, up to 5 tons of plastic waste has been collected each month: enough to build 46 Ecoboats used for fishing and ecotourism. This is creating jobs within the Londji community in coastal Cameroon, and area youth are being trained in entrepreneurship for green businesses. More than 15,000 students have been affected by the environmental education programs that have been launched in fifteen secondary schools and two universities in Cameroon.

This company in Cameroon is turning waste plastic bottles into boats

This start-up is tracking ocean traffic to fight illegal fishing and piracy

UNSEENLABS
Maritime surveillance service breaking new ground in the fight against illegal fishing

Unseenlabs is a French company (Brittany) whose core business model is the development, production and operation of innovative Earth observation instruments, specialized in the detection of electromagnetic emissions. Unseenlabs is a maritime surveillance service, allowing the location and characterization of ships at sea from space, based on electromagnetic intelligence instruments, deployed on a constellation of satellites. Unseenlabs stands out from the other players in the field of maritime surveillance with an innovative and unique electromagnetic intelligence service capable of observing maritime traffic, even without any cooperative beacon. Unseenlabs is a maritime surveillance data provider and its service will provide the capability to find and follow ships, even in uncooperative use cases.

OLSPS Group
Providing data-driven solutions for fisheries worldwide

Two new technologies have been attracting significant interest: On-board Camera Monitoring and eLog Reporting. While the underlining technologies of the EM and ER core components are different from each other, they are complimentary in that together they can deliver effective Monitoring, Control and Surveillance of fishing operations and related activities. The Olrac iEMR project combines technology to offer a novel and holistic solution to fisheries management. By significantly modernizing fisheries data management systems and processes, Olrac iEMR has the potential to make a dramatic, positive impact on the Blue Economy. The overall aims of the iEMR project are to improve the quality, quantity, accessibility and transparency of fishing data for compliance, scientific and management purposes; to accurately and efficiently monitor and report on fishing activity; to avoid unsustainable fishing practices and combat illegal unreported and unregulated (IUU) fishing; to improve economic efficiency in the fishing sector; and to empower fishers through technology and data-collection, equipping them with a cost-effective tool that far outstrips the capabilities of paper logbooks, at-sea observers and existing compliance-based electronic logbooks.

GLOBAL CORALITION
Uniting art, science and communities for coral reef protection worldwide

This amazing underwater sculpture in Thailand is an artificial coral reef

Global Coralition is using art as a vehicle to help alleviate poverty, implement water and waste solutions, and empower communities to activate grassroots climate change action. They are creating restoration hubs consisting of large-scale sculptural reefs and land-based coral farms, while engaging the world to promote coral science, climate change education, and regenerative grassroots development to facilitate lasting sustainable growth. Alongside the restoration hubs, Global Coralition is working with schools, hotel developers, sequestration specialists, and water solutions engineers to provide impoverished communities with the opportunity to be a part of a regenerative community. In March of 2020 they helped a fishing village in the Dominican Republic to form a new economy around reforesting mangroves instead of fishing unsustainably. They are currently developing a crypto wallet and savings account mobile app where users can donate directly to regional NFP campaigns to save certain coral species, to generate interest in restoration in the Dominican Republic, and to activate future holistic ecological restoration projects in Thailand, Indonesia, and India.

OCEAN SOLUTIONS SPRINT

RESTORING, PROTECTING & INVESTING IN THE OCEAN BY ACCELERATING PROGRESS ON THE UN SUSTAINABLE DEVELOPMENT GOALS (SDGs)

LIFE OUT OF PLASTIC
A clean-up campaign that empowers citizens to take action against plastic pollution

Life Out of Plastic is a national campaign that empowers citizens to take action against plastic pollution. The campaign culminates in a weekend of decentralized beach clean-ups across Peru and Latin America. Clean-ups are done along beaches, rivers and wetlands, allowing people to not only take action, but also collect debris data from each location. The data collected captures everything from the different brands found on beaches to the different kind of items, down to the microplastics collected. This data was used to defend the need for a national law in Peru to ban single use plastic in Congress in 2018. The law was subsequently unanimously adopted. They have cleaned over 1,000 beaches, approximately 200 tons of debris collected as well as the success of knowing that their efforts not only cleaned up exisiting plastic pollution but prevented more plastic from reaching the sea.

PLASTIC LOOP
Reducing plastic in dumpsites by formalizing waste picking in Asia

Dumpsites (non-sanitary but legal landfills) are the most common waste disposal solutions in Southeast Asia and are also a major root cause of plastic pollution leeching into the waterways and thereby the ocean. Landfill waste pickers generate a significant volume of recycled plastic under unhygienic conditions to earn a living. Plastic LOOP is working with dumpsites near major waterways and within the waste-picker communities in Asian and ASEAN countries to formalize and upgrade the work environment of waste pickers and to improve and increase the waste separation through small-scale material recycling facility installation. This group's major aim is to stem the flow of plastic waste from leaking into the environment and to monitor the impacts through low-cost waste traps in nearby waterways.

THE FLIPIFLOPI PROJECT
Bringing attention to the problems of single-use plastic

Flipflopi is the world's first sailboat made entirely from plastic waste including flip-flops collected from beaches and towns on the Kenyan coast. They envision a world that has banned single-use plastic, and where responsible production and consumption of plastic is part of a circular economy. They believe we can achieve this by encouraging the plastic revolution movement and inspiring change worldwide. Their ongoing projects include a petition to end single-use plastic in East Africa, and 3 Flipflopi hubs in Kisumu, Lamu, and Diani that are supporting communities to tackle plastic pollution through coordinating waste management. Upcoming projects include a Lake Victoria Expedition that will span the East African countries of Kenya, Tanzania, and Uganda: all connected by Lake Victoria and source of the Nile: one of the 10 major rivers responsible for 90% of the total ocean plastic pollution. The FlipFlopi team aim to coalesce communities, school children, conservationists, business leaders, and policymakers around the issue of plastic pollution and the threat to the health of communities and the ultimate survival of the lake itself. At the same time, they hope to spotlight the great work being done to protect this critical ecosystem through events, workshops, and media engagement.

LEARN MORE: uplink.weforum.org/uplink/s

PINOVO
A zero-emission circular sandblasting system to prevent paint-based microplastics on rigs from entering the ocean

Plastic-based paint is used to protect steel from corrosion. Annual emission of microplastics from marine and protective coatings into the ocean is estimated at 60,000 tonnes globally, which is equivalent to 6 billion plastic bottles being dumped in the ocean each year. Pinovo's solution prevents microplastics from entering the ocean, and grit from entering the workspace. Pinovo's technology also delivers superior surface quality, lengthening the asset's life, and at a lower cost. Their impact on SDG 14 could be huge, measurable and immediate: with Pinovo technology there are zero emissions of microplastics. In addition, all blasting grit is re-used during sandblasting operations. This provices a clean, circular, safe and cost-efficient solution to a plastic pollution problem.
Pinovo has developed technology which eliminates all emissions from surface treatment of rust and old paint into the oceans. To put this into perspective, and taking the 184 oil rigs in the North Sea, sand-blasting and water-jetting on those rigs causes microplastic emissions that are equivalent to dumping 14 millions plastic bottles into the North Sea every year. Use of Pinovo technology would reduce that to zero.

WORLD ECONOMIC FORUM: THE U.N. SUSTAINABLE DEVELOPMENT GOALS AND THE 2020 OCEAN SOLUTIONS SPRINT

To respond to the scale and complexity of our global challenges, the United Nations created a framework in which to tackle them: 17 Sustainable Development Goals (SDGs) to create a healthier, greener, more equal and more prosperous planet by 2030.

In early 2020 the World Economic Forum UpLink launched a competition to find solutions for our seas, through the Ocean Solutions Sprint. UpLink is a response to the demands facing our planet: a new digital platform to surface the best ideas and solutions for pressing issues and connect them to the world's decision makers. Uplink focuses on areas where progress is critical to meet SDG14: *Life Below Water*, identified in partnership with leading global conservation and restoration experts. Covering nearly three-quarters of the world's surface, the ocean is by far our largest natural ecosystem, the engine of our weather systems and a barometer of the planet's health.

The second World Economic Forum Uplink Ocean Sprint was announced in October 2020 to identify top solutions that can restore, protect and invest in the ocean and its blue economy. To participate, visit #UpLinkOcean, a digital platform that crowdsources innovations for the world's most pressing challenges. Do you have an idea that could make a

CONSERVE AND SUSTAINABILY USE THE OCEANS, SEAS AND MARINE RESOURCES FOR SUSTAINABLE DEVELOPMENT

3 HACKING 4 OCEANS

WHAT'S COMING TO THE FUTURE OF MARINE CONSERVATION

A cohort of international college students working with top academics, scientists and business leaders are building transformative solutions for real-world problems facing the world ocean.

BLUE WALTZ BIO
eDNA measurements for marine resource management

TRACING NEMO
On-board video image processing for fish traceability and identification

PACIFIC TUNA POINTS
Reducing bycatch in modern industrial fishing

BYCATCH LOANS
Recovery funds providing loans to communities for conservation management

URCHIN KELP RESTORE
Reducing urchin explosions to allow kelp forests to grow

OUR DECISIONS ARE RESPONSIBLE (ODAR)
Purchasing sustainability through fish traceability technology

HACKING 4 THE OCEANS SPRING TEAMS
Arctic Oracle, Search Party, Proteus, Fresh or Fishy and Micropolyp

The HACKING 4 OCEANS initiative is tackling complex problems critical to our oceans, inventing and adopting new technologies with a team of engineers, scientists, social scientists, MBAs and policy experts from Scripps Institution of Oceanography and the University of California, San Diego

HACKING 4 THE OCEANS

STUDENTS POISED TO TACKLE ENVIRONMENTAL CHALLENGES

A new course offering led by Scripps Oceanography scientists enables students at UC San Diego to tackle ocean-related problems with guidance from industry mentors. Launched in the spring of 2020, HACKING 4 THE OCEANS is a solutions-focused class wherein interdisciplinary teams of students work closely with outside sponsors to develop rapid prototypes and innovative solutions to ocean pollution, illegal fishing, and real-time monitoring. Students are challenged to develop feasible solutions that are not only scientifically or technically possible, but also have high potential to be adopted by end-users and a revenue generating strategy.

Blue Waltz Bio

PROBLEM
eDNA measurements for marine resource management

BACKGROUND
Environmental DNA (eDNA) measurements have shown promise for measuring the biological state of aquatic resources with higher fidelity and lower cost than traditional survey methods. There are a range of potential applications for this nascent technology, including, but not limited to, water quality monitoring, invasive species detection, fish stock assessment, endangered species assessment, environmental impact assessments and aquaculture monitoring. Currently, eDNA tools still require custom sampling equipment and expert users in order to generate useful data and insights.

SOLUTION PRESENTATION
youtube.com/watch?v=UW8rC6eX kck&feature=youtu.be

Example Barcode: ATTCGTTGGCT

Tracing Nemo

PROBLEM
Fish traceability - On-board video image processing for fish identification
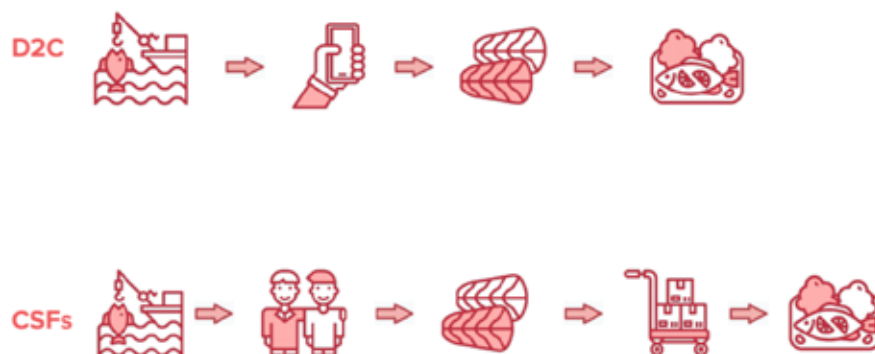
BACKGROUND
Electronic monitoring (EM) refers to the use of camera systems on fishing vessels to identify fishing activity and monitor compliance with rules. Roughly 1,000 vessels globally have EM systems on board. Ideally, this systems would be able to use AI to identify fish volumes and species for improved scientific management purposes. On many vessels (e.g., tuna on the high seas), video recordings are physically offloaded from the vessel by hand infrequently, and the data analysis may have several months lag. Satellite communications on the high seas limits the ability to transmit large data files. Improved on-board processing would allow vessels to report effort and catch estimates via text file, with fuller data downloads at a later time.

Can we work with existing EM providers to develop a software that can record and transmit real-time analysis?

SOLUTION PRESENTATION
youtube.com/watch?v=Wlcj0Rv xVYw&feature=youtu.be

Pacific Tuna Points

PROBLEM
Reducing bycatch in modern industrial fishing

BACKGROUND
There have been several innovations in the last decade to reduce bycatch in industrial fishing, yet very few have been implemented at scale. How could we develop scalable technologies/ processes/policies to reduce bycatch while increasing yield of the desired catch, within current or future regulatory frameworks? Modern industrial fishing often results in large amounts of unintended catch--or bycatch-- which is then dumped overboard.

Sometimes the bycatch itself is valuable, other times (e.g. for sharks) it is critical for the health of the entire system. In all cases, the bycatch consumes fishing resources that were intended to catch the target species. Modifications such as use of circle hooks (reduce shark and turtle bycatch) and changing long line depth (reduce seabird bycatch), slow release shark repellents, and flashing LEDs that repel turtles. However, very few have been implemented at scale.

SOLUTION PRESENTATION
youtube.com/watch?v=EkWwA 0OhMlk&feature=youtu.be

BuyCatch Loans

PROBLEM
Recovery funds providing loans to communities for conservation management

BACKGROUND
All over our planet oceans and rivers are over-fished, grasslands over-grazed, forests over-harvested, and agricultural lands degraded. This is bad for the people who depend on these systems for their livelihood and bad for the rest of life on earth. It's also unnecessary. Collectively we know how to restore and manage these systems so they can provide dramatically improved livelihoods for people, provide more food and habitat for other species, store more carbon and produce more clean water. BuyCatch Loans has developed a recovery fund that provides moderate interest loans to communities to get them through the valley of death and cover some of the direct costs of conservation management. Repayment of the loans can start once yields have surpassed a predetermined threshold, above pre-conservation management levels. The loan would be analogous to college student loans (such as those provided by Chancen International).

So why is overexploitation and degradation so widespread? Technical and social obstacles are part of the problem, but the main obstacle is finance. The first stage of conservation management is to reduce harvest so systems can start to recover. Harvests can then slowly increase to much higher levels. This valley of death is the main obstacle to conservation management in tens of thousands of communities around the world. People in poor communities simply cannot afford to reduce harvest while the system recovers. Even wealthier people may not be able to afford lower harvest due to obligations of school tuition, healthcare bills, and loans to pay.

SOLUTION PRESENTATION
youtube.com/watch?v=a205-

Urchin Kelp Restore

PROBLEM
Reducing urchin explosion to allow kelp forests to grow

BACKGROUND
There is an over-abundance of kelp-grazing purple urchin along California's North Coast that have destroyed 95% of the kelp forest in that region. Scientists attribute this decline to a *perfect storm*: warming water, loss of a key urchin predator, and an explosion in the purple urchin population. To slow kelp forest decline and support restoration of this critical ecosystem, the first step involves significantly reducing the urchin population.

Urchin removal is costly, as much as $750 per diver per day, and requires a specific set of skills. Due to the high cost of urchin removal and the sheer volume of urchin, there isn't enough funding to support these efforts without a market based incentive. Although urchins are harvested around the world for their valuable roe, called "uni", the Northern California purple urchins are starving and as such, not a marketable seafood product.

SOLUTION PRESENTATION
youtube.com/watch?v=chHtTkAaTeE&feature=youtu.be

Our Decisions are Responsible (ODAR)

PROBLEM
Purchasing sustainability through fish traceability technology

BACKGROUND
According to NOAA, about 80% of the seafood consumed in the US is imported. Tracking and regulations around fishing in other countries tend to be lax or poorly enforced, making fish traceability a truly global problem. Fish supply chains are quite complex and fish from different batches are often mixed together, with the result that about a third of fish sold in the US has been found to be mislabeled (source: Oceana). Traceability of legitimate sustainable fish (separated from unsustainably sourced fish) is a big challenge in all existing sustainable fish certification programs, e.g. Marine Stewardship Council certified fish carried by Whole Foods. There are several apps like *Abalobi*, *OurFish*, and *WorldFish* which are being used to track small fishing boats and/or collect data at the point of exchange between fishers and buyers early in the supply chains. Motivating technology use can be a challenge everywhere, but with seafood traceability it is especially tricky as those being asked to do the traceability/data entry work are often not those that will see much benefit from the information.

SOLUTION PRESENTATION
youtube.com/watch?v=-uiSqM6VDps&feature=youtu.be

Hacking 4 The Oceans Upcoming Projects:

ARCTIC ORACLE
Mining satellite data to detect routes in sea ice that can be used for safe polar navigation. Sponsor: Capella Space; Mentor: Gwen Nero, Scripps Oceanography

SEARCH PARTY
Path-planning software suite for unmanned surface vehicles (USV) to adaptively monitor harmful algal blooms (HABs). Sponsor: Boeing; Mentor: Ellen Chang, BMNT

PROTEUS
Designing a low-cost, durable flooding sensor and data acquisition system to provide critical alert information for vulnerable coastal communities. Sponsor: Center for Climate Change Impacts and Adaptation Mentor: Blue Robotics

FRESH OR FISHY
Anomaly detection and supply chain tracking of illegal, unreported, and unregulated fishing. Sponsor: NASA; Mentor: Chris Ward, Delawarde Consulting)

MICROPOLYP
Designing a hardware attachment that rapidly collects and analyzes in-situ water samples for micro-pollutants/plastics. Sponsor: AIIM Partners; Mentor: Port of San Diego

SOLVING REAL PROBLEMS RIGHT NOW

Students in the Hacking 4 the Oceans program tackle complex problems critical to our oceans, and invent and adopt new technologies with a team of engineers, scientists, social scientists, MBAs, and policy experts from Scripps Institution of Oceanography and the University of California, San Diego, in collaboration with a non-profit organization focused on ocean health.

- Video Identification of Reef Fish for Stock Assessment

- AI-Based Seabed Classification: Geology, Biota, and Man-made objects

- Mining Satellite Imagery for Ocean Health Monitoring

- CatchReporter App Development

- Real-time Inundation Monitoring

- Remote Monitoring of Ocean Stratification

- How Does Oceanographic Variability Inform Seasonal Fishery Projections?

- Harmful Algal Bloom and Dungeness Crab Closures

- Land to Sea Runoff: Eutrophication Management

- Cowell Beach Cleanup

- New Techniques for Monitoring IUU

- Optimal Path Planning for Stock Assessment from an Unmanned Surface Vessel (USV)

- Unmanned Aerial Vehicles (UAVs) on Research Vessels

4 TOOLS

DATA VISUALIZATIONS FOR A MODERN WORLD

Data visualizations offer us innovative and fascinating ways to look at and interpret ocean and climate events and can transform the way we learn about scientific facts related to the ocean

COASTAL RISK EXPLORER
Helping Maine communities prepare for sea level rise

CLIMATE REANALYZER
A climate and weather data platform from the Climate Change Institute

GLOBAL MAP OF HUMAN IMPACTS
Spatial and temporal changes in cumulative human impacts on the ocean

SURGING SEAS RISK ZONE MAP
Exploring seal level rise and flooding down to neighborhood scale

OCEAN HEALTH INDEX
Informing decisions about how to use and protect marine ecosystems

VISUALIZATION THEATER
Engaging with ocean data in visually appealing ways

UN ATLAS FOR THE OCEAN
An internet portal for the sustainable development of the ocean

COASTAL RISK EXPLORER

ENABLING MAINE COMMUNITIES TO ASSESS AND RESPOND TO AREAS VULNERABLE TO FLOODING

Maine's vast rocky coast will be impacted by sea level rise in many different ways. One important effect will be the inundation of roads, which will prevent access to homes and businesses as roads are flooded.

A new tool developed by the Nature Conservancy in partnership with Bowdoin College, the Maine Geological Survey, and community-planning consultant, Blue Sky Planning Solutions, the Coastal Risk Explorer tells first-responders and city/town planners which streets will flood and where vulnerable citizens might lose access to help.

This tool shows how rising sea levels will affect roads in coastal cities and towns, see where road networks will be inaccessible to emergency responders, and how that relates to the overall social vulnerability of the community. Social vulnerability is provided for each coastal block group, based upon 17 socioeconomic and demographic factors.

WHAT WILL THE IMPACTS OF CLIMATE CHANGE BE IN MAINE?

While average temperatures continue to rise—by more than 1.5 degrees in the United States as a whole and by more than 3 degrees in Maine over the last 100 years—sea level rise and precipitation will surge along the coast, according to a 2018 National Climate Assessment. The ocean is now rising at an ever-faster rate, and the possibility that we could see a 6-foot increase is now more likely than ever.

HOW CAN WE PLAN FOR FLOODING AND SEA LEVEL RISE?

This tool uses projected sea level rise scenarios to understand which locations would be cut off from emergency medical services due to road flooding. It also incorporates a unique, Maine-specific analysis that indicates how vulnerable the members of a community are to the challenges created by sea level

rise based on several demographic factors, including socioeconomic status, household ages, disabilities, housing and transportation access.

Emergency service providers know of the quickest routes to reach homes in an emergency. However, it can become impossible for them to access someone in need when roads are flooded. In many emergency situations, taking extra time to take an alternate route can be the difference between life and death. The Coastal Risk Explorer allows communities to explore the social vulnerability of their towns and understand the demographic factors that would make it difficult for certain populations to evacuate or relocate when faced with flooding events and other emergencies. Planners can use this information to strategically upgrade culverts and locate emergency medical services based on where their most vulnerable populations are located, reducing the likelihood that they will be inaccessible during a flooding event.

MAINE

MAINE

The Coastal Risk Explorer is part
of a collection of decision-support
tools on TNC's Coastal Resilience
Platform.

A VISUALIZATION FROM THE
CLIMATE CHANGE INSTITUTE

Climate Reanalyzer

Weather Forecasts

Today's Weather Maps

Outlook Forecast Maps

Hourly Forecast Maps

U.S. Radar & Satellite

Archived U.S. Satellite

Climate Models and Data

Daily Sea Ice Timeseries & Maps

Daily Reanalysis & Sea Ice Maps

Monthly Reanalysis Maps

Monthly Reanalysis Timeseries

Monthly Reanalysis Correlations

Monthly U.S. Timeseries & Maps

Global SST Timeseries & Maps
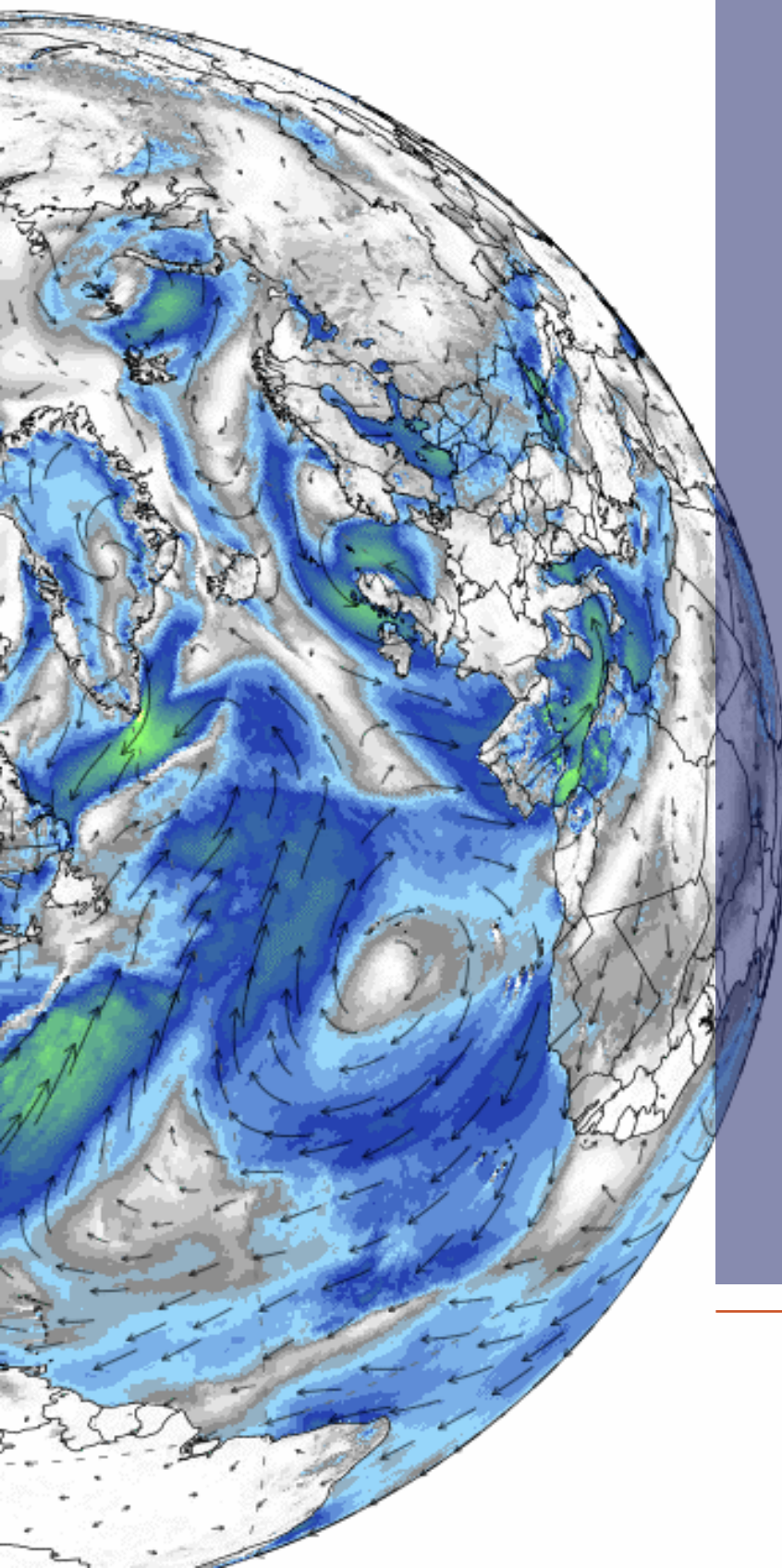
Environmental Change Model

Animation Gallery

About Climate Reanalyzer

Site Overview

image caption

Explore Climate Change

CLIMATE CHANGE INSTITUTE
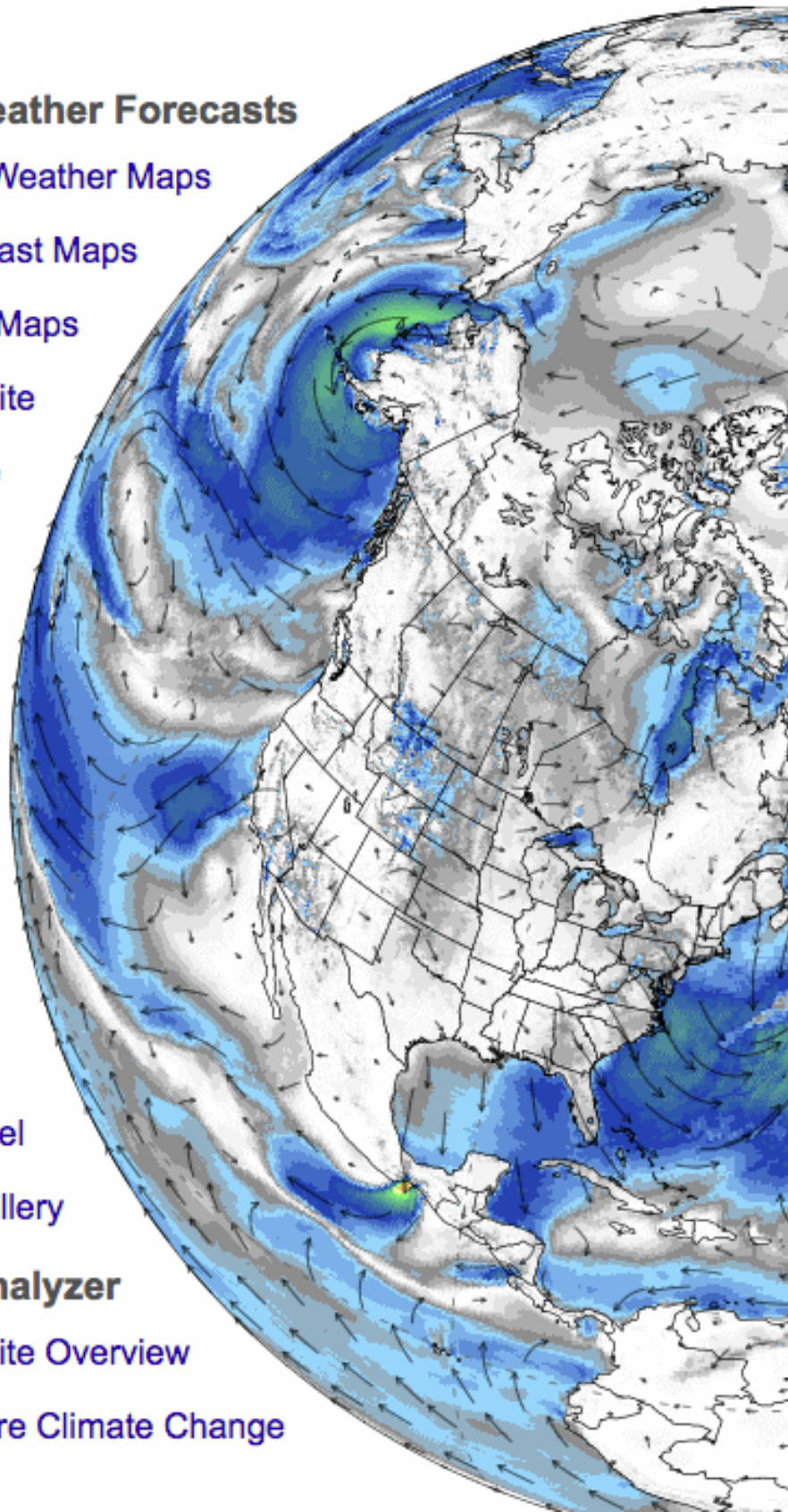
Climate Reanalyzer is a platform for visualizing climate and weather data sets. The site is coded and maintained by Dr. Sean Birkel through support from the Climate Change Institute and the School of Earth and Climate Scitences, and partial support from the National Science Foundation.

On the Climate Reanalyzer you can investigate climate using historical station data, plot maps, export data and use exports in Google Earth. It also provides access to weather forecast models, allowing you to get 10-day animated forecast maps from global and regional models.

This is a resource as deep and vast as the ocean itself. To access the Climate Reanalyzer interface visit cci-reanalyzer.org.

TOOLS

4

1865 THE UNIVERSITY OF MAINE

GLOBAL MAP OF HUMAN IMPACTS
SPATIAL AND TEMPORAL CHANGES IN CUMULATIVE HUMAN IMPACTS ON THE WORLD'S OCEAN

The management and conservation of the world's oceans require synthesis of spatial data on the distribution and intensity of human activities and the overlap of their impacts on marine ecosystems. The global map of human impacts is an ecosystem-specific, multiscale spatial model to synthesize global data sets of anthropogenic drivers of ecological change for marine ecosystems, allowing for maps that provide flexible tools for planning, education, and basic research.

Human pressures on the ocean are increasing globally, yet we know little about their patterns of cumulative change, which pressures are most responsible for change, and which places are experiencing the greatest increases. Managers and policymakers require such information to make strategic decisions and monitor progress towards management objectives, giving researchers an opportunity to calculate and map changes in cumulative impacts to marine ecosystems globally from fishing, climate change, and ocean- and land-based stressors.

As human populations increase and migrate to coastal regions, demand for ocean space and resources expands, increasing the individual and cumulative pressures from a range of human activities. Marine species and habitats have long experienced detrimental impacts from human stressors, and these stressors are generally increasing globally. However, the spatial patterns of these stressors are varied and the amount of recent change is largely unknown. In many places, we know little about which stressors are having the biggest impact on ecosystem conditions, their cumulative effect, or how the composition of pressures is changing over time.

Quantifying and mapping local- and global-scale stressors in a standardized, comparable manner offers a powerful means to assess both the spatial pattern and temporal change of individual human pressures, as well as their total impact on natural systems across highly variable geographies. Quantitative methods to map cumulative human impacts were recently developed and initially applied to marine ecosystems globally. To date, these methods have been applied to marine and freshwater regions around the world to assess spatial patterns of cumulative impact and to explore how cumulative impacts affect or relate to other ecological processes or conservation needs.

These efforts have helped identify which areas and ecosystem types are relatively pristine or heavily impacted, where hotspots of biodiversity and impacts overlap, and which stressors dominate human impact, in turn informing biodiversity conservation, threat mitigation and spatial planning decision processes. Missing from this research is an assessment of the location and intensity of change in cumulative impacts over time. Such temporal assessments would illuminate where and to what degree stressors are increasing or decreasing in intensity and impact, thus providing a means to assess management efficacy and adaptively respond to change. They can also support proactive management by informing expectations of future states by tracking current trajectories.

Change in cumulative impact

TOOLS

4

Score/trend

Permanent ice cover   Seasonal ice cover
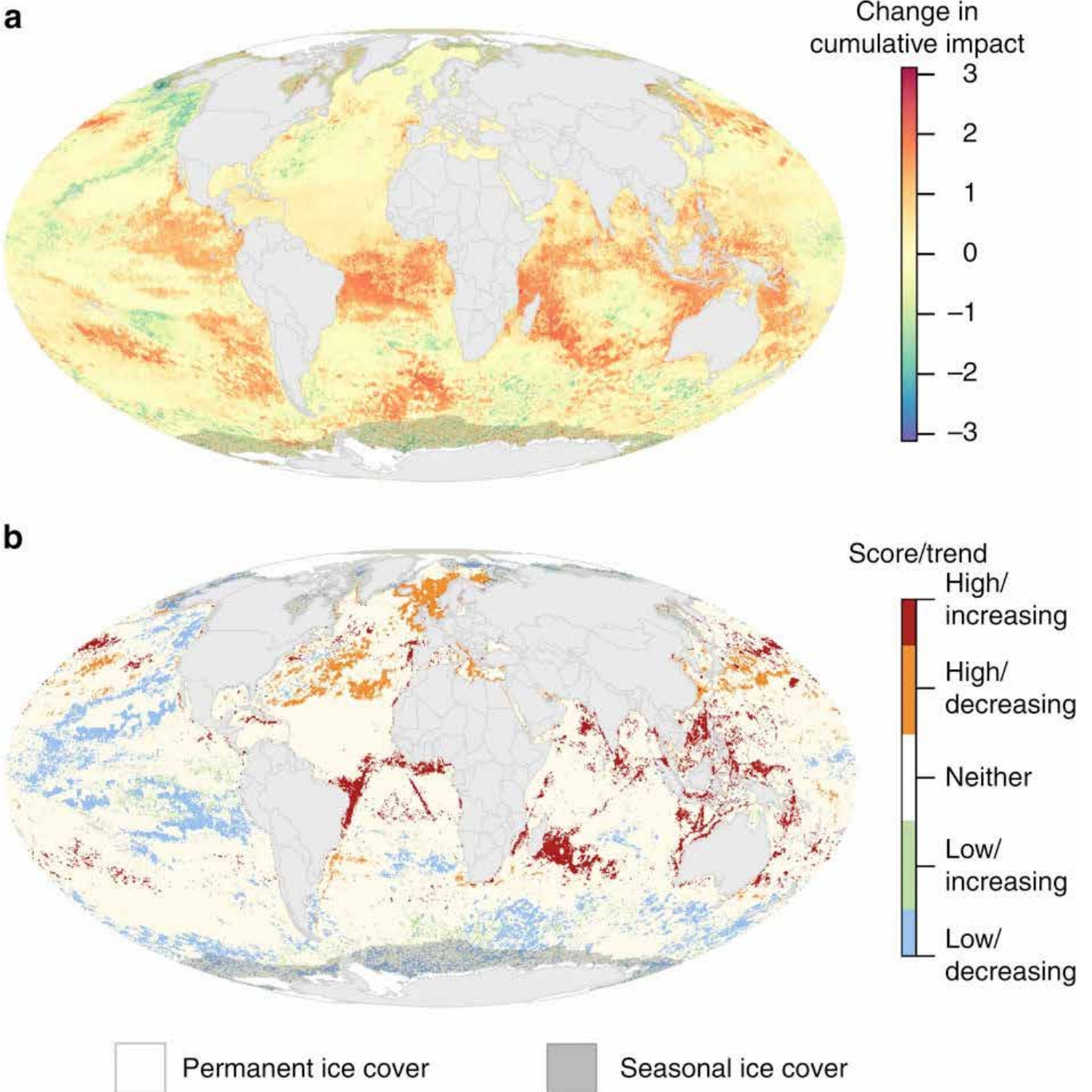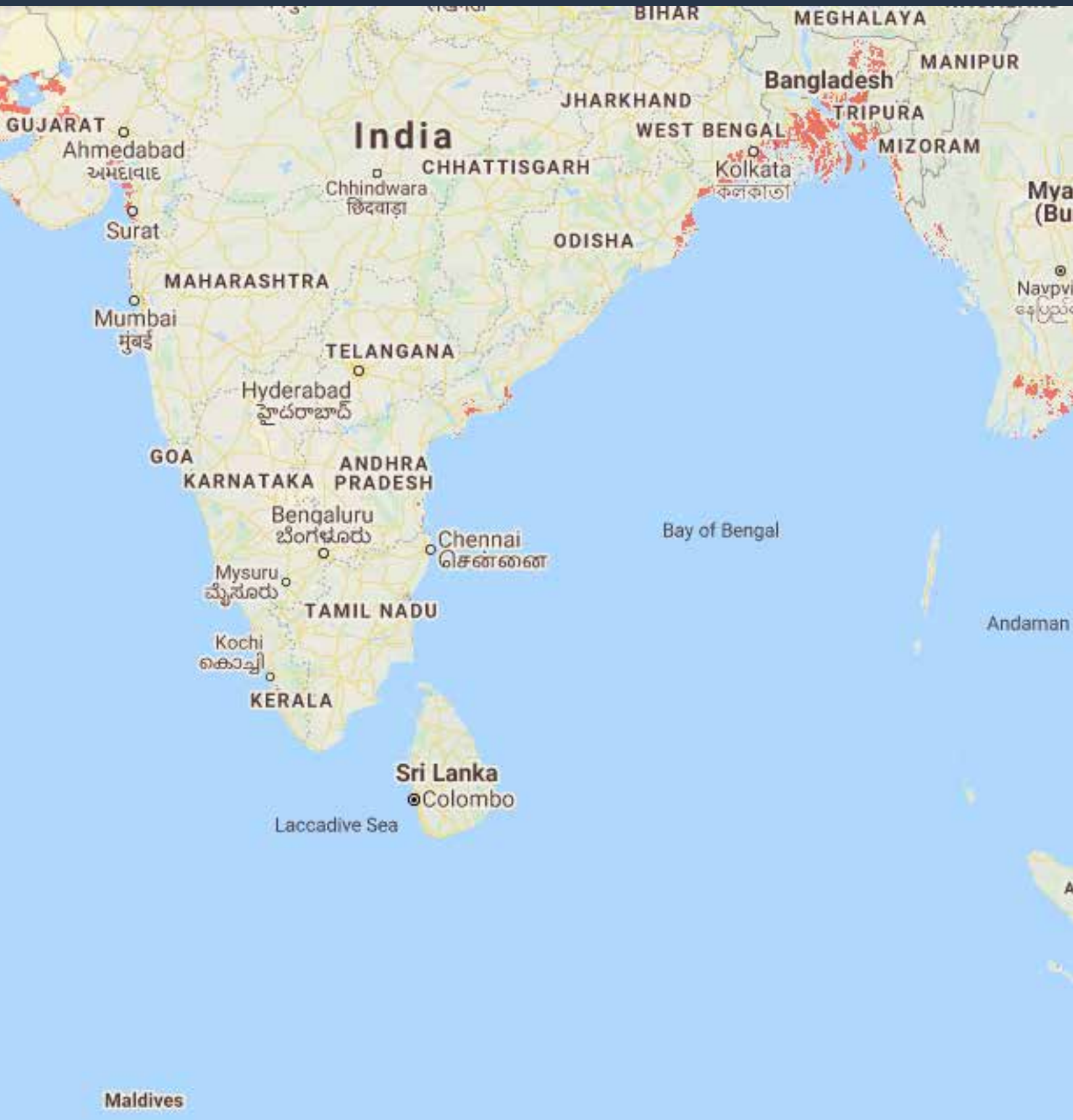
Global warming has raised global sea level about 8 inches since 1880, and the rate of rise is accelerating. Rising seas dramatically increase the odds of damaging floods from storm surges. A Climate Central analysis finds the odds of "century" or worse floods occurring by 2030 are on track to double or more over widespread areas of the U.S. These increases threaten an enormous amount of damage. Across the country, nearly 5 million people live in 2.6 million homes at less than 4 feet above high tide — a level lower than the century flood line for most locations analyzed. And compounding this risk, scientists expect roughly 2 to 7 more feet of sea level rise this century — a lot depending upon how much more heat-trapping pollution humanity puts into the sky.

Using the mapping tool at sealevel.climatecentral.org you can explore sea level rise and flooding down to neighborhood scale, matched with area timelines of risk. The tool also provides statistics of population, homes and land affected by city, county and state, plus links to factsheets, data downloads, action plans, embeddable widgets and more.
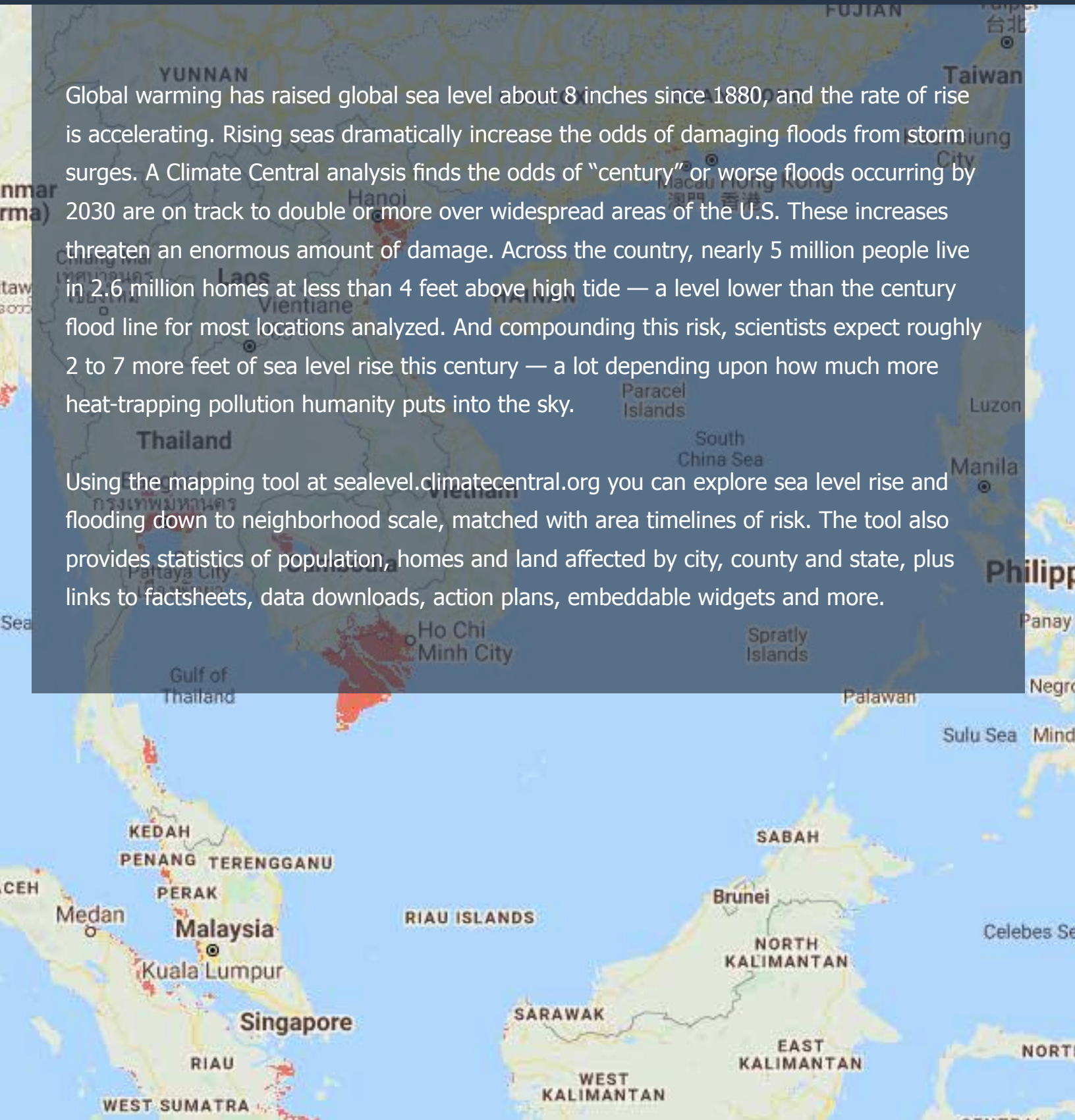
OCEAN HEALTH INDEX

A HEALTHY OCEAN SUSTAINABLY DELIVERS A RANGE OF BENEFITS: NOW AND IN THE FUTURE

Understanding the current state of the ocean is the first step toward ensuring it can continue to provide benefits to all. By offering a means to both advance comprehensive ocean policy and measure future progress, the Ocean Health Index informs decisions about how to use and protect marine ecosystems. Following its launch in 2012 in the scientific journal NATURE, OHI is now utilized around the world and has been successful in a variety of contexts.
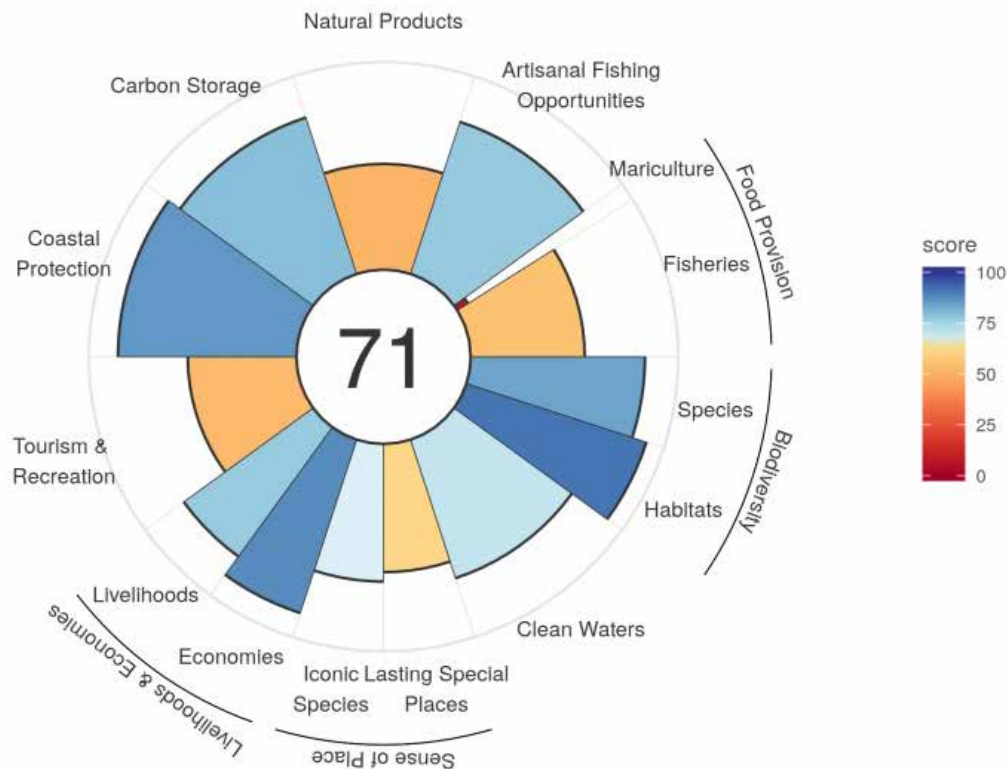
The Ocean Health Index is a tool for ongoing assessment of ocean health. It rates the health of the ocean by country on one of ten goals: food provision, artisinal fishing opportunities, natural products, carbon storage, coastal protection, coastal livelihoods & economies, tourism & recreation, sense of place, clean waters, and biodiversity. One of the goals of the Index is to help countries make more informed policy decisions, especially in those regions that have already expressed a commitment to improving ocean health.

GOALS
1. Establish a new world standard for measuring ocean health;
2. Influence decision-makers and raise global awareness to generate positive and dramatic action for improved ocean governance and health;
3. Establish (globally) clean water, food provision, carbon capture, biodiversity, coastal protection, recreational opportunities, artisanal fisheries, support of local economies, and a "sense of place".

The 2019 Global Ocean Health Index score, 71, is a slight improvement over 2018. Key findings are as follows:

TRENDS

Trends in goal scores across eight years of assessments vary among regions. At the global scale, OHI observed an increase in Artisinal Opportunities, Carbon Storage, Clean Water, Food Provision, and Tourism & Recreation.

Overall, scores declined for Biodiversity, Coastal Protection, Natural Products, and the Species sub-goal. Declines in scores for Coastal Protection were primarily driven by the substantial loss of coastal sea ice in sub-Arctic regions.
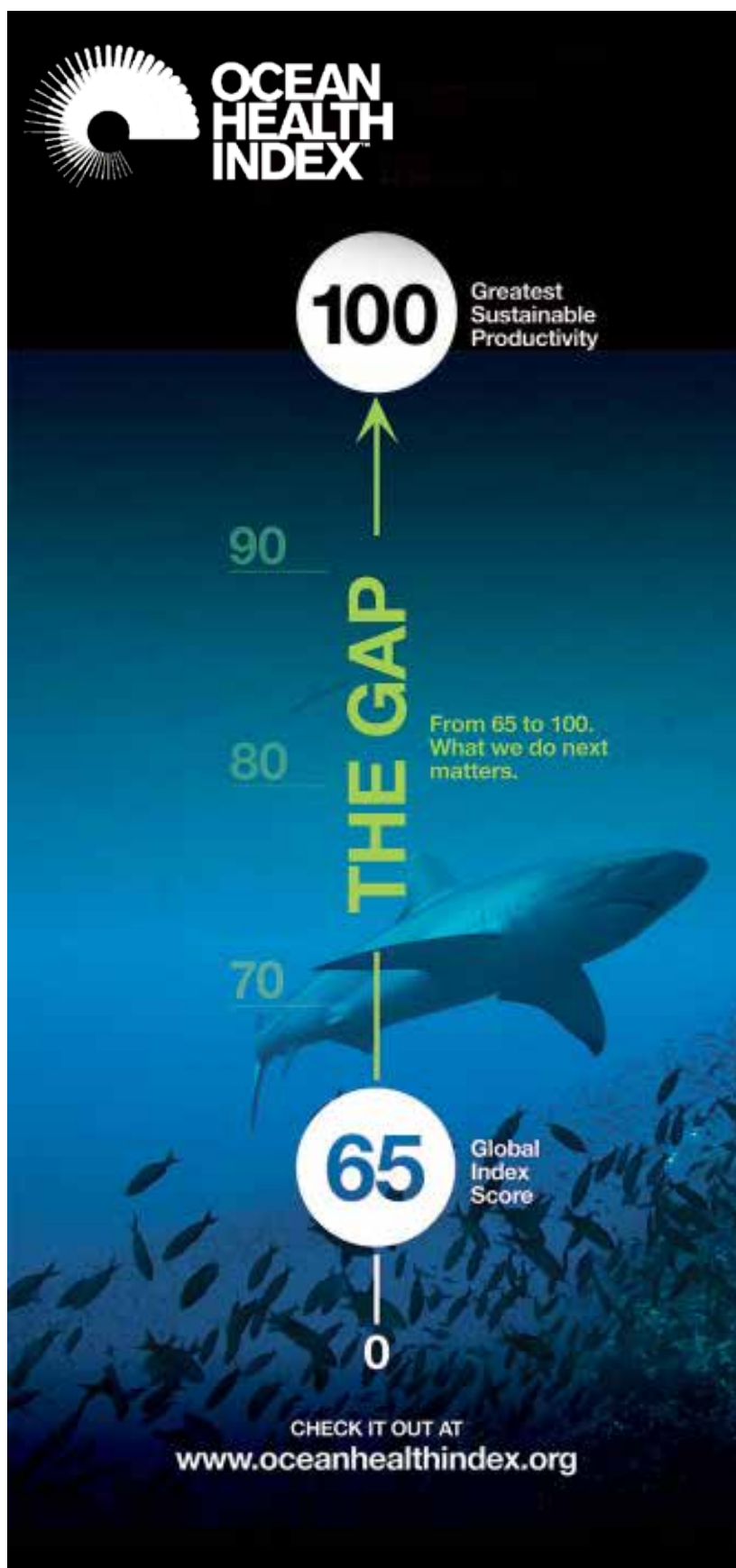
HIGHLIGHTS

24 regions scored 80 or higher, many of them island nations

Germany was the only region with a population exceeding 1 million to score 80 or above.

Ten regions scored below 50. Seven of these are in Africa, one in Central America and two in the Middle East.

As observed in prior years, regions with stable and effective governance tend to score much higher than areas where corruption, dictatorship, civil strife, war and poverty are chronic issues. This finding underscores that improving ocean health will require efforts from all sectors to promote peace, justice, gender equality, social responsibility, and other aspects of civil health.


OCEAN HEALTH INDEX™

100 Greatest Sustainable Productivity

90

THE GAP

From 65 to 100. What we do next matters.

80

70

65 Global Index Score

0

CHECK IT OUT AT
www.oceanhealthindex.org

VISUALIZATION THEATER

ENGAGING WITH OCEAN DATA IN VISUALLY APPEALING WAYS

Modern data visualizations on the world ocean, waterways, water supplies, climate and weather provide a fun and engaging alternative to the more traditional graphing of information used in the past. Our Visualization Theater offers links to innovative and fascinating ways to look at, actively engage in, and interpret data and ocean events. The use of the links found here, both online and in the classroom, has the potential to transform the way in which we engage with and learn about scientific facts related to the world ocean.

The complex ocean system is difficult to map and plot, resulting in billions of data points. Thankfully, there are innovators around the world transforming complex modeling data into easily understandable visualizations. From animations to time series, renderings to interactive graphs, scientists can present complex data such as carbon levels, circulation, sea ice, sea level rise, salinity, ocean temperatures, nutrient runoff, plastic pollution, and climate models in visually appealing ways. Modern visualizations bring the complexity of the world's systems to life for us to learn and to grasp a physical understanding of the ocean world.
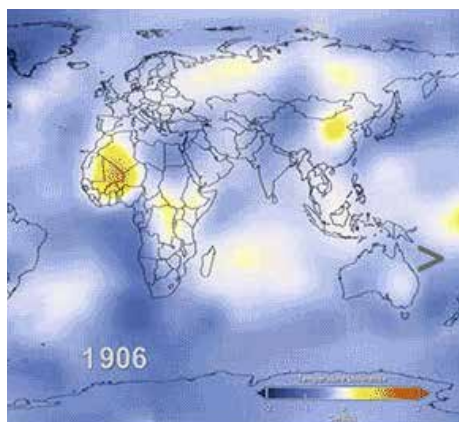
131 YEARS OF GLOBAL WARMING IN 26 SECONDS

This video from NASA is a compelling 26-second animation depicting how temperatures around the globe have warmed since 1880. The data comes from NASA'S Goddard Institute for Space Studies in New York, which monitors global surface temperatures.
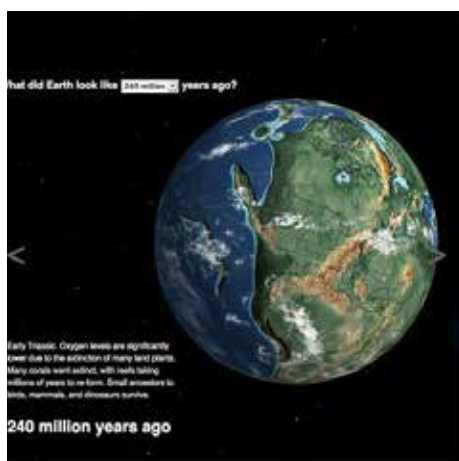

NASA WORLDVIEW

What did your town look like on a global map 540 million years ago? How about 90 million years ago? Or during the Jurassic period? This fantastic interactive map by Ancient Earth allows you to enter an address and track the location of the geological change occuring since before the pre-Cambrian period.

ANCIENT EARTH

This tool from NASA's Earth Observing System Data and Information System provides the capability to interactively browse global, full-resolution satellite imagery and to download underlying data. Many of the 600+ available products are updated within 3 hours of observation, essentially showing the entire Earth as it looks "right now."
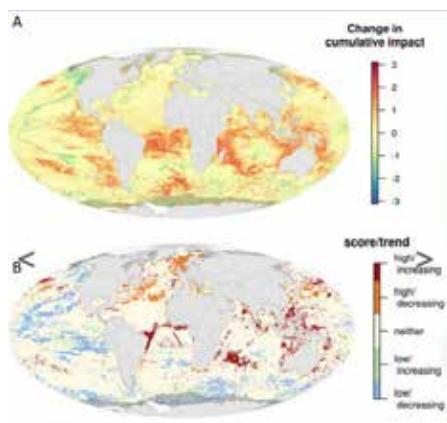
The goal of the research presented here is to estimate and visualize the global impacts humans are having on the ocean's ecosystems. The cumuliative impact map can be viewed in Google Earth or as an interactive feature by visiting their companion website.

AMERICAN RIVERS: A GRAPHIC
How much water is in America's rivers, and where is it? Perhaps unsurprisingly, people have little sense of how their local water resources compare in size to others. Is that a big river? A little river? Now, thanks to the Pacific Institute, it is possible to visualize the nation's waterways differently.

DETECTING OCEAN ACIDIFICATION
Information from the Integrated Ocean Observing System (IOOS) provides real-time data from offshore IOOS buoys, acting as an early warning system for shellfish hatcheries. They are our eyes on the ocean, coasts and Great Lakes. IOOS is an integrated network of people and technology gathering observing data and developing tracking and predictive tools to benefit the economy, the environment and public safety from local to global.

See more, learn more:
worldoceanobservatory.org/visualization-theater

WORLD OCEAN Observatory®

TOOLS

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UN ATLAS OF THE OCEANS

AN INTERNET PORTAL OF INFORMATION RELEVANT TO THE SUSTAINABLE DEVELOPMENT OF THE OCEAN

The UN Atlas of the Oceans is designed for policy-makers who need to become familiar with ocean issues and for scientists, students and resource managers who need access to databases and approaches to sustainability.

The UN Atlas can also provide the ocean industry and stakeholders with pertinent information on ocean matters.

The original partnership has expanded to include the National Geographic Society, the World Resource Institute (WRI) and the World Ocean Observatory (W2O).

Traditionally, an atlas was a bound collection of maps, charts, plates and tables illustrating a subject. The UN Atlas of the Oceans is an online version, an encyclopedic survey of the best ocean information. The project is a partnership of six UN Agencies and other public and private partners, including the World Ocean Observatory.

The UN Atlas of the Oceans is the most comprehensive online resource for inquiry about the full spectrum of ocean issues. It is an essential tool for students, teachers, and others interested in detailed information about ocean systems and services.

To access information, the Atlas offers four main points of entry:

ABOUT THE OCEANS
history, biology, maps and statistics to research, climatology and ecology. *About* provides information about how the oceans formed, how they change, ocean dynamics, ecology and biology of oceans, as well as monitoring the oceans.

USES OF THE OCEANS
from fishing, shipping and mining to tourism, dumping and marine biotechnology. *Uses* covers ocean resources and topics such as energy, biotechnology, ocean dumping, coastal settlements, and fisheries.

ISSUES
from food security and climate change to governance and human health. *Issues* discusses governance of ocean resources.

GEOGRAPHY
information categorized by geographical area. *Geography* allows users to search all topics and knowledge entries pertaining to a geographic location.

This portal provides information relevant to the sustainable development of the oceans. This atlas is designed for policy makers who need to become familiar with ocean issues and for scientists, students and resource managers who need access to databases and approaches to sustainability. The UN Atlas can also provide the ocean industry and stakeholders with pertinent information on ocean matters.

The Atlas of the Oceans is developed under the authority of UN-Oceans, the inter-agency coordination mechanism on oceans and coastal issues within the United Nations System.

WHAT COMES NEXT?

We have an astonishing opportunity to think about solutions and the future we want to see for the next generation. What do you think about when you envision a better world?

What are the new technologies and sustainable solutions yet to be born? What are the visions for our collective future? Ideas for a new iteration of sustainable civil society on a wide range of themes and concepts? Global biodiversity protections? Technical invention and management restructure? Renewable energy production and distribution? How do we manage environmental abuses? What might an improved sanitation system look like? How can we better manage water distribution and aquifer conservation? What could green cities look like? What are the incentives for sustainable products and manufacturing processes? Affirmation of ecosystem services analysis for policy and planning? Policy and inter-governmental agreements to advance public benefit, health, education, human rights, and social justice worldwide? Other targeted innovations?

Send us your ideas: director@thew2o.net

CONTRIBUTORS & SUPPORT

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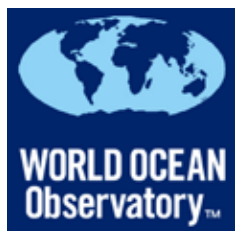
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The World Ocean Observatory offers a new model for ocean communications, aggregating comprehensive ocean information, consolidating educational resources, promoting other organizations' programs and successes, amplifying the ocean message, and multiplying ocean engagement with an audience above and beyond that of any individual endeavor. We are a collective voice for many ocean voices, a central place of exchange of content and accomplishment, and the promoter of best practices, innovation, and effective connection to the global ocean community. Today we perform this task with energy, imagination, economy, and efficiency, reaching a significant audience worldwide through the free distribution of a full catalogue of ocean information. We do so at modest cost, with a conservative annual budget, and all programs funded by prescient donors and private foundations who understand our concept, see our results, and are committed to our future.

Part 2 of the
Solutions series
coming in 2021

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