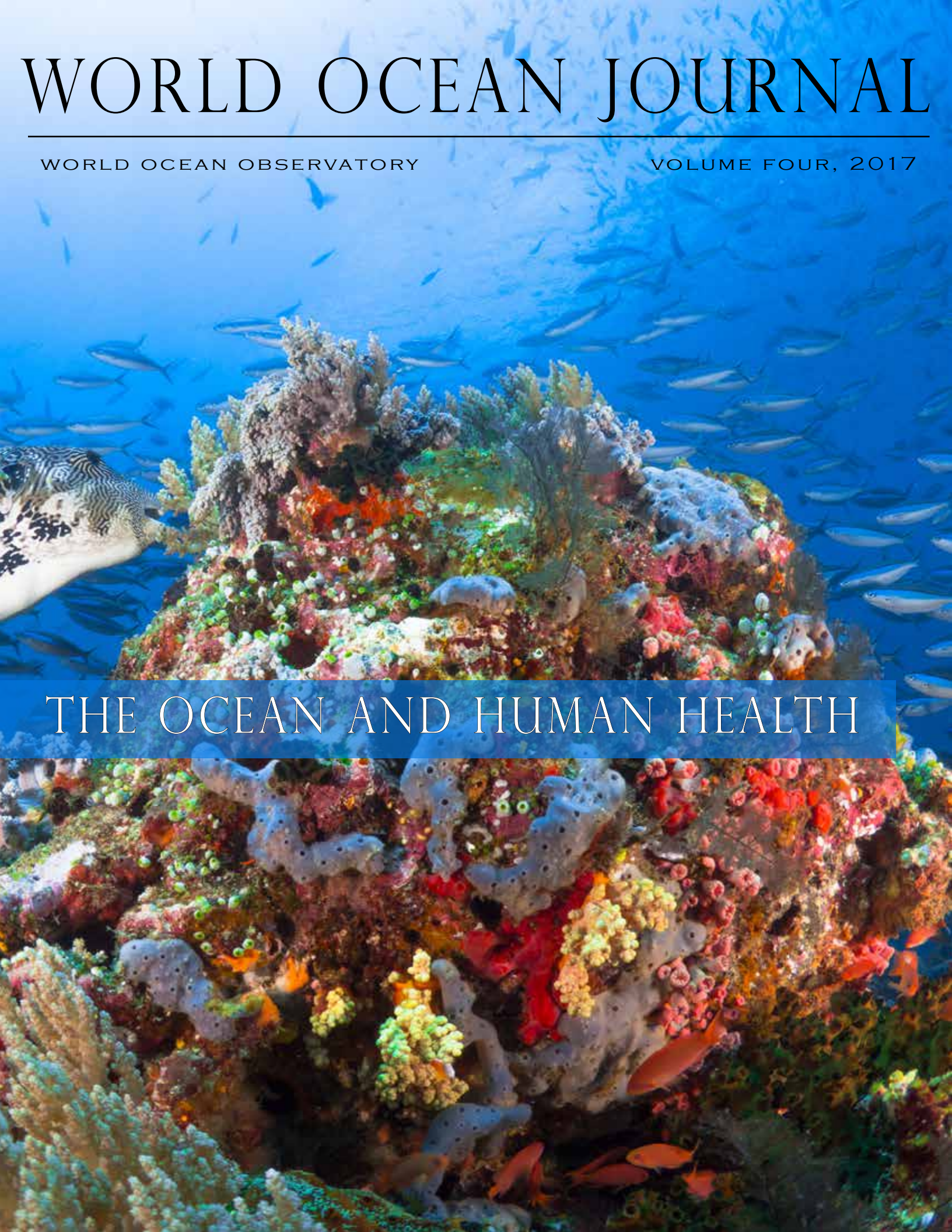
WORLD OCEAN JOURNAL

WORLD OCEAN OBSERVATORY

VOLUME FOUR, 2017



THE OCEAN AND HUMAN HEALTH

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On the Cover:

Map pufferfish and school of fusiliers dance around coral structure.
Photo by Mike Workman | 723129691

World Ocean Journal
volume four 2017

EDITOR
Peter Neill

DESIGN & PRODUCTION
Trisha Badger

WORLD OCEAN JOURNAL
is a publication of the World Ocean Observatory. WOJ is a digital magazine on ocean culture and solutions to today's ocean issues. Each volume includes essays, interviews, art, exhibits, and performances profiling the vital impacts of the ocean on our lives. This and future editions focus on a particular theme.

WORLD OCEAN OBSERVATORY
is a major utility for ocean communication as a means to advance public awareness and political will, and is dedicated to providing information and education about the health of the ocean. It is our belief that the sea connects all things.

CONTACT
director@thew2o.net

ANTHROPOGENIC

Peter Neill

EDITOR'S LOG

Anthropogenic is an adjective that describes changes in nature made by people; from the Greek *anthropogenes*, meaning "born of man." It is a word that has taken a new pejorative meaning in the 21st century, used to describe causative actions that a majority of scientists and scientific organizations connect to changes in the climate and other natural systems due to human activities and interventions.

In discussions with those who argue against these assertions it has become apparent to me that it is not the changed conditions that are in dispute, but rather the role of individuals responsible for the modern technology, manufacture, and natural resource extraction that must be denied. Yes, the situation exists, but humans, the politicians, managers, and investors, are not to be held responsible for the outcome of their actions. It is as if our world has simply become without any intervention by any human hand.

World Ocean Journal is not a place to resolve this dispute. But it is a place where we can address how science and technology, invented and executed by individuals, can engage the ocean, marine species and processes, in the treatment of disease, nutrition, and other aspects of human health.

This perspective seems obvious, but it nonetheless unusual. A search of publications on the subject reveals an astonishing lack. The scientific literature is more fertile ground, but it is often difficult to access and incomprehensible to the lay reader.

In consideration of a theme for the 2017 edition of World Ocean Journal, this topic, to be collected into a modest anthology, seemed surprisingly unaddressed and unknown, even prescient, pertaining pervasively and essentially to our understanding of the true value of the ocean and marine life beyond the more familiar awareness of species and habitat. Indeed, what concerns us about the threats to global fishing and pollution of coastal waters and the deep ocean is in fact primarily a health issue whereby the protein on which so many of us rely as the source of our diet and food security is threatened and our survival in health at risk.

But the subject is so much more, extending to the use of 100% of the fish, to new products derived, to synthesized drugs as cures for cancer or even diseases presently unknown.

Human health and the ocean represent both prevention and cure, from new drugs to psychological treatments, from the sustainability of an individual to that of a community or nation state. What we've included here is only a brief survey of these advancements, an opening to the perspective and information required to help us all understand the true value of the ocean for our physical, social, and planetary well-being.

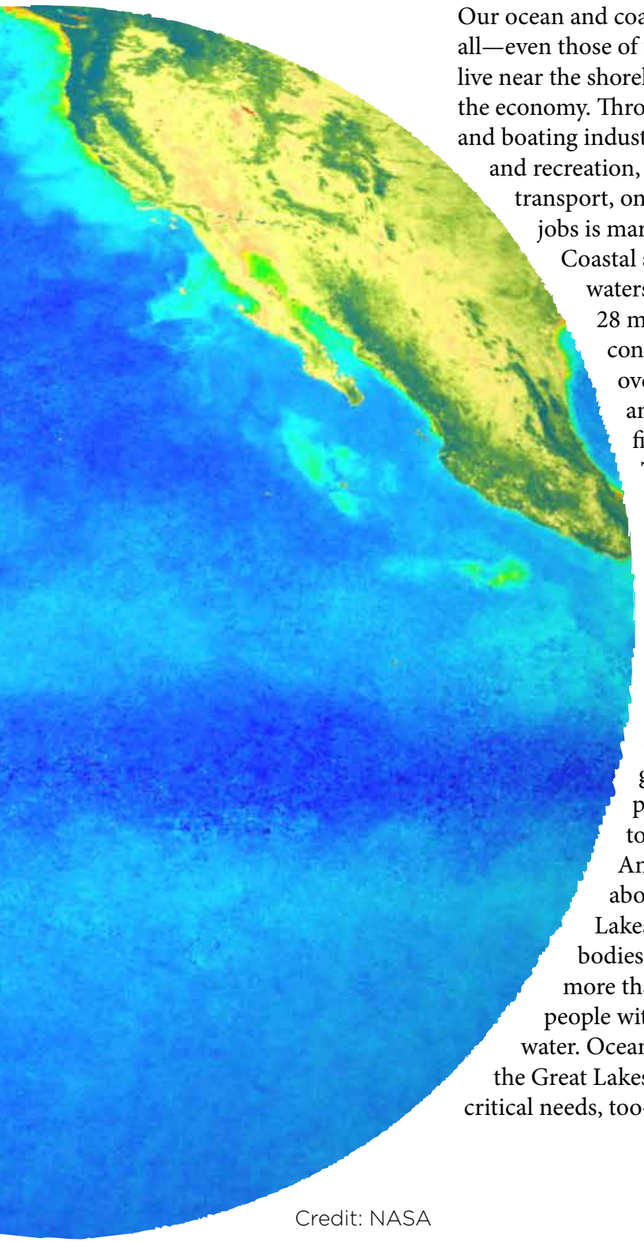
Thank you for reading. As an anthropogenic act, I urge you to please to share World Ocean Journal with friends, colleagues, family, educators and students, and the growing number of *Citizens of the Ocean* for which this digital magazine and the World Ocean Observatory is designed to serve.

newatlas.org

WHAT DOES THE OCEAN HAVE TO DO WITH HUMAN HEALTH?

NOAA Ocean Service

AN OCEAN AND HUMAN HEALTH INITIATIVE



Credit: NASA

Our ocean and coasts affect us all—even those of us who don't live near the shoreline. Consider the economy. Through the fishing and boating industry, tourism and recreation, and ocean transport, one in six U.S. jobs is marine-related. Coastal and marine waters support over 28 million jobs. U.S. consumers spend over $55 billion annually for fishery products. Then there's travel and tourism. Our beaches are a top destination, attracting about 90 million people each year. Our coastal areas generate 85 percent of all U.S. tourism revenues. And let's not forget about the Great Lakes—these vast bodies of water supply more than 40 million people with drinking water. Oceans, coasts, and the Great Lakes serve other critical needs, too—needs that are harder to measure, but no less important—such as climate regulation, nutrient recycling, and maritime heritage. Last but not least, a healthy ocean and coasts provide us with resources we rely on every day, ranging from food, to medicines, to compounds that make our peanut butter easier to spread! So what does all of this have to do with human health?

OCEAN IN DISTRESS

When we think of public health risks, we may not think of the ocean as a factor. But increasingly, the health of the ocean is intimately tied to our health. One sign of an ocean in distress is an increase in beach or shellfish harvesting closures across the U.S. Intensive use of our ocean and runoff from land-based pollution sources are just two of many factors that stress our fragile ecosystems—and increasingly lead to human health concerns. Waterborne infectious diseases, harmful algal bloom toxins, contaminated seafood, and chemical pollutants are other signals. Just as we can threaten the health of our ocean, so, too, can our ocean threaten our health. And it is not public health alone that may be threatened; our coastal economies, too, could be at significant risk.

CLOSING THE SAFETY GAP

Throughout the U.S., there are thousands of beach and shellfish closures or advisories each year due to the presence of harmful marine organisms, chemical pollutants, or algal toxins. To address public health threats and benefits from the sea, NOAA scientists and partners are developing and delivering useful tools, technologies, and environmental information to public health and natural resource managers, decision-makers, and the public. These products and services include predictions for harmful algal blooms and harmful microbes to reduce exposure to contaminated seafood, and early warning systems for contaminated beaches and drinking water sources to protect and prevent human illness.

EMERGING HEALTH THREATS

Marine mammals eat much of the same seafood that we consume, and we swim in shared coastal waters. Unlike us, however, they are exposed to potential ocean health threats such as toxic algae or poor water quality 24 hours a day, seven days a week. These mammals, and other sentinel species, can shed important light on how the condition of ocean environments may affect human health now and in the future.

As the principal stewardship agency responsible for protecting marine mammals in the wild, NOAA's Marine Mammal Health and Stranding Response Program supports a network of national and international projects aimed at investigating health concerns. One project is an assessment of the health conditions of dolphins in coastal waters in areas where contaminants may be of concern.

These assessments involve a veterinary examination, medical sampling, and attachment of radio transmitters that track dolphin movements and help determine contaminant sources. This research can not only warn us about potential public health risks and lead to improved management of the protected species, but may also lead to new medical discoveries.

CURES FROM THE DEEP

Keeping our ocean healthy is about more than protecting human health—it's also about finding new ways to save lives. The diversity of species found in the ocean offers great promise for a treasure chest of pharmaceuticals and natural products to combat illness and improve our quality of life. Many new marine-based drugs have already been discovered that treat some types of cancer, antibiotic resistant staph infections, pain, asthma, and inflammation. For example, NOAA and U.S. Department of Agriculture researchers recently found that a fish-killing toxin has the potential to kill or slow the growth of cancer cells, even at very low concentrations. Preliminary studies have demonstrated the toxin to be highly effective against renal cancer, one of the most challenging cancers to treat. NOAA and its partners are involved in many studies like this to seek out potential new benefits to make us healthier.

NOAA Ocean Service on the web:

Instagram: @noaaocean
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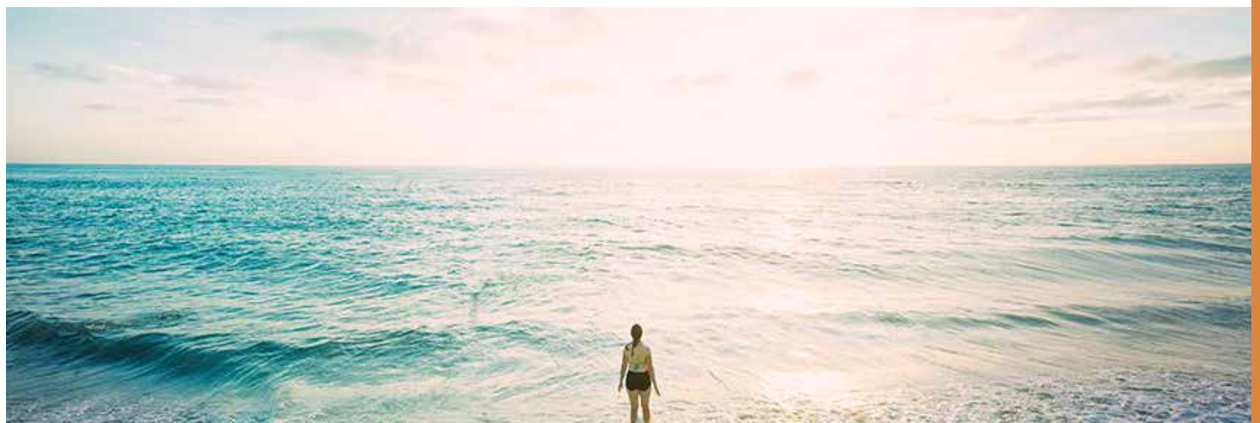


THE OCEAN AND HUMAN HEALTH

Peter Neill

THE STORY OF THE RELATIONSHIP BETWEEN HUMAN AND OCEAN HEALTH IS NOT ONE EASILY TOLD

Healthy, vibrant oceans are essential for human health and well-being. A surprising statement? It shouldn't be.

The world ocean provides important health benefits to humans, ranging from food, nutritional, and other resources, to recreational opportunities, to support for industries, to better understanding of human physiology, and to new treatments for human disease. However, as oceans become more degraded, human health effects from exposure to dangerous substances, including synthetic organic chemicals, polycyclic aromatic hydrocarbons, heavy metals, marine toxins, and pathogens have been increasingly recorded and are now of great concern. Coastal and marine habitats that have been impacted negatively by human use and development are unable to provide goods and services, and add to the human health risks posed by degraded oceans. Degraded seas thus move from being great providers to becoming threatening to human health. The result: increased rates of starvation and poverty, diminished sanitation and hygiene, accelerated spread of disease and poisoning, beach closures and reduced access to ocean areas, and ever-increasing public health costs and societal conflict.

Oceans suffer from being downstream, of everything. All our chemical inputs, unused fertilizers, pesticides and herbicides, debris, eroded silt and topsoil, untreated sewage, medicines—from our farms, our factories, our suburbs, and our cities— eventually make their way to the world ocean. As a result, coastal seas are now described as the most chemically altered environments on earth. Pollutants reach the seas via river inputs, atmospheric deposition, and run-off, resulting in expanding dead zones and endangering fisheries, biodiversity, and human health.

The indirect degradation of oceans is an increasing problem, despite government regulations on pollutants. This is partly due to the fact that the ocean system's most vital organs: the coastal wetlands, sea-grass beds, and mangrove forests that are its lungs, liver and kidneys, filtering out toxins before they reach the open sea, continue to be destroyed through coastal development. Eutrophication —the over-fertilization of near-shore waters caused by too many nutrients from fertilizers, sewage, animal waste, food processing residues—threatens to disrupt the ecological balance of coastal areas around the world. At the same time, toxins enter the marine system, are distributed worldwide by ocean circulation, and reside everywhere for long periods—until they are actively removed by mitigation—or until they enter the human food chain, elements of the corrupted marine environment now residing in our own tissues.

The story of how human health and ocean health are related is not one easily told. How much easier to portray the plight of the great whales, or to document the decline in fisheries, or to show a coastline sullied by unsustainable development. But make no mistake, the oceans contributes to almost every aspect of our lives, and thus as it deteriorates so too, inevitably, will the quality of our lives and our children's be comprised to critical points of survival.

"The Ocean and Human Health" first appeared as a World Ocean Radio audio broadcast. Learn more at worldoceanobservatory.org/world-ocean-radio.

CORAL BLEACHING IN THE MALDIVES
Credit: The Ocean Agency / XL Catlin Seaview Survey. Richard Vevers

GLOBAL HEALTH ASSESSMENT

Ocean Health Index

A HEALTHY OCEAN SUSTAINABLY DELIVERS A RANGE OF BENEFITS TO PEOPLE BOTH NOW AND IN THE FUTURE

Understanding the current state of our oceans is the first step toward ensuring the ocean can continue to provide benefits to humans. 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.

FIFTH ANNUAL GLOBAL ASSESSMENT

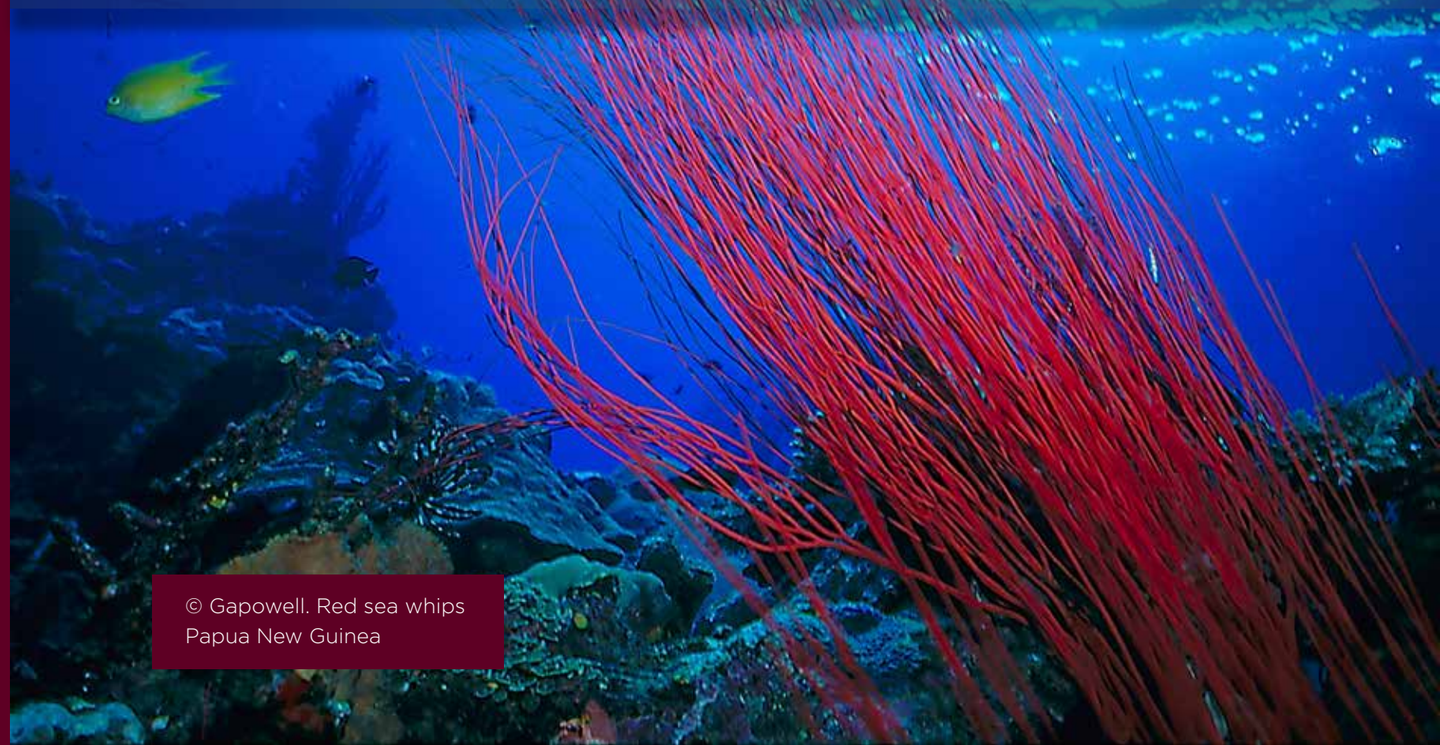
With the release of the 2016 global OHI scores (available online at ohi-science.org/ohi-global) five annual global assessments have now been completed for 220 Exclusive Economic Zones (EEZs) in addition to the assessments for Antarctica, the Southern Ocean and 15 sectors of the High Seas conducted in 2014.

KEY FINDINGS

A fourth consecutive global score of 71 indicates that, while the ocean has remained at a stable state, it is far from the desired 100 of a fully sustainable ocean. High scores for populated areas such Germany (ranked 4th among the 220 EEZs assessed, with a score of 85 and a population of ~81 million) and Seychelles (ranked 8th, with a score of 84 and a population ~97,000) exemplify the effectiveness of engaged and targeted social and environmental governance systems for improving ocean health.

"We've given the oceans their annual check-up and the results are mixed. It's as if you went to the doctor and heard that, although you don't have a terminal disease, you really need to change your diet, exercise a lot more, and get those precancerous skin lesions removed. You're glad you're not going to die but it's clear you need to change your lifestyle."

~ Dr. Ben Halpern, Lead Scientist, Ocean Health Index



© Gapowell. Red sea whips Papua New Guinea

2016 REPORT
EXECUTIVE SUMMARY

The pressures on the ocean environment are all too familiar: vanishing biodiversity, degraded habitats, sea-level rise, ocean acidification, expansive 'dead zones', and increasing pollution and marine debris. As a larger and wealthier global population grows towards an expected 10 billion, these pressures will threaten food security, climate stability, livelihoods, biodiversity and the global economy.

Ocean management and governance actions cannot fully counter challenges threatening the health of our oceans without integrating the complex synergies and dynamic relationships among all of the ocean's elements—physical, biological, economic, social, and cultural.

In response, Conservation International and more than 65 experts across academia, businesses, and non-governmental organizations came together to develop the Ocean Health Index — a scientific method for channeling the best available scientific information into marine policy.

By developing a means to easily assess all factors contributing both positively and negatively to the current state of our oceans, the Ocean Health Index (OHI) can create for any country a comprehensive coordinating platform for informing decisions about how to manage and protect their marine and coastal ecosystems. This produces the tangible, scientific evidence that is essential for motivating healthy ocean policy making at all scales and measuring future progress.

First launched in 2012, the OHI is now utilized by more than 30 countries to help inform and guide integrated decision-making for improved ocean management at regional, national, and global scales.

It has been used in varying contexts such as inspiring the development of Colombia's National 'Blue Agenda' to being utilized as an indicator for the United Nations Convention on Biological Diversity.

Due to the OHI's rapid success, it is well positioned for continued success over the short and long term, especially as increased attention is brought to marine conservation e orts. For example, in June 2017, world leaders will gather for a historic Call For Action for ocean health under the United Nations Sustainable Development Goal 14: Life Below Water, with its ambition to "conserve and sustainably use the oceans, seas, and marine resources for sustainable development."

The OHI has already been identi ed as a means for national level implementation of this unprecedented effort.

In order to catalyze change and promote action through comprehensive measures, as described by Goal 14, we must rely on integrated solutions that simultaneously alleviate pressures on marine and coastal environments and maximize the sustainable delivery of ocean bene ts to society.

Sustainably delivering the ocean's benefitts to society is the core of the Ocean Health Index.

Ocean Health Index on the web:

Instagram: @oceanhealth_index
Twitter: @OceanHealthIndx
Facebook: /Ocean-Health-Index
and at oceanhealthindex.org

2016 HIGHLIGHTS

Following its launch in 2012 in the scientific journal NATURE, the OHI is now utilized by government, civil, private and academic organizations around the world. During these first five years, the OHI has been successful in a variety of contexts. Here are key highlights for 2016:

• Fifth annual global OHI assessment conducted for all 220 exclusive economic zones (EEZs) around the world.

• With the addition of Africa, on-going, independently-led assessments (OHI+) are being implemented across all inhabited continents and many priority marine regions such as the Pacific Oceanscape, East Africa, and Southeast Asia.

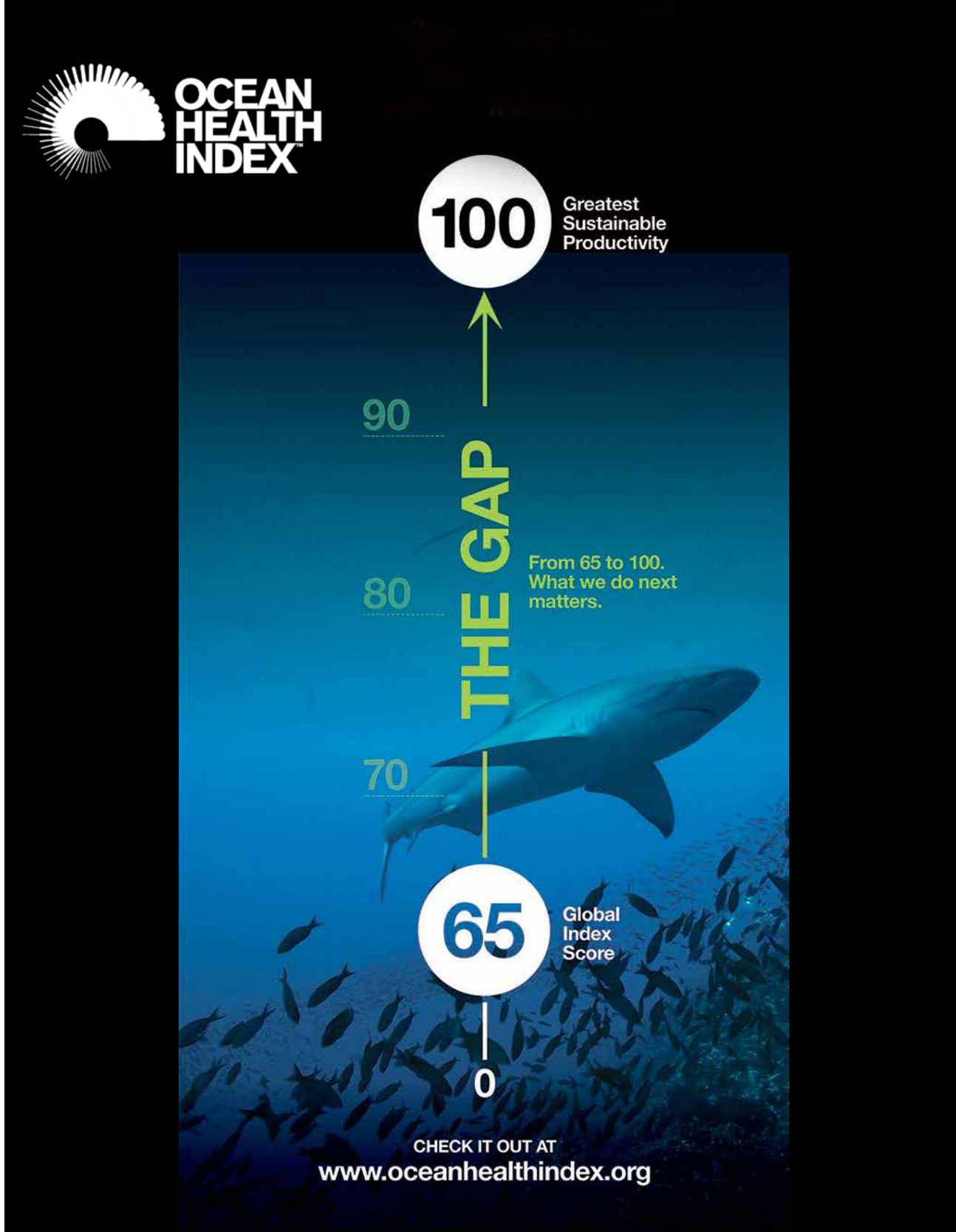
• Mexico publicly committed to using the OHI as the structure for the national Interdepartmental Commission for Sustainable Management of Seas and Coasts.

• The United States of America included the OHI in their first-ever National Ocean Plan for the Northeast Region.

• The United Nations Sustainable Development Goal 14: Life Below Water proposed the OHI as an implementation mechanism.

• The government of Indonesia is using the OHI to inform ocean management priorities as it develops its 5-year national development plan for 2019-2024. In late 2016, the Ministry of Oceans and Fisheries began the process of developing an OHI+ assessment for Bali as a pilot project. In 2017, they will begin a OHI-West Papua project.

• The Baltic Health Index launched in November 2016 represents the fitrst regional multi-national OHI assessment.



WATER IS MEDICINE FOR LIFE

Wallace J Nichols

AN EXCERPT FROM *BLUE MIND*

This summer I swam in the ocean,

And I swam in a swimming pool,

Salt my wounds, chlorine my eyes,

I'm a self-destructive fool, a self-destructive fool.

~ Loudon Wainwright III, Swimming Song

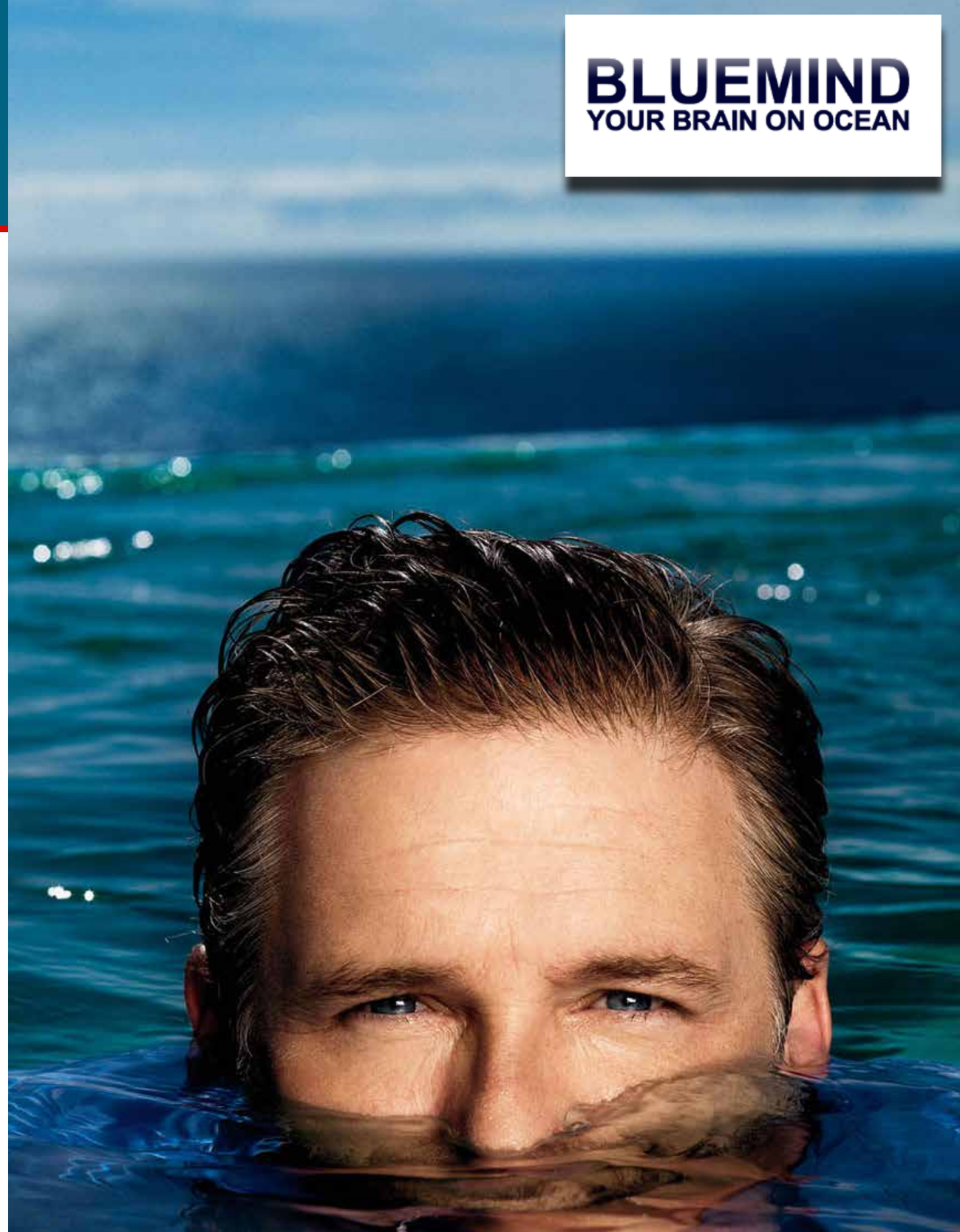
There are several reasons why swimming is the fourth most popular recreational activity in the United States, and the one people most aspire to take up if they're not swimming already. First is convenience: all you need is yourself and a body of water. But it's the ways in which we interact with water that make swimming both healthful and enjoyable for body and brain.

It all comes down to viscosity, pressure, and buoyancy. Archimedes (the Greek philosopher who supposedly came up with the concept of water displacement while getting into a bathtub) stated that when an object enters the water, water moves out of its way. At the same time the water pushes upward against the object with a force equal to the weight of water displaced. That force creates buoyancy, or the ability to float. If an object is compact and dense (like a boat anchor, for example), it's heavier than the amount of water displaced, and it sinks. If an object is either light (like an inflated beach ball) or its weight is spread out over an area big enough to displace water equal to its weight (like the hull of a boat), it floats.

So why should the human body, which would seem pretty dense and compact for its weight, float? Easy: recall that the body (our blood, bones, organs, skin, and muscle) is up to 78 percent water when we are born (slowly decreasing with age), so we have close to the same density as the medium in which we swim. We're also around 15 percent fat, which is lighter than water, and we have lungs that are filled with air, which makes us more buoyant (like that beach ball). Therefore, a 200- pound human body actually weighs only around 10 pounds in water. (This relative weightlessness is why, since the 1960s, astronauts have used water immersion to train for missions in outer space.) This helps explain why such small flotation devices can keep us afloat.

But there's much more to the experience of swimming than buoyancy. Water has a tangible quality, a weight, and it has 600 times the resistance of air. Unlike earth or air, we can explore water in multiple dimensions — up, down, sideways; as neurologist Oliver Sacks comments, we feel tangibly supported and embraced by this "thick, transparent medium." The resistance and pressure of water contribute to swimming's role as one of the best forms of both aerobic exercise and muscle toning. Because the pressure of water outside the body is greater than the pressure inside, explains Bruce E. Becker, director of the National Aquatics and Sports Medicine Institute at Washington State University, water forces blood away from the extremities and toward the heart and lungs.

The heart responds by upping its effort, pushing this extra volume of blood more efficiently with each heartbeat, and thus circulating upwards of 30 percent more blood volume than normal throughout the body. To cope with this increased load, the arterial blood vessels relax and create less resistance to blood flow.



Here's the intriguing part: one of the hormones that regulates arterial function is catecholamine, and catecholamines are part of the body's response to stress. As Becker describes it, "During immersion, the body sends out a signal to alter the balance of catecholamines in a manner that is similar to the balance found during relaxation or meditation." In other words, just being in the water can create a feeling of relaxation and a decrease in stress.

But that's not all. The lungs are receiving a greater volume of blood as well, which, combined with the pressure that water exerts on the chest wall, makes them work harder to breathe — approximately 60 percent harder than on land. This means that aquatic exercise can strengthen the respiratory muscles and improve their efficiency. In one study that compared aquatic aerobics with "dry" aerobics, Becker discovered that while various forms of aerobics improved fitness levels and some respiratory capacity, only aquatic exercise improved respiratory endurance. The muscles, too, are benefiting from the increased circulation as they receive greater amounts of blood and oxygen. And it's a good thing, too, because it requires effort to propel the body through water; in swimming, every muscle is benefiting from what is essentially resistance training (one of the best ways to increase both tone and strength). In addition, swimming works the large, smooth muscles of the body, stretching and lengthening the muscles, joints, and ligaments with each stroke, while the head and spine get a good workout with every breath you take. It all means that stroking through the water not only puts you into a psychologically relaxed state, but also makes you physically stronger.

Like other forms of aerobic exercise, swimming can produce the release of endorphins and endocannabinoids (the brain's natural cannabis-like substances), which reduce the brain's response to stress and anxiety. Some theorize that the feel-good effects of swimming are related to the same "relaxation response" triggered by activities like hatha yoga. In swimming, the muscles are constantly stretching and relaxing in a rhythmic manner, and this movement is accompanied by deep, rhythmic breathing, all of which help to put swimmers into a quasi-meditative state. As one of the greatest competitive swimmers of our time, Michael Phelps, describes it, "I feel most at home in the water. I disappear. That's where I belong."

That sense of belonging increases with exposure. Recent studies have shown that regular exercise is associated with an increase in the number of new neurons in the hippocampus, the area of the brain linked to learning and memory. More neurons means greater cognitive functionality; this may be the reason why regular aerobic exercise, like swimming, has been shown to help maintain our cognitive abilities as we age. But there's something more going on with the exercise that swimming provides. Even though we spend our first nine months in "water," we are not born learning how to swim.

We talk about babies "learning" how to crawl, and then walk, and then run, but this happens without instruction. Our brains are designed for the natural emergence of these abilities. But the ways we use our bodies in water — having to time our breaths consciously, reaching up and over and pulling the water toward us, moving the legs independently of the pace that the arms are setting — is nothing like the way we move on land. We must learn how to swim, and this combination of cognitive effort and aerobic exercise has actually been proven to provide the greatest amount of what is called " cognitive reserve" — that is, the mind's resilience to damage to the brain.

Sadly, according to a 2010 study commissioned by the USA Swimming Foundation, 40 percent of Caucasian children, 60 percent of Hispanic children, and 70 percent of African American children have low or no swimming ability. (Worldwide, drowning remains the leading cause of "unintentional injury" deaths among children under the age of five.) Given what we're learning about the physical and Blue Mind benefits of swimming, this isn't just a disappointment — it's a public health crisis.

And that's why open-water swimmer Bruckner Chase is in American Samoa, a small U.S. territory that sits 15 degrees above the equator and a six- hour plane flight from Hawaii. To help promote ocean awareness, in 2011 he swam the nine miles from Aunu'u Island to Pago Pago Harbor, something that no one had ever done before — not because it was a challenging open-water swim, but because all of the locals were sure he'd be eaten along the way. "This is a three-thousand year- old culture, with a strong oral tradition," Chase remarked. "One shark attack two hundred years ago can be passed down generations and keep people from going into deep water. It's a culture that has ties to the sea, yet they had marine-

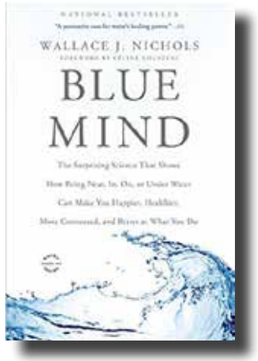
patrol first responders who couldn't swim. Not surprising, the rate of drownings here is very high." Long memories (especially those involving sharp teeth) mean that fear of the water can transform a concern into a fundamental legacy. So Chase and his wife, Dr. Michelle Evans- Chase, set out to change the culture around swimming. They established a program called Toa o le Tai — Ocean Heroes — in which they trained teenagers to safely be in and around the ocean and then to teach younger kids the same skills. Chase is justly proud of the results of his Ocean Heroes, one of whom is a young man named Tank. "When I first talked to Tank, he wouldn't go in water over his head, period," Chase says. "Today, Tank is jumping into water that's one hundred feet deep and a year ago he thought was full of sharks. And his buddies are all begging to be part of the program."

My biological father, Jack Hoy, was a "water guy" and an avid, lifelong swimmer. Indeed, he was built to swim: wide shoulders, barrel chest, his body tapering cleanly to his feet.

He competed on swim teams in high school and college, and throughout his life he swam, sailed, and fished. Jack's favorite spot in the world was Cape Rosier, and he returned to that part of Maine's rocky coast again and again. It was where his family and friends came together to hold his memorial service in August 2013. At Bakeman Beach, Jack's kids and grandkids stripped down at sunset and plunged into the cold Atlantic.

We swam out into the cove, as he loved to do. I felt every stroke. It was cold, yes, but that didn't matter. Swimming together, in his name, here in this place, was perhaps the best tribute we could offer Jack. Somewhere out in the dimming deep water we naturally gathered in a circle. There really wasn't much to be said, the ocean and our exposed bodies — similar due to Jack's DNA but different due to diversity in his mates and spouses and those of his kids — spoke clearly for generations and ancestors, and we were all the same, connected by the thread, connected by water. A love of water was one of his gifts.

Some of the strongest recollections people can have around water are swimming alongside family. The dad who holds his arms out to you as you jump into the pool for the first time. The mom who sits with you on the beach in the shallow water, laughing with you as the waves rush around the two of you. The big brother or sister or cousin who leads you out into deeper water than you might ever attempt on your own. The love of swimming is often passed down through families, and being in the water together can bond you at every stage of life.



BLUE MIND
The Surprising Science That Shows How Being Near, In, On, or Under Water Can Make You Happier, Healthier, More Connected, and Better at What You Do by Wallace J Nichols

Little, Brown and Co.
July 2014

BLUE MIND 8:
WATER IS MEDICINE

The eighth annual convening of interdisciplinary professionals working at the intersection of brain science and conservation. The 2018 summit will examine water as medicine – as practioners, researchers, artists and writers bring world-changing research and practical applications to support that water (in all shapes and forms) is indeed medicine.
June 7 - 9, 2018
Frost Museum of Science
Miami, Florida

LIVE BLUE:
THE SEVEN AGES OF WATER

J's next book, *Live Blue: The Seven Ages of Water,* explores how a lifelong relationship with water can help us thrive, create and connect more on our little blue planet.

On the web at:
Facebook: /nicholswj
Twitter: @wallacejnichols
www.wallacejnichols.org

RESURFACING FROM TRAUMA

Operation Surf Project

CAN THE OCEAN AND SURFING CHANGE THE LIVES OF MILITARY VETERANS?

A growing body of evidence shows the healing effects on the brain and the body from surf therapy and being in the ocean. Groups like Operation Surf are turning to ocean therapy to help active duty servicemen and veterans cope with physical and mental trauma.

One in three combat troops report symptoms of PTSD. Only 40% seek help. In the US, 22 war veterans kill themselves every 24 hours. These are just the reported numbers, and they are alarming.

A new film by directors Josh Izenberg and Wynn Padula sets out to raise awareness of these critical issues, and to help and inspire veterans suffering from physical and psychological difficulties to explore the therapeutic benefits of being on and near the ocean.

"Resurface" opens with the story of Iraq war veteran Bobby Lane, a soldier stuggling with trauma, sleeplessness, seizures, and depression. His plan: to cross surfing off of his bucket list and then take his own life. He did surf, he didn't kill himself, and for him, Operation Surf became a life-saving experience.

Founded by Van Curaza, a lifelong surfer who personally understands the value and contribution of the surfing experience, Operation Surf is a not-for-profit organization located on the Pacific coast in San Luis Obispo, California. Curaza knows first hand the rehabilitative power of the ocean, the increased confidence surfing instills, and the realization that one can surpass personal limitations. Curaza resolved to extend these known benefits to men and women whose bodies and lives have been dramatically and painfully altered by war.

For them, the ocean becomes a place to advance physical recovery, to demonstrate strength and ability, to build relationships and bonds with others, and to regain the psychological strength to transcend trauma, to return to their families, to reengage in positive and remunerative work – in the military and elsewhere – and to regain the wholeness of mind and spirit that will enable their survival and success.

According to Christopher Bergland for *Psychology Today,* one big reason surfing can alleviate PTSD is that the ocean itself has the cathartic ability to wash away negative emotions, by putting them in a context of something much larger and more powerful that someone's individual life experience. When you're "in the zone" the stress and trauma of your daily life seems to dissolve.

War veteran Bobby Lane describes his conversion as such: "Now I see it. If life gets too hard, there's always the ocean."

The ocean provides tangible and intangible qualities for our lives. It is an immersion that we literally cannot live without.

A 28 minute documentary by directors John Izenberg and Wynn Padulae entitled "Resurface" shows the positive effects of being in and near the ocean for military veterans. Participants in Operation Surf experience a decrease in PTSD symptoms by 36%, a decrease in depression by 47%, and an increase in self-efficacy by 68%. Watch "Resurface" on Netflix.

CLIMATE CHANGE REFUGEES

Secretary of State John Kerry

RESILIENCE, ADAPTATION, AND SURVIVAL IN THE 21ST CENTURY AND BEYOND

Image Credit: Reuters. Icebergs floating in Harlequin Lake near Yakutat in southeastern Alaska. October 7, 2014

World Ocean Journal chose an excerpt from Secretary Kerry's remarks at the *Global Leadership in the Arctic: Cooperation, Innovation, Engagement, and Resilience* (GLACIER) Conference. August 31, 2015
Visit 2009-2017.state.gov/secretary/remarks/2015/08/246489.htm to read the remarks in entirety.

"

The motto of Alaska is "North to the Future." So I think it's particularly fitting today that men and women from every corner of the globe have come north for the future. Because what we can decide here – and not just here but what we make real in Paris and beyond – will profoundly impact the future of life on this planet.

I have struggled for years, as I'm sure many of you have, with how to adequately take an issue of this magnitude, this kind of challenge, and put it in terms that average folks can really grab onto, where it isn't so intimidating that people walk away and say, "Well, there's no way I can deal with that." Where people somehow feel that there are individual steps you can take even as countries, states decide to come together – and take the larger steps.

But what we discuss here today is important not just for the Arctic, it is important for the rest of this planet. Everywhere I travel, leaders and average folks talk to me about the impacts of climate change and what they feel and see is happening to their lives in one particular part of the world or another. And the Arctic is so important for us to visit and understand because the Arctic is in many ways a thermostat, a computerized system, if you will, where we don't even understand fully what the algorithm is, and yet we already see is having a profound impact on the rest of the planet.

The temperature patterns, the weather patterns, what happens in the ocean in the Arctic can, in fact, we know – though we don't completely understand the ways in which it will happen – but we know it has this profound impact on habitat everywhere, on breeding grounds everywhere, on the ecosystem itself.

And one of the beauties of what we heard today from each of the speakers is this notion of balance. The balance between our activities – we, having the power of reasoning and choice over all of these other living species, what we choose has this profound downstream impact. Dr. Holdren just painted a very straightforward, purely scientific, absolutely factual picture. And it's hard for people to digest that fully. Some people just want to write it off as a natural change, notwithstanding that at the end of the 19th century a Swedish scientist actually first described the impact of global heating and of the greenhouse effect itself. And we all know that were it not for the existence of the greenhouse itself, life itself would not exist on this planet because it is the greenhouse effect that has held the temperature at a steady average of about 57 degrees for life to be able to exist.

Now we know the Arctic is warming at this pace that was described today, twice as fast, four times in certain places, glaciers now melting three times faster than the rate observed in the last century, and as they melt the level of sea level rises. But in the figures that we saw regarding Greenland there is cause for greater concern, because the ice sheet on Greenland sits on rock, not in the ocean. Therefore it doesn't displace water, it only adds to it. And as that level of ice melts, that is a magnitude greater of increase in the rate of sea level rise. And as we saw from Dr. Holdren's presentation, in the most recent days the giga-tonnage, billions of level of meltdown, is significantly greater than it has been at any time in the past, giving greater cause for concern.

We see the permafrost melting, which is releasing methane, and methane we all know is about 30 times on average more damaging than CO2. And sometimes, in the short term it's 86 times more damaging, but over an average of about a hundred years 30 times more damaging. But 30 times more damaging than something that we're already having trouble getting control of is a threat to everybody.

We've seen 5 million acres of fires in Alaska alone, equal to the size of my state of Massachusetts, in this last year. And on top of that, we see significant challenges to life itself as it invades the communities that have been built, not just in Alaska, but in other parts of the world – low-lying nation-states in the Pacific and others that are increasingly facing this challenge. The bottom line is that climate is not a distant threat for our children and their children to worry about. It is now. It is happening now. And I think anybody running for any high office in any nation in the word should come to Alaska or to any other place where it is happening and inform themselves about this. It is a seismic challenge that is affecting millions of people today.

Villages in Alaska are being battered by storms and some have had to move, or will. As the permafrost continues to thaw, the infrastructure is being challenged. Houses and other buildings are literally collapsing into rubble.

Already this is happening. There's a village a few hours northwest of Anchorage called Galena. In 2013, Galena and a number of other villages in the state faced terrible hardships after an ice jam caused the Yukon River to flood. And because natural defenses had melted away, 90 percent of Galena's buildings were completely destroyed.

The Arctic has never been an easy place to survive let alone to raise a family or make a living. The story of Arctic communities is inherently one of resilience, adaptation, and survival from one generation to the next. But global climate change now threatens life in this region in a way that it hasn't been threatened for all of those 10,000 years that Chief Stephan talked about. And unless the global community comes together to address this challenge, the dramatic climate impacts that we're seeing in this part of the world will be a harbinger for every part of the world.
And we as leaders of countries will begin to witness what we call climate refugees moving – you think migration is a challenge to Europe today because of extremism, wait until you see what happens when there's an absence of water, an absence of food, or one tribe fighting against another for mere survival.

So over the course of this conference, we will discuss all of this. And the many opportunities that are actually staring us in the face right now to be able to respond to this challenge and, ironically, to respond to it in a way that creates millions of jobs, improves our economy, improves health, improves our ability to respond to the environment, does all of the plus-ups that you search for in public policy without the long-term damage and costs that we're witnessing by not taking those actions.

America's first climate change refugees
It is predicted that within a decade the Alaskan village of Kivalina will be completely underwater.
Credit: Associated Press

SECRETARY OF STATE JOHN KERRY (2013-2017)
At his confirmation hearing for Secretary of State in 2013, Senator John Kerry (D-MA) pledged to be a "passionate advocate of action" on climate. After his confirmation and throughout his tenure as the 68th United States Secretary of State, Kerry took strong positions on climate change, the need for renewable energy, and the importance of a healthy ocean for the future of the planet to sustain the human race.

The World Ocean Observatory is grateful to Secretary Kerry and the Administration under which he served for their dedication to ocean and climate issues and the enactment of policies to protect the planet and its finite resources.

SEASONS OF STRESS

Henry J.F. Penn, etal

Understanding the Dynamic Nature of People's Ability to Respond to Change and Surprise

Authors:

Henry J. F. Penn, Water & Environmental Research Center, University of Alaska Fairbanks

S. Craig Gerlach, Dept of Anthropology & Archaeology, University of Calgary, Canada

Philip A. Loring, School of Environment & Sustainability, University of Saskatchewan, Saskatoon, Canada

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Climate change is impacting coastal communities in rural Alaska in multiple direct and indirect ways. Here, findings are reported from ethnographic research done with municipal workers, community leaders, and other local experts in the Bristol Bay region of Alaska, where it is found that climate change is interacting with local social and environmental circumstances in ways more nuanced than are generally captured by frameworks for vulnerability analysis. Specifically, the research herein shows the importance of the temporal dimension of vulnerability to environmental change in rural Alaska, both in terms of temporal patterns that emerge from climate-driven stressors and also with respect to how, and under what conditions, people in rural communities may design or manage effective responses to change. There are multiple factors that play into how rural communities will be affected by some climatic or environmental stress; ultimately, the impacts of climatic and environmental stressors will differ depending on where, when, and how frequently they occur. To capture these interactions, two analytical concepts—community capacity and cumulative effects—are discussed and then incorporated into a visual tool for improved planning and vulnerability analysis.

With Bristol Bay no longer freezing in winter, storms have ripped earth away from the Togiak seawall.
Credit: City of Togiak, Alaska

In September of 2007 in the community of Red Salmon, Alaska, coastal erosion caused a wastewater lift station to fail, releasing untreated waste water onto the beach adjacent to the Red Salmon River. The sewage main runs along the river; whereas it was formerly completely buried, parts of it were uncovered and left exposed as a result of weather-driven erosion. The failed lift pump in particular was exposed to high water levels, weather, and continued erosion. Municipal workers were able to respond to the failure quickly enough to limit the extent of environmental contamination, but in interviews local managers expressed how fortunate they were that the failure did not occur during the height of the salmon fishing season. For one, the wastewater system would have likely been running at 150% of its designed capacity due to a seasonal increase in population from fishermen, cannery workers, and other seasonal residents.

Second, a coordinated response by community workers would have been difficult at this time because some local workers would have been fishing themselves. Finally, the prospect of releasing untreated wastewater into a river when it is full of highly valued salmon raises human health and safety issues; an event such as this could have had devastating impacts on the reputation of these commercial fisheries and on the economy, health, and well-being of Red Salmon and the region as a whole.

This anecdote highlights important social and ecological dynamics that enter into how communities experience the impacts of changing weather and climate, and whether they are able to effectively respond. Specifically, we see the importance of the timing of events, fluxes in human resources, and other drivers of short-term variability in a community's vulnerability to some event or surprise. Below, we discuss these dynamics in greater detail as they relate to the many challenges facing coastal communities in rural Alaska, where both climate change and life in general have strong seasonal dimensions. We propose a framework for capturing these nuanced aspects of how communities are impacted by change, one based on the concepts of cumulative effects and community capacity (CEQ 1997; Beckley et al. 2009). We pair these concepts with a visual decision calendar framework (see also Corringham et al. 2008; Kim and Jain 2010; Ray and Webb 2016), which we then operationalize with the data on climate and weather impacts gleaned through interviews with municipal workers and other local experts in rural Alaska in order to illustrate how these concepts provide an informative framework to help determine whether or not people are able to effectively manage environmental challenges.

Our study is thus situated within the general area of vulnerability analysis, which has emerged as an important and popular framework for thinking about the impacts of climate change (e.g., Cutter 1996; Adger 1999; Turner et al. 2003; Adger 2006; Ford et al. 2006; Gallopin 2006; Smit and Wandel 2006; Hinkel 2011; Haalboom and Natcher 2012.) As we discuss below, vulnerability analysis and other analytical frameworks that attend to climate change do not always specifically address the

nuanced temporal dynamics highlighted in the story above (Ray and Webb 2016). The decision calendar framework we present here provides both a vocabulary and a compelling visual tool for examining the place-based complexities of how communities experience and respond to change (Parris et al. 2016).

THE SEASONALITY OF CLIMATE CHANGE AND LIFE IN RURAL ALASKA

Climate change is already affecting people in Alaska and the rest of the circumpolar North through a variety of meteorological and environmental changes in annual precipitation; the form and patterns of precipitation (i.e., rain vs snow); snow and winter frost depth; the distribution, movement, and quality of nearshore sea ice; and growing season length (Markon et al. 2012). The frequency, intensity, and seasonality of marine storms are also increasing, and these bring both heavy waves and water level surges that can worsen coastal erosion (Atkinson et al. 2011). Land cover changes are also occurring, including permafrost thaw, expansion of shrubs in the tundra, and a northward and westward drift of the arctic tree line (Markon et al. 2012). Along with other impacts, continuation of these trends could increase water loss due to evapotranspiration and result in overall drier seasonal and annual means for Alaska in the future (SNAP 2011).

Many of the changes expected in high latitudes, including but not limited to the ones mentioned above, pose risks for rural and urban communities in these regions, and in many cases, these changes and their associated risks are playing out with a distinctive seasonal signal. Strong fall storms are the norm now; seasonal sea ice cover can protect coastal communities from these storms by buffering wave action, but declines in sea ice extent and changes in the timing of freeze up can make communities more vulnerable to surge and erosion (Overeem et al. 2011). Likewise, the timing and duration of rapid and often dramatic "break up" and "freeze up" seasons: the period of time during which coastal or river ice is transitioning from open to frozen or vice versa, is also changing. In recent years uncertainty about break up and freeze up timing has complicated shipping and travel along rivers, and in many cases has resulted in large ice dams and severe spring flooding (Hopkins 2013; Friedman 2013).

Ongoing vulnerability to flooding, erosion, and deficiencies in sanitation: issues of coastal Alaska community residents.
Credit: Alaska Native Tribal Health Consortium

Many aspects of life in rural Alaska are also marked by a distinct seasonal pattern. These remote rural communities are peopled by cultures very familiar with the highs and lows of seasonal resource productivity and seasonally mobile lifestyles. Historically, indigenous people across Alaska moved from summer fish camps to fall hunting and spring trapping camps (Nelson 1969, 1986).

Today, hunting, fishing, and the country food harvest remain very important to local culture and food security although people are less mobile and trips are often shorter than in the past (Loring and Gerlach 2009; Gerlach et al. 2011). Other seasonal aspects of life in coastal communities include winter constraints on shipping; in communities where sea ice or river ice is a factor, barge service may only be available for a few months per year. Commercial fisheries, sport fisheries, and other tourism activities also contribute a seasonal rhythm to life in many coastal communities. Finally, many people from these communities also take seasonal employment, working in summers for firefighting crews or mining companies, for example. Many of these seasonal aspects of life in rural Alaska factor directly into how climate and weather impacts are experienced.

CONCLUSIONS

Rural Alaskans are keenly aware of climate change and are actively searching for innovative and effective solutions that complement rather than detract from community plans for development and prosperity (Cochran et al. 2013; Loring et al. 2016). Intuitively, we all understand that people are creative – that they experiment and innovate in different ways, and therefore we should expect that no two communities can or will mobilize resources in the same manner. Our attempt with this paper is to shed further light on how communities mobilize resources and to craft a robust framework for visualizing how communities will be impacted by change or surprise.

Methods, discussion, and references of this research can be found online at: journals.ametsoc.org/doi/full/10.1175/WCAS-D-15-0061.1

Communities in western Alaska experience drastic changes as melting permafrost shifts the ground beneath them. Here: A changing Alaskan landscape in the Yukon-Kuskokwim Delta, Bering Sea, Alaska. Image courtesy of Calista Education and Culture, Inc.

What are the overall effects of the plastics we unwittingly ingest?

Plastics surround us. A vital manufacturing ingredient for nearly every existing industry, these materials appear in a high percentage of the products we use every day. Although modern life would be hard to imagine without this versatile chemistry, products composed of plastics also have a dark side, due in part to the very characteristics that make them so desirable: their durability and longevity.

Now Rolf Halden, Associate Professor in the School of Sustainable Engineering at Arizona State University and Assistant Director of Environmental Biotechnology at the Biodesign Institute, has undertaken a survey of existing scientific literature concerning the hazards of plastics to human health and to the ecosystems we depend on. His findings, which appear in the latest issue of the *Annual Review of Public Health*, are sobering.

Today, plastics accumulate in garbage dumps and landfills and are sullying the world's oceans in ever greater quantity. And plastics and their additives aren't just around us, they are inside virtually every one of us, present in our blood and urine in measureable amounts, ingested with the food we eat, the water we drink and from other sources.

Halden's study reiterates the fact that the effects to the environment from plastic waste are acute. Measurements from the most contaminated regions of the world's oceans show that the mass of plastics exceeds that of plankton sixfold. Patches of oceanic garbage – some as large as the state of Texas – hold a high volume of nonbiodegradable plastics. Aquatic birds and fish are increasingly victims because biodegradation processes are inadequate to eliminate this durable refuse.

Polluted beach in Benin, Africa on the Gulf of Guinea (bordered by Togo to the west and Nigeria to the east). Credit: Mike Markovina, Marine Photobank

The magnitude of society's burden of plastic waste is only beginning to be fully appreciated. In the US, the average person produces a half pound of plastic waste every day. Around the world, some 300 million tons of the material are produced each year, a figure poised to expand as new forms of plastics are devised to serve a voracious global appetite. As Halden points out, this annual production alone would fill a series of train cars encircling the globe. "We're doomed to live with yesterday's plastic pollution and we are exacerbating the situation with each day of unchanged behavior."

Adverse effects to human health remain a topic of fierce controversy, though a growing consensus is emerging that plastics and their additives are not always the benign companions we once assumed them to be. Halden says he accepted the invitation to write about plastics and human health "because the topic showcases the bigger problem of how to create a sustainable future for modern civilization."

Two broad classes of plasticrelated chemicals are of critical concern for human health: bisphenolA or BPA, and additives used in the synthesis of plastics, which are known as phthalates. Halden explains that plastics are polymers – long chains of molecules usually made of carbon, hydrogen, oxygen and/or silicon, which are chemically linked together or polymerized. Different polymer chains can be used to create forms of plastics with unique and useful properties.

BPA is a basic building block of polycarbonate plastics, such as those used for bottled water, food packaging and other items. While it has been considered benign in the form of a heavily crosslinked polymer, its bonds can break down over time, when plastics are repeatedly washed, exposed to heat or other stresses, liberating the building blocks of the chemical, which are toxic. BPA has been recognized since the 1940s as an endocrine disrupting chemical that interferes with normal hormonal function.

Adding to the health risks associated with BPA is the fact that other ingredients – such as plasticizers – are commonly added to plastics. Many of these potentially toxic components can also leach out over time. Among the most common is a chemical known as diethylhexyl phthalate or DEHP. In some products, notably medical devices including IV bags or tubing, additives like DEHP can make up 40 or 50 percent of the product. "If you're in a hospital, hooked up to an IV drip," Halden explains, "the chemical that oozes out goes directly into your bloodstream, with no opportunity for detoxification in the gut. This can lead to unhealthy exposure levels, particularly in susceptible populations such as newborns."

What are the overall effects of the plastics we unwittingly ingest? The literature Halden surveyed is ambiguous on this point, despite more than half a century of study. Part of the difficulty lies in the absence of good controls for studying health outcomes, as plastic exposure is a global phenomenon, and finding unexposed subjects for comparison is nearly impossible. It is known, however, that health effects vary depending on who is exposed and when. Infants and pregnant or nursing mothers are at heightened risk for toxic exposure or passage of BPA and additives like DEHP.

In January of 2010 the FDA announced an important reversal of its 2008 claims regarding the safety of bisphenolA, expressing new concern about "potential effects of BPA on the brain, behavior and prostate gland of fetuses, infants and children," and pledging to collaborate with other federal health agencies to reevaluate the chemical's safety.

Studying the effects of lowdose exposure is tricky, usually requiring a very large number of study subjects. Instead, epidemiologists tracking the problem frequently base their conclusions on data gathered from individuals known to have unusually high levels of a chemical, often the result of high level occupational exposure. Halden insists that further study on lowdose exposure is essential to settle the matter of health risks, noting some evidence in the literature suggests that high-dose studies may be inadequate to properly understand toxic effects from continuous low level exposures.

Halden explains that while plastics have legitimate uses of benefit to society, their brazen misuse has led to a radically unsustainable condition. "Today, there's a complete mismatch between the useful lifespan of the products we consume and their persistence in the environment." Prominent examples of offending products are the ubiquitous throwaway water bottles, Teflon-coated dental floss and cotton swabs made with plastic PVC sticks. All are typically used for a matter of seconds or minutes, yet are essentially non-biodegradable and will persist in the environment, sometimes for millennia.

Despite the scourge of discarded plastics and the health risks these substances pose, Halden is optimistic that society can begin to make wiser choices and develop more sustainable products, formed from biodegradable, nontoxic chemical building blocks. New forms of polymer, some made from renewable materials that are digestible by microorganisms, are being explored.

Ultimately, converting to petroleumfree construction materials for use in smart and sustainable plastics will become a necessity, driven not only by health and environmental concerns, but by the world's steadily declining oil supply. As Halden emphasizes, the manufacture of plastics currently accounts for about 8 percent of the world's petroleum use, a sizeable chunk, which ultimately contributes to another global concern the accumulation of carbon dioxide in the atmosphere.

"We are at a critical juncture," Halden warns, "and cannot continue under the modus that has been established. If we're smart, we'll look for replacement materials, so that we don't have this mismatch: good for a minute and contaminating for 10,000 years."

Source:
Arizona State University
March 20, 2010
Original Link:
www.news-medical.net/news/20100320/Impact-of-plastics-on-human-health-and-ecosystems.aspx

THE IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH

US Global Change Research Program
Climate and Health Assessment

A SCIENTIFIC ASSESSMENT

Hurricane Isabel from space. Credit: Mike Trenchard, Earth Sciences & Image Analysis Laboratory, Johnson Space Center. 2003

Climate change is a significant threat to the health of the American people. This scientific assessment examines how climate change is already affecting human health and the changes that may occur in the future. This article provides a summary of the assessment.

CLIMATE CHANGE AND HUMAN HEALTH

The influences of weather and climate on human health are significant and varied. Exposure to health hazards related to climate change affects different people and different communities to different degrees. While often assessed individually, exposure to multiple climate change threats can occur simultaneously, resulting in compounding or cascading health impacts.

With climate change the frequency, severity, duration, and location of weather and climate phenomena – like rising temperatures, heavy rains and droughts, and some other kinds of severe weather – are changing. This means that areas already experiencing health-threatening weather and climate phenomena, such as severe heat or hurricanes, are likely to experience worsening impacts, such as higher temperatures and increased storm intensity, rainfall rates, and storm surge. It also means that some locations will experience new climate-related health threats.

For example, areas previously unaffected by toxic algal blooms or waterborne diseases because of cooler water temperatures may face these hazards in the future as increasing water temperatures allow the organisms that cause these health risks to thrive. Even areas that currently experience these health threats may see a shift in the timing of the seasons that pose the greatest risk to human health. Climate change can therefore affect human health in two main ways: first, by changing the severity or frequency of health problems that are already affected by climate or weather factors; and second, by creating unprecedented or unanticipated health problems or health threats in places where they have not previously occurred.

TEMPERATURE-RELATED DEATHS AND ILLNESS

Increasing concentrations of greenhouse gases lead to an increase of both average and extreme temperatures. This is expected to lead to an increase in deaths and illness from heat and a potential decrease in deaths from cold (see Figure ES3), particularly for a number of communities especially vulnerable to these changes, such as children, the elderly, and economically disadvantaged groups. Days that are hotter than the average seasonal temperature in the summer or colder than the average seasonal temperature in the winter cause increased levels of illness and death by compromising the body's ability to regulate its temperature or by inducing direct or indirect health complications. Loss of internal temperature control can result in a cascade of illnesses, including heat cramps, heat exhaustion, heatstroke, and hyperthermia in the presence of extreme heat, and hypothermia and frostbite in the presence of extreme cold. Temperature extremes can also worsen chronic conditions such as cardiovascular disease, respiratory disease, cerebrovascular disease, and diabetes-related conditions. Prolonged exposure to high temperatures is associated with increased hospital admissions for cardiovascular, kidney, and respiratory disorders.

AIR QUALITY IMPACTS

Changes in the climate affect the air we breathe, both indoors and outdoors. The changing climate has modified weather patterns, which in turn have influenced the levels and location of outdoor air pollutants such as ground-level ozone (O_3) and fine particulate matter. Increasing carbon dioxide (CO_2) levels also promote the growth of plants that release airborne allergens (aeroallergens). Finally, these changes to outdoor air quality and aeroallergens also affect indoor air quality as both pollutants and aeroallergens infiltrate homes, schools, and other buildings. Poor air quality, whether outdoors or indoors, can negatively affect the human respiratory and cardiovascular systems. Higher pollen concentrations and longer pollen seasons can increase allergic sensitization and asthma episodes and thereby limit productivity at work and school.

EXTREME EVENTS

Climate change projections show that there will be continuing increases in the occurrence and severity of some extreme events by the end of the century, while for other extremes the links to climate change are more uncertain. Some regions of the United States have already experienced costly impacts – in terms of lives lost and economic damages – from observed changes in the frequency, intensity, or duration of certain extreme events. While it is intuitive that extremes can have health impacts such as death or injury during an event (for example, drowning during floods), health impacts can also occur before or after an extreme event, as individuals may be involved in activities that put their health at risk, such as disaster preparation and post-event cleanup. Health risks may also arise long after the event, or in places outside the area where the event took place, as a result of damage to property, destruction of assets, loss of infrastructure and public services, social and economic impacts, environmental degradation, and other factors. Extreme events also pose unique health risks if multiple events occur simultaneously or in succession in a given location. The severity and extent of health effects associated with extreme events depend on the physical impacts of

the extreme events themselves as well as the unique human, societal, and environmental circumstances at the time and place where events occur.

VECTOR-BORNE DISEASES

Vector-borne diseases are illnesses that are transmitted by vectors, which include mosquitoes, ticks, and fleas. These vectors can carry infective pathogens such as viruses, bacteria, and protozoa, which can be transferred from one host (carrier) to another. The seasonality, distribution, and prevalence of vector-borne diseases are influenced significantly by climate factors, primarily high and low temperature extremes and precipitation patterns. Climate change is likely to have both short- and long-term effects on vector-borne disease transmission and infection patterns, affecting both seasonal risk and broad geographic changes in disease occurrence over decades. While climate variability and climate change both alter the transmission of vector-borne diseases, they will likely interact with many other factors, including how pathogens adapt and change, the availability of hosts, changing ecosystems and land use, demographics, human behavior, and adaptive capacity. These complex interactions make it difficult to predict the effects of climate change on vector-borne diseases.

WATER-RELATED ILLNESS

Across most of the United States, climate change is expected to affect fresh and marine water resources in ways that will increase people's exposure to water-related contaminants that cause illness. Water-related illnesses include waterborne diseases caused by pathogens, such as bacteria, viruses, and protozoa. Water-related illnesses are also caused by toxins produced by certain harmful algae and cyanobacteria and by chemicals introduced into the environment by human activities. Exposure occurs through ingestion, inhalation, or direct contact with contaminated drinking or recreational water and through consumption of contaminated fish and shellfish. Factors related to climate change – including temperature, precipitation and related runoff, hurricanes, and storm surge – affect the growth, survival, spread, and virulence or toxicity of agents (causes) of water-related illness. Whether or not illness results from exposure to contaminated water, fish, or shellfish is dependent on a complex set of factors, including human behavior and social determinants of health that may affect a person's exposure, sensitivity, and adaptive capacity. Water resource, public health, and environmental agencies in the United States provide many public health safeguards to reduce risk of exposure and illness even if water becomes contaminated. These include water quality monitoring, drinking water treatment standards and practices, beach closures, and issuing advisories for boiling drinking water and harvesting shellfish.

FOOD SAFETY, NUTRITION, AND DISTRIBUTION

A safe and nutritious food supply is a vital component of food security. The impacts of climate change on food production, prices, and trade for the United States and globally have been widely examined, including in the recent report "Climate Change, Global Food Security, and the U.S. Food System."

An overall finding of that report was that "climate change is very likely to affect global, regional, and local food security by disrupting food availability, decreasing access to food, and making utilization more difficult." This chapter focuses on some of the less reported aspects of food security, specifically the impacts of climate change on food safety, nutrition, and distribution. There are two overarching means by which increasing carbon dioxide (CO_2) and climate change alter safety, nutrition, and distribution of food. The first is associated with rising global temperatures and the subsequent changes in weather patterns and extreme climate events. Current and anticipated changes in climate and the physical environment have consequences for contamination, spoilage, and the disruption of food distribution.

The second pathway is through the direct CO_2 "fertilization" effect on plant photosynthesis. Higher concentrations of CO_2 stimulate growth and carbohydrate production in some plants, but can lower the levels of protein and essential minerals in a number of widely consumed crops, including wheat, rice, and potatoes, with potentially negative implications for human nutrition.

MENTAL HEALTH AND WELL-BEING

The effects of global climate change on mental health and well-being are integral parts of the overall climate-related human health impacts. Mental health consequences of climate change range from minimal stress and distress symptoms to clinical disorders, such as anxiety, depression, post-traumatic stress, and suicide. Other consequences include effects on the everyday life, perceptions, and experiences of individuals and communities attempting to understand and respond appropriately to climate change and its implications. The mental health and well-being consequences of climate change related impacts rarely occur in isolation, but often interact with other social and environmental stressors. The interactive and cumulative nature of climate change effects on health, mental health, and well-being are critical factors in understanding the overall consequences of climate change on human health.

POPULATIONS OF CONCERN

Climate change is already causing, and is expected to continue to cause, a range of health impacts that vary across different population groups in the United States. The vulnerability of any given group is a function of its sensitivity to climate change related health risks, its exposure to those risks, and its capacity for responding to or coping with climate variability and change. Vulnerable groups of people, described here as populations of concern, include those with low income, some communities of color, immigrant groups (including those with limited English proficiency), indigenous peoples, children and pregnant women, older adults, vulnerable occupational groups, persons with disabilities, and persons with preexisting or chronic medical conditions. Characterizations of vulnerability should consider how populations of concern experience disproportionate, multiple, and complex risks to their health and well-being in response to climate change.

Source: Arizona State University, March 20, 2010
Read the report in its entirety at health2016.globalchange.gov.

FOLIA WATER

W2O with contribution from Jonathan Levine, Ph.D, CEO and Co-Founder, Folia Water

Paper for Pennies. Water for Billions.

With a simple and robust new technology, a California-based startup is making a water filter that can provide safe drinking water for billions around the globe, for less than a penny per day.

The need for fresh water is universal. Each of us – no matter who we are, what we earn, or where we live – must consume at least two quarts of water per day to sustain basic daily physical health. According to the World Health Organization (who.int), an individual requires 18 gallons per day to provide medium term maintenance to include drinking, cooking, personal hygiene, washing clothes, cleaning homes, growing food, sanitation and waste disposal.

More than 2.1 billion people on the planet – nearly 1 in 10 – do not have access to safe, germ-free water. And there are 2 billion people more who overpay for water. The World Health Organization reports that disease due to poor drinking water access, unimproved sanitation, and poor hygiene practices cause 4% of all deaths and 5.7% of all disability or ill health in the world. 50% of urban residents in developing countries are affected at one time or another by disease related to insufficient access to safe drinking water and improved sanitation. And in light of the recent spate of hurricane-related disasters in Texas and the Caribbean, we see that water security is increasingly tenuous. Climate change will surely exacerbate existing challenges to water resources around the globe.

The most recent estimates of global population assert that there will be up to 10.5 billion people on the planet by 2050, an increase of over 2.3 billion in three decades. The demands to sustain such a population are enormous. According to a 2015 UN World Water Development Report, fresh water demand will increase 70% to satisfy these basic water needs. "People in many parts of the world enjoy improved access to safe drinking water, but there are [vast populations] without such access, and in cities the numbers are growing."

SCIENTIFIC INNOVATION

What is the cost of providing clean water? With Folia Water, it's a few cents. Theresa Dankovich, PhD, invented a germ-killing nano-silver coated paper filter as the focus of her doctoral work in Chemistry at McGill University in Montreal, Canada. Her invention uses non-toxic reagents and renewable materials. Folia Water is a thick paper filter embedded with silver that cleans water by removing dirt and particulate. The silver nanoparticle filter paper kills 99.99% of EColi, Cholera, Typhoid, bacteria, viruses, and physically filters out protozoa, dirt, and worms.

FROM LAB TO WORLD

For her post-doctoral research at University of Virginia in 2013, Dankovich successfully field-tested the filters in rural Limpopo, South Africa. Since 2014, Dr. Dankovich and her partners have field-tested filters in Ghana, Honduras, Bangladesh, Kenya, China, and Haiti, showing repeatedly that they can purify many types of polluted water, including well water, streams, rivers, ponds, springs, and even gray water.

The next challenge was to create culturally appropriate filter holders for international markets that would ensure correct and consistent use of the filters. Through non-profit partnerships, Dr. Dankovich and Dr. Jonathan Levine (Folia Water's cofounder and CEO) began field testing different filter holders and collecting feedback from potential customers, those primarily responsible for household water purification and hygiene.

FROM COOL TECHNOLOGY TO ROBUST PRODUCT

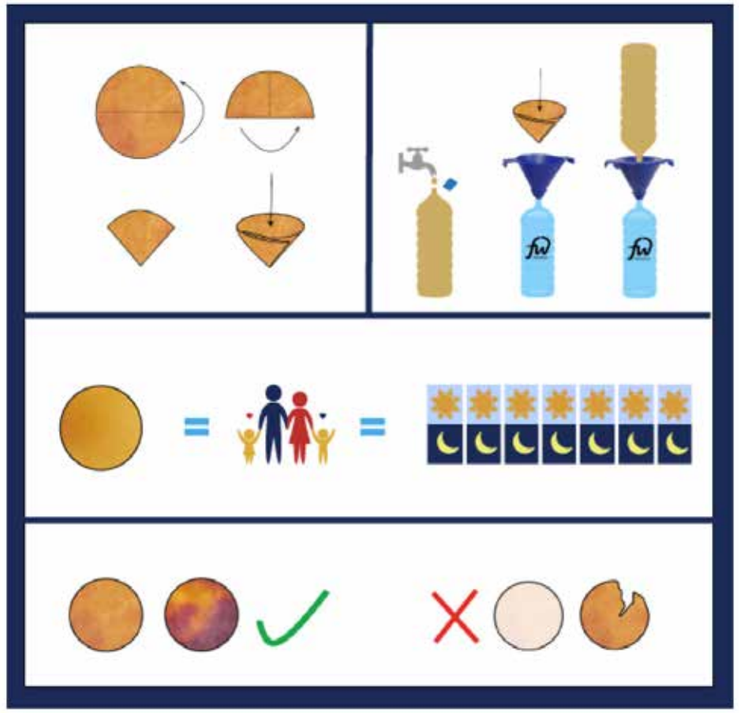
In 2016 Folia Water achieved many technical milestones including design iterations, technology scale-up, product development, and customer engagement and feedback. Folia Water can produce

over 1.5 tonnes of Folia Filters per day which translates to approximately 150,000 filters. The Keystone Funnel™ was developed as a filter holder that fits with a variety of household water collection and storage container around the world, including two-liter bottles, jerry cans, Bangladeshi kolshis, 5-gallon buckets and Guatemalan tinajas. Case studies of customer engagement through filter distribution trials have been carried out in Honduras, China, the Dominican Republic, Haiti, Ghana, Kenya, Tanzania, South Africa, Bangladesh, and India.

Each .50-cent filter provides clean drinking water to a family for an entire week. These filters provide a less expensive (and more sustainable) alternative to bottled water for the 3 billion people who pay $20 billion per year on household water.

Folia Water is a wholesale technology manufacturer of paper filters. Their business model is to sell large volumes of Folia Filters to distributors who have the expertise and know-how to handle local distribution. Folia aims to partner with commercial, entrepreneurial, social enterprise, and NGO distribution partners capable of handling marketing and localization including product positioning, messaging, supply chain, and last mile distribution.

Silver-infused Folia Filters are packaged like coffee filters. Each filter provides germ-free water at a retail price of only .50 cents for a week's worth of safe



water for a family. Filters are used with Keystone Funnel ™ for simple hands-free water filtration using any common household water container.

Folia Water promotes human welfare through innovation to reduce waterborne disease, one water filter at a time. They are working with an early-stage venture fund and seed-stage accelerator called 500 Startups in Silicon Valley.

On the web at:
Facebook: /foliawater
Twitter: @foliawater
www.foliawater.com

THE UNITED NATIONS, SUSTAINABLE DEVELOPMENT GOALS, AND WATER

Fresh water sustains human life and is vital for human health. There is enough fresh water for everyone on Earth. However, due to bad economics or poor infrastructure, millions of people lack access to a clean water supply, proper sanitation, and water required for hygiene. Water scarcity and affordability affect more than 40 per cent of the global population and is projected to rise. It is estimated that 783 million people do not have access to clean water and over 1.7 billion people are currently living in river basins where water use exceeds recharge.

Access to safe drinking water and adequate sanitation services is vital to human health, but also has other important benefits ranging from the easily identifiable and quantifiable (costs avoided, time saved) to the more intangible (convenience, well-being, dignity, privacy and safety).

The UN is prioritizing access to water and sanitation as Goal 6 of its sustainable development goals. Goal 6 of the SDGs has clear linkages to health, food security and climate change, and resiliency to disasters and ecosystems (among many other issues).

Among the targets within Goal 6 are improved water quality and water-use efficiency; the protection of water-related ecosystems such as mountains, forests, wetlands, rivers, aquifers and lakes; and the expansion of international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies.

LEARN MORE
sustainabledevelopment.un.org

In South Africa, Ghana, Honduras, Bangladesh, Kenya and Haiti, field testing has proven that Folia filters can purify even the most polluted gray water.

WE ALL LIVE DOWNSTREAM

Chris Clarke for KCET

At Risk from the Dakota Access Pipeline

Oil spills are an increasing threat to human health worldwide. That's true enough when crude oil spills on land: it ruins any soil it touches, and pollutes the air as its volatile components evaporate.

Spill that crude in water, and the damage can become far more widespread. Wetlands, streams and rivers can carry spilled oil many miles away from the site of the spill. As the heavier substances in the oil settle out, they can permanently damage the waterway and all the living things that depend on it. Meanwhile the lighter fractions of that crude can be carried farther, hundreds or even thousands of miles away.

The Dakota Access Pipeline (DAPL) will carry at least 450,000 barrels of crude oil a day along 1,172 miles of 30-inch-wide pipeline from the Bakken oil fields in North Dakota to an oil terminal at Patoka, Illinois. Along the way, it will cross and recross major rivers belonging to the nation's largest watershed, the Missouri-Mississippi.

At 22 of those crossings, the risk of spills from a conventional pipeline is severe enough that DAPL's owners, Energy Transfer Partners, have tunneled deep under the river beds to reduce the likelihood that a spill will affect surface water. At the controversial crossing of Lake Oahe near the Standing Rock Sioux Reservation, the pipeline will be up to 90 feet beneath the riverbed.

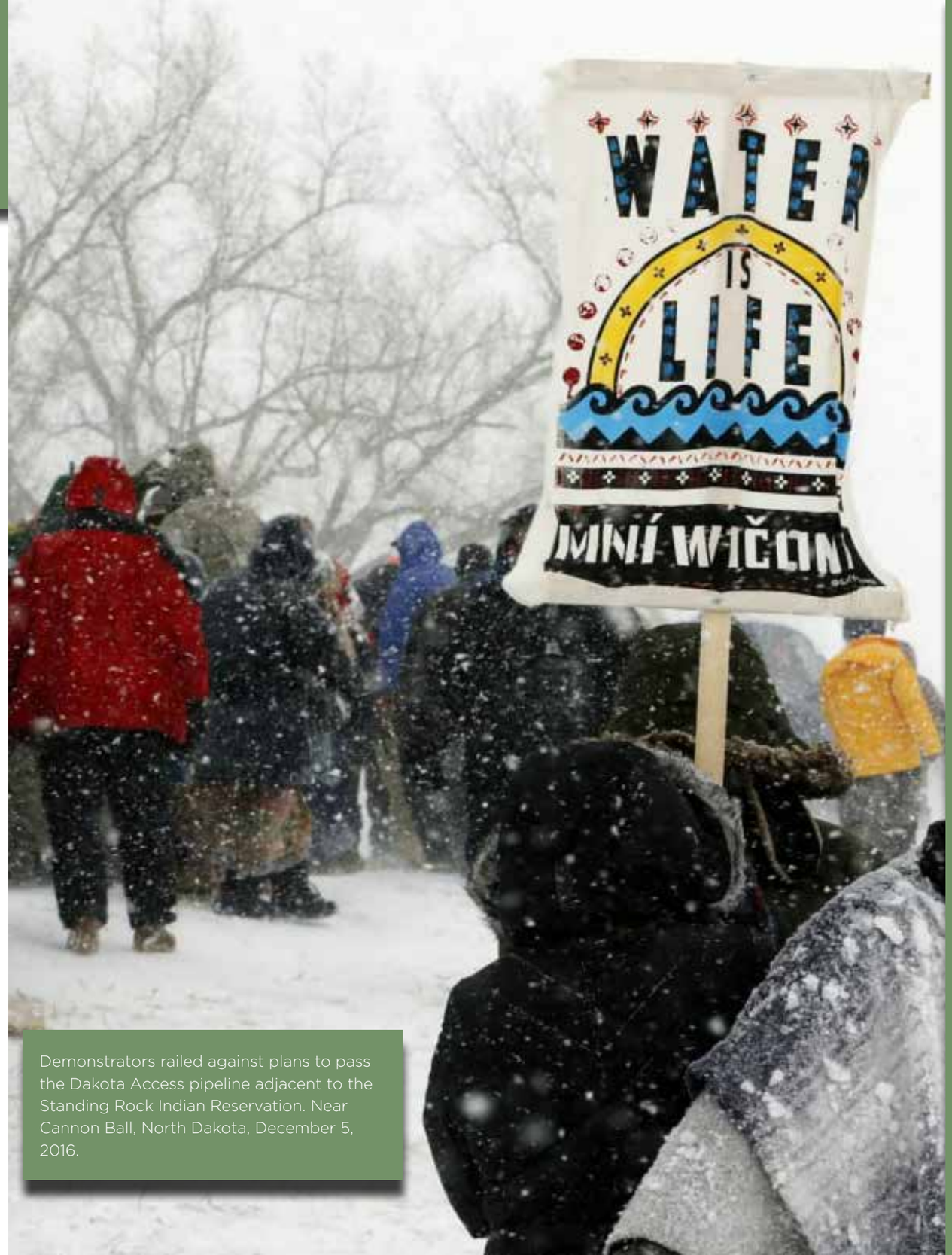
But even the pipeline's most ardent defenders don't claim DAPL won't leak. The simple reason: all pipelines leak.

Oil and gas companies reported 162 pipeline spills in North Dakota in 2014 alone, and that doesn't include spills that took place inside the fence-lines of oil company facilities.

Buried pipelines, in fact, may pose a much more serious threat to public health than those on the surface. An above-ground pipeline can be monitored and repaired much more easily with even a small leak. A leak in a hardened pipeline 90 feet below the Missouri River may not be detected for months, and cleanup may prove impossible. That means the leaked oil is free to percolate into the river, there to endanger the health of those downstream.

There are a lot of people downstream of the DAPL's many river crossings. Approximately 17 million people rely on downstream portions of the Missouri and Mississippi rivers for their drinking water, more than 10 million of them in the nine major metropolitan areas downstream: Bismarck, Sioux City, Omaha, Kansas City, St. Louis, Des Moines, Memphis, Baton Rouge, and New Orleans.

And that's not counting the many smaller communities, some of



Demonstrators railed against plans to pass the Dakota Access pipeline adjacent to the Standing Rock Indian Reservation. Near Cannon Ball, North Dakota, December 5, 2016.

them far from affluent, along the Missouri and Mississippi in 11 states. As geographer Jennifer Veilleux notes, some of those more rural downstream communities include Native nations. The Standing Rock and Cheyenne River reservations got a lot of press on the topic of their vulnerability to DAPL, but spills from the Dakota Access Pipeline could also harm the water supply for other downstream reservations including the Crow Creek, Iowa, Omaha, Ponca, Rosebud, Sac and Fox Nation, Santee, Lower Brule, Mandan Hidatsa Arikara, Winnebago and Yankton reservations.

The effects of oil contamination are wide-ranging. There is the direct harm to human health done by short-term exposure to petroleum products, which can include poisoning, respiratory damage and apparent nervous system damage. These ailments can be experienced by anyone in proximity to a spill, but they're especially dangerous for anyone working on cleaning up the oil, whether they're operating booms to skim oil off the water or cleaning affected wildlife.

Secondly, there are the long-term effects from consistent exposure to smaller amounts of petroleum and its components. These are too varied to create a complete list; petroleum can contain dozens or even hundreds of different hydrocarbon compounds, each with its own set of health risks, and crude oil's chemical composition varies depending on where it comes from.

But in general, chronic exposure to the constituents of crude oil causes a range of cancers as well as respiratory ailments such as bronchitis and asthma, and has been linked to reproductive disorders including miscarriage and stillbirth, central nervous system disorders, and mental health problems.

People are also hurt by spilled crude oil's effect on other organisms. When the 1989 *Exxon Valdez* spill in Alaska wiped out the salmon and herring fisheries in and near Prince William Sound, fishing-dependent communities such as Cordova were devastated. That toll fell especially hard on Native communities with salmon-based cultures. In places like the oil-drenched Cross Rivers State in Nigeria, traditional farmers and herders suffer from oil contamination of their livestock and game.

Dakota Access Pipeline
Image credit: *Democracy Now!*

Much the same thing happened in the wake of the Deepwater Horizon disaster in 2010, as the shrimp fishery was devastated, tourism collapsed and real estate values for coastal properties affected by the spill nose-dived.

In the vicinity of a large spill from DAPL or other pipelines, we can expect to see similar health problems and economic dislocation. But significant accidents can even affect communities far downstream. While the levels of contaminants in the Mississippi River at New Orleans may not be significantly affected by a large accident near Bismarck, each accident does add to the overall burden of pollution endured by communities downstream.

The Missouri and Mississippi watersheds are among the most heavily industrialized in the world, and pollution from Montana to Ohio and New York washes downstream toward the Gulf. The burden of toxic substances is great enough to cause a [hypoxic]*dead zone* in the Gulf offshore from the Mississippi Delta.

Pollutants in the river don't just flow downstream. Water from the Missouri-Mississippi watershed is used in consumer food and hygiene products, as irrigation water for food crops, and to slake the thirst of livestock. Persistent organic pollutants from an oil spill — or more likely, a series of spills — may end up in your food, beverages, and toothpaste even if you live hundreds of miles outside of the Missouri-Mississippi watershed.

Or we could wean ourselves off oil, saving our health, our wildlife, and our climate in the process.

Chris Clarke is California Desert Program Manager at National Parks Conservation Association. He was KCET's Environment Editor until July 2017. He is a veteran environmental journalist and natural history writer and lives in Joshua Tree, California, USA.

"We All Live Downstream" first appeared at KCETLink on May 2, 2017. Re-printed courtesy of KCET. Original publication available at www.kcet.org/shows/earth-focus/we-all-live-downstream-at-risk-from-the-dakota-access-pipeline. #DAPL

Oil and water don't mix. When they come into contact, humans and wildlife suffer. Image credit: Chris Clarke

THE OCEAN IS OUR FRESH WATER FUTURE

Peter Neill

THE CARLSBAD PROJECT AND THE RISE OF DESALINATION PLANTS AROUND THE WORLD

Carlsbad Desalination Plant San Diego, California

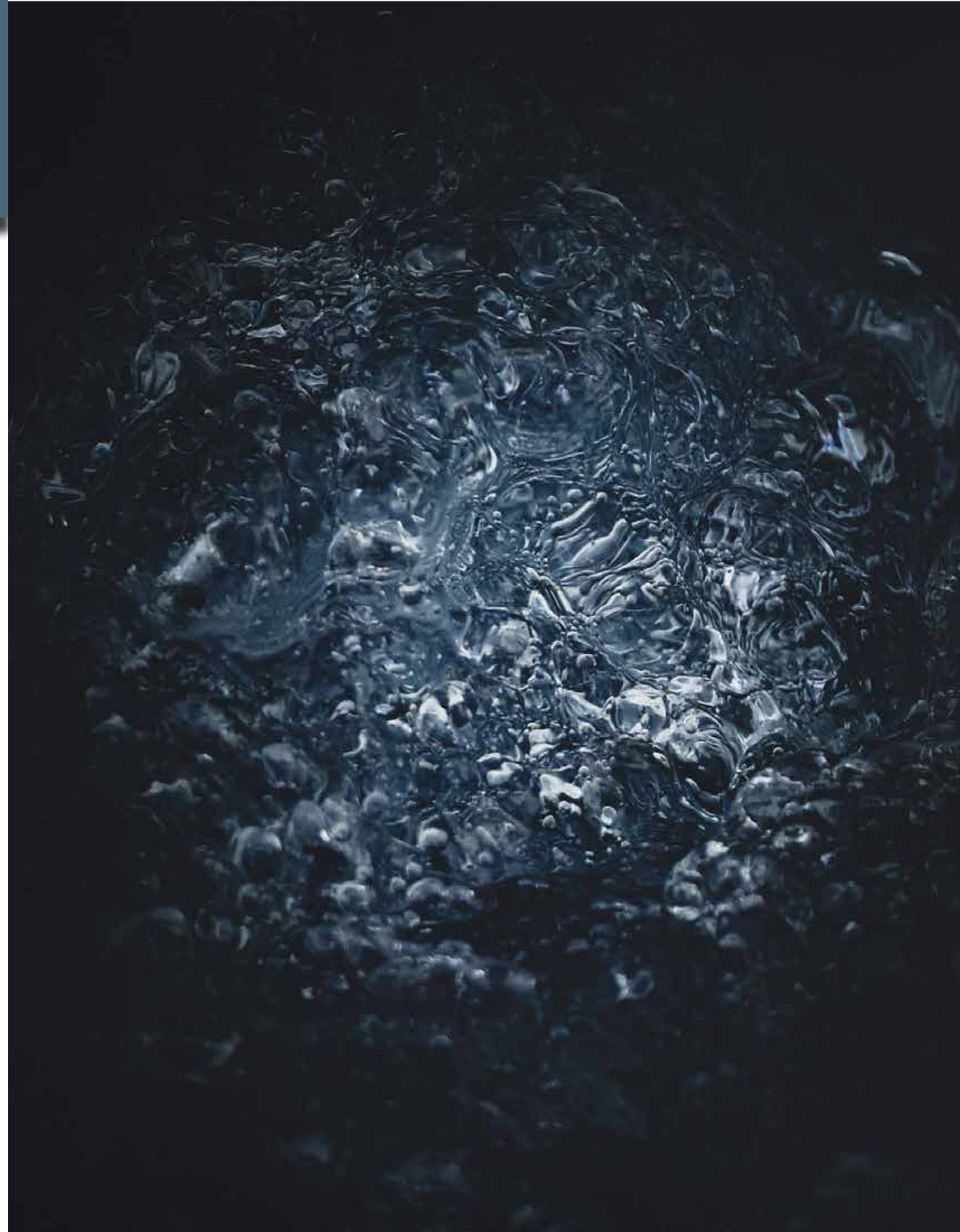
The recent drought and continually unpredictable water situation in California is a highly visible realization of our lack of water awareness and its destructive undermining of the financial structure and social organization we have built in that most progressive state in that most successful global economy. If we fail in California, how can we succeed anywhere else?

At the most reductive level, the traditional water supply system in California has been overwhelmed by climate, industrial agriculture, and water consumption that cannot survive without revolutionary change. If there is not enough water on the mountaintops to supply the watersheds, rivers, and reservoirs, then where will the requisite water come from?

In 2012, the San Diego County Water Authority signed an agreement with Poseidon Water to build the Carlsbad Desalination Plant, the largest desalination such plant in the United States. The process of converting seawater to fresh is not new. According to the International Desalination Association, 18,426 desalination plants operated worldwide (June 2015,) producing 86.8 million cubic meters of desalinated water per day, providing drinking water for 300 million people. Plants continue to crop up, and exist in over 120 countries around the world including Italy, Australia, Spain, Greece, Portugal, Japan, China, India, United Arab Emirates, Malta, Cape Verde, and Cyprus. Saudi Arabia leads the world, meeting 70% of the daily water needs of its population.

Increasingly, the ocean is an enormous contributor to any new strategy of resilience, maintenance, and enhancement of global bio-diversity and capacity, essential to the life-support system of the earth from the beginning, but ever so much more needed now. As we continue to deplete underground aquifers, to increase irrigated land, to disrupt and pollute streams and rivers, the ocean becomes even more valuable as a primary component of the world water cycle, a necessary circulation, filtration, and purification system, and as outlined above, an inevitable source of desalinated drinking water to meet future global demand.

As the ocean is essential to our need for fresh water, as water security and food security are linked, as food security and the alleviation of poverty are linked, and as alleviation of poverty is key to civilization, justice and peace, the ocean simply cannot go the way of the earth, be brutalized, ignored, taken for granted, or abandoned.



Special thanks to the Atlantic Holdfast Seaweed Company for sharing this data. Atlantic Holdfast is a small company working to sustainably hand-harvest the highest quality sea vegetables from the Gulf of Maine. Online at www.atlanticholdfast.com. Facebook: @atlanticholdfast. Blog: atlanticholdfast.com/blog

WHY IS SEAWEED SO NUTRITIOUS (AND DELICIOUS)?

Seaweeds (kombu, bladderwrack, sugar kelp, dulse, wakame, etc.) contain more Vitamin C than oranges, more Calcium than milk, more Iron than spinach and beef. Seaweed concentrates the naturally occurring trace minerals in ocean water and makes them available to us in dietary form. There are 66 trace minerals in seawater, and seaweed contains all of them. Trace minerals promote healthy thyroid function, prevent cellular damage, strengthen the immune system, and aid in brain development.

Seaweeds are also...

- ~ The best dietary source of iodine
- ~ High in antioxidants
- ~ High in Omega-3 fatty acids
- ~ Rich in a broad spectrum of vitamins
- ~ A source of beneficial compounds found nowhere else in nature

These compounds include Laminarin, Fucoidan, and Algin. These unique compounds have been found to soothe the gastrointestinal tract, aid in removing heavy metals from the body, and prevent carcinogens from being absorbed by the digestive system.

REINVENTING OUR FOOD SYSTEM

Robert Jones, Global Aquaculture Strategy Lead, The Nature Conservancy

USING AQUACULTURE TO MAKE FOOD PRODUCTION SMARTER

What if we had the chance to reinvent the world's food system and make local, more sustainable food the new norm rather than the exception?

It might seem like a crazy idea, but with 9 billion people expected on our planet by 2050, it's more like a necessity.

Experts agree that world food production will need to increase by 2050, but we can't exponentially increase the amount of land or freshwater that would be required to meet that demand. With arable land in limited supply, some estimates indicate we only have 60 years of food production left in our soils if we continue with current agricultural practices.

One food production sector that is growing rapidly is aquaculture—the practice of growing food in the water. Nearly every coastal country has significant potential to farm its oceans, and the global sector is poised to grow.

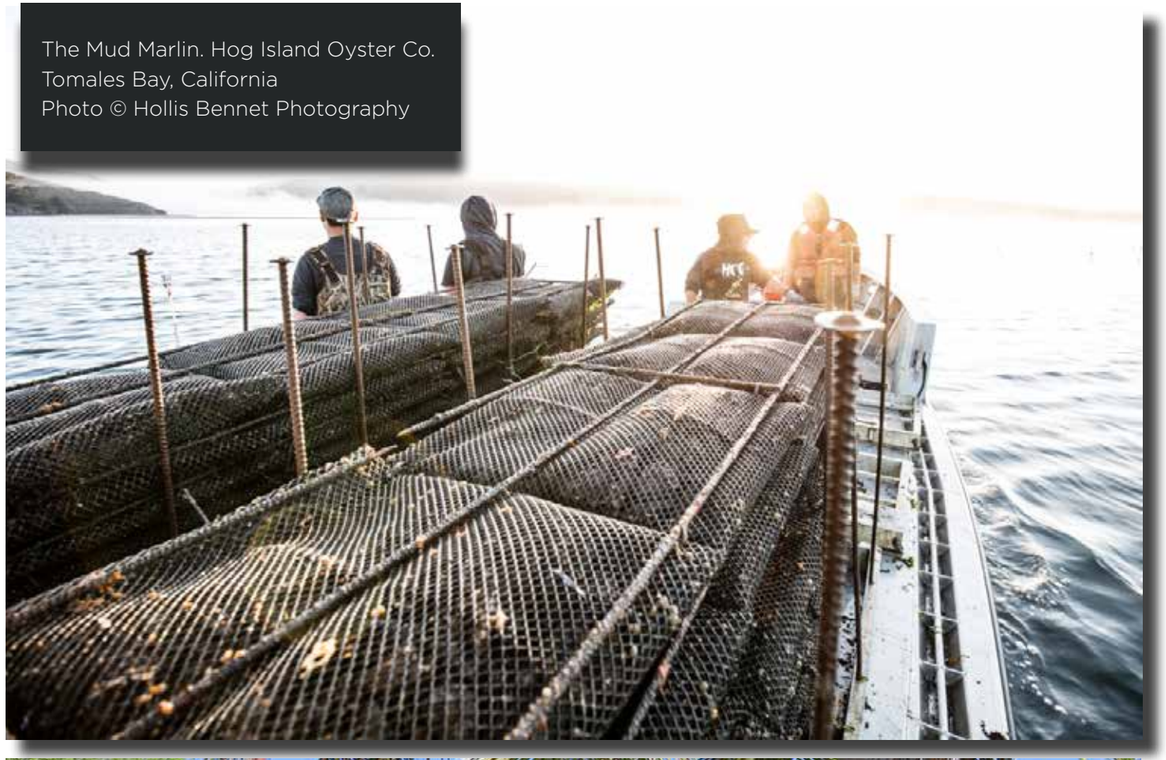
We're now at a critical inflection point where we can alter the trajectory of aquaculture to avoid the mistakes of our land-based agriculture systems, and capitalize on the unique physiological characteristics of fish, shellfish, and seaweed.

Food production must get smarter, using resources like land and freshwater more efficiently, emitting less carbon and overall limiting impacts on the environment. The growth we're going to see in the aquaculture sector over the next several decades is something we can't ignore—we must act now to get aquaculture right. With smart planning, aquaculture can use resources and space efficiently.

Aquaculture is inherently a resource--efficient means of producing food. Marine aquaculture requires no land, and minimal fresh water. Since fish are grown in the water, where the effects of gravity are lessened, they can devote more energy towards growth and need less food per unit of production than animals on land. And farming in the ocean allows for three-dimensional farming, allowing much more animal protein to be produced in the same areal footprint.

Our ocean is largely undeveloped and traditionally not subject to the same extent of governance as land. But now, many governments are undertaking robust marine spatial planning, which can allow for better planning of aquaculture growth. Sustainable commercial use zones can direct aquaculture away from critical habitats like mangroves, corals, and sea grasses, towards areas that have the right bio-economic conditions for growing seafood-reducing many of aquaculture's negative impacts in the process. Aquaculture can even be integrated with other emerging ocean uses like offshore sustainable energy production, including wind turbines. At the same time, critical environmental assets can be protected from commercial development. We can create an aquaculture industry that functions in harmony with the environment, instead of one that conflicts with it.

Imagine food production that contributes to ecosystem health instead of ecosystem decline. Consider a low-footprint, vertical farm that uses the entire water column to simultaneously farm shellfish and seaweed. Sited near the mouth of an estuary, the farm's bivalves filter impurities while seaweeds soak up excess nitrogen from coastal pollution like land-based runoff.



The Mud Marlin. Hog Island Oyster Co. Tomales Bay, California Photo © Hollis Bennet Photography

A woman sorts seaweed after harvest. Rote, Indonesia. Photo © Robert Jones

The farm's design is such that it provides a nursery ground for local fish species and crustaceans to grow to adults, making up part of the lost ecological function once provided by wild shellfish reefs. Increased use of ecological principles can help improve design and location of marine fish farms as well.

With aquaculture, we can shorten supply chains and grow food locally. On average in the United States, food travels 1500 miles before it reaches the consumer. Many major countries from the European Union, to the United States and Japan, import most of the seafood they consume at home, making seafood one of the most highly traded commodities on the planet. If we could grow more seafood locally, that would shorten the seafood supply chain, reduce seafood's carbon footprint, stimulate local economies and provide local jobs.

With cities growing exponentially across the world, more local food production is becoming a must, but most of the available land for food production in their vicinity has been fully utilized. Most major cities are coastal, and within short distances there is significant aquaculture potential to farm the ocean safely and sustainably. There are still many barriers to making this happen. We need smart policies for aquaculture that enable growth while protecting our environment. Working with businesses, coastal communities, and governments can ensure the future of aquaculture will live up to its potential and exist in harmony with our oceans and coasts.

The Nature Conservancy, alongside many partners, is conducting a number of pilot projects around the world to determine how, where, and when aquaculture can actually help improve the environment by improving water quality, habitat function, and mitigating localized ocean acidification. If we can figure out the right conditions, we can unlock a powerful market-based solution to coastal restoration, while creating food and jobs.

Robert Jones is the Global Lead for Aquaculture and oversees all aspects of The Nature Conservancy's new Aquaculture Program. The program consists of active projects in seven countries designed to demonstrate the environmental, social, and economic benefits aquaculture provides for people and nature.

Find The Nature Conservancy at:
Facebook: @thenatureconservancy
Twitter: @nature_org
and at nature.org/aquaculture

Aquaculture production & growth to 2030 by region. Aquaculture is now the fastest growing form of food production on the planet, growing at an annual rate of 6% per year. In 2012, aquaculture was a $144 billion industry that exceeded beef production.
© The Nature Conservancy
Source: World Bank, Fish to 2030, 2013

THE OCEAN:
FRONTIER FOR NEW MEDICINES

What becomes abundantly clear from reading the contributions to this year's Journal is that the ocean represents a unique opening to a vast new pharmacopeia, still mostly unknown. The ocean must be both protected *and* explored if this potential is to be sustained. If we continue to pollute and degrade the ocean, to ignore this powerful opportunity, it will certainly be lost, and with it, an infinite benefit for human health and survival.

OCEAN AS A MEDICAL RESOURCE

Jessica Macdonald

AN ARGUMENT FOR MARINE CONSERVATION

If we start to see the ocean as source of potential cures for cancer, Alzheimer's, AIDS, or other diseases that affect the human race, we will be encouraged to fight harder than ever before for its protection.

That humans depend upon the ocean for our existence is common knowledge. The ocean controls the planet's climate, provides us with food, and generates oxygen. What isn't as well known is the potential of the ocean as a medical resource. Many of the medicines that we use today are derived from natural terrestrial sources, including penicillin, perhaps the most important drug ever discovered.

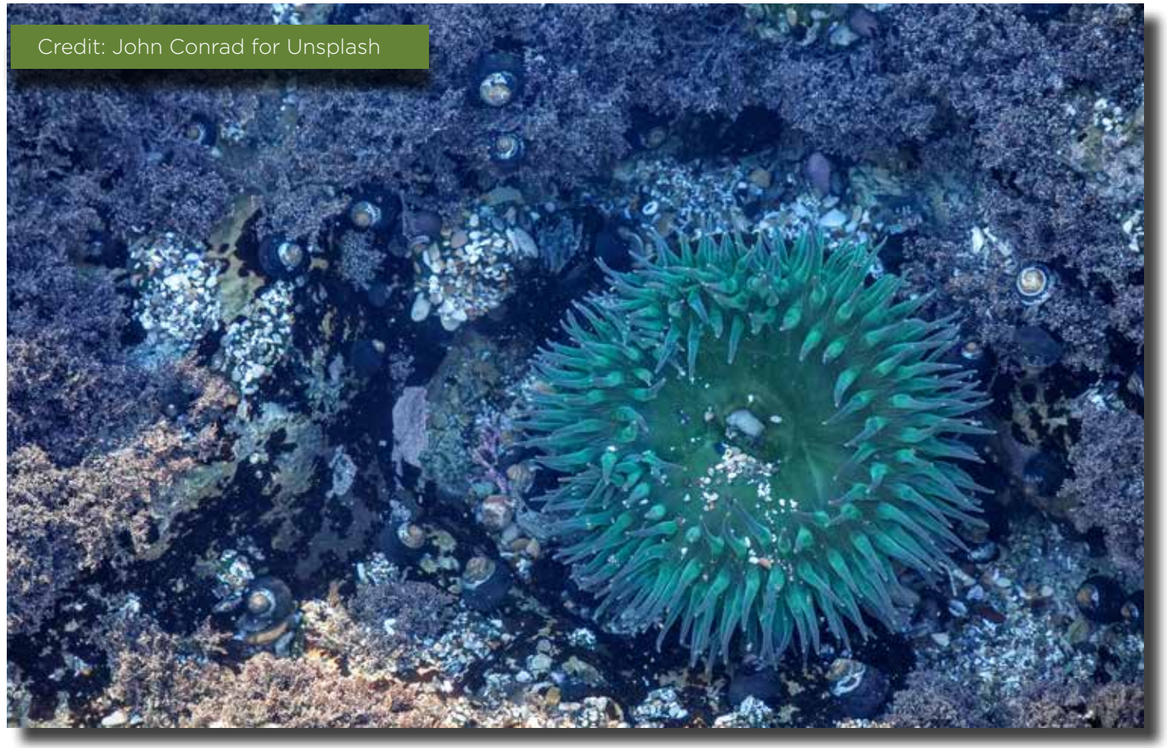
However, the biodiversity found on land pales in comparison with that found in the ocean — perhaps predictably, since the ocean accounts for 71 percent of the Earth's surface. It is therefore likely that the ocean, much of which remains undiscovered today, harbors an incredible number of potentially life-saving compounds. The healing properties of the sea have been recognized by many cultures, including the ancient Greeks, who examined the effects of seawater on human health. However, it is only recently that we have developed the technology to harness the healing power of the ocean in a more tangible sense. Although marine-medical prospecting remains a difficult and expensive endeavor, more research than ever before is now being conducted on the seafloor, as both scientists and corporations search for disease cures.

POTENTIAL CURES

Thanks to the relative newness of marine-medical research, many of the potential cures derived from the ocean are still in the testing and development stages. In 2003, a research group led by William Fenical, the director of the Center for Marine Biotechnology and Biomedicine at Scripps Institution of Oceanography reported the discovery of a previously unknown strain of bacteria found in deep-ocean sediments. These bacteria are not only useful as powerful natural antibiotics, but may also prohibit the growth of cancer cells. The research group created a natural product known as Salinosporamide A from the ocean-sediment bacteria, which may someday be used as a cure for colon cancer, certain types of lung cancer, and most effectively of all, breast cancer. Early trials of the drug as it relates to a number of different cancers are ongoing.

Another marine substance thought to aid in the treatment of cancer is bryostatin, first isolated in the 1960s from a species of bryozoan, or sea moss, known as Bugula neritina. In in-vitro trials, bryostatin has proven effective when used in conjunction with other anti-cancer drugs against a large variety of tumor cells, including lung cancer, prostate cancer and non-Hodgkin's lymphoma. In a recent issue of *Current Alzheimer's Research Medical Journal*, a team of researchers from Louisiana State University's Health Sciences Center published findings that suggest that bryostatin could also be useful as a memory-enhancing agent.

The drug is thought to prevent the accumulation of toxic amyloid in the brain, allowing a greater return of normal memory. Several other marine substances are currently undergoing clinical trials, including a Caribbean sponge species that



Credit: John Conrad for Unsplash

may generate the compounds needed to create the anti-retroviral drug used to fight AIDS.

ON THE MARKET

Despite the enormous potential for medical discovery, relatively few marine substances have so far been approved for clinical use. The process of gaining approval is time-consuming, expensive and legally complicated, and as such, medical trials can take many years. For commercial approval, a substance must be deemed both effective and safe, and from a logistical perspective, it must also be possible to manufacture the substance on a large scale.

The first marine-derived drug approved for use by the Food and Drug Administration (FDA) was Ara-C, or Cytarabine. Cytarabine owes its discovery to the Caribbean sponge Cryptothetya crypta, whose unusual nucleosides (a component of their DNA) inhibit the replication of genetic material. Researchers realized that this characteristic could be used to prevent tumor cells from dividing and replicating, and therefore used the sponge nucleosides to create a cytostatic drug that was the basis for the synthesis of Cytarabine. Today, Cytarabine features on the World Health Organizations' List of Essential Medicines, and is used in chemotherapy treatment. It kills cancer cells by interfering with DNA synthesis, and is primarily used to treat acute myeloid leukemia, acute lymphocytic leukemia and non-Hodgkin's lymphoma.

Another approved substance is the peptide Ziconotide, or Prialt. Derived from the venom of various cone snail species, Ziconotide modifies the toxins in this venom to treat chronic pain. Whereas cone snail venom naturally induces paralysis in its victims, Ziconotide blocks the nerves in the spinal cord that send pain signals to the brain. As a painkiller, it's 1,000 times more powerful than morphine, and is used for patients whose pain is so severe that morphine is unable to provide relief. Alternatively, Ziconotide is also given to those patients that are allergic to morphine.

Other marine-derived substances are already used within the medical profession, including a drug derived from the tunicate species

Ecteinascidia turbinate, which helps prevent patients from building up a resistance to chemotherapy drugs. Another commonly used substance is coagulan, a chemical derived from the unique blood of the horseshoe crab. These alien-looking invertebrates use amebocytes instead of white blood cells to fight infection, and theirs are so accurate that they coagulate rapidly around as little as one part in a trillion of bacterial contamination. Coagulan is therefore used to test medical equipment and vaccines for bacterial infection before they are used on humans, preventing the spread of disease in hospitals and other medical environments.

PROS AND CONS

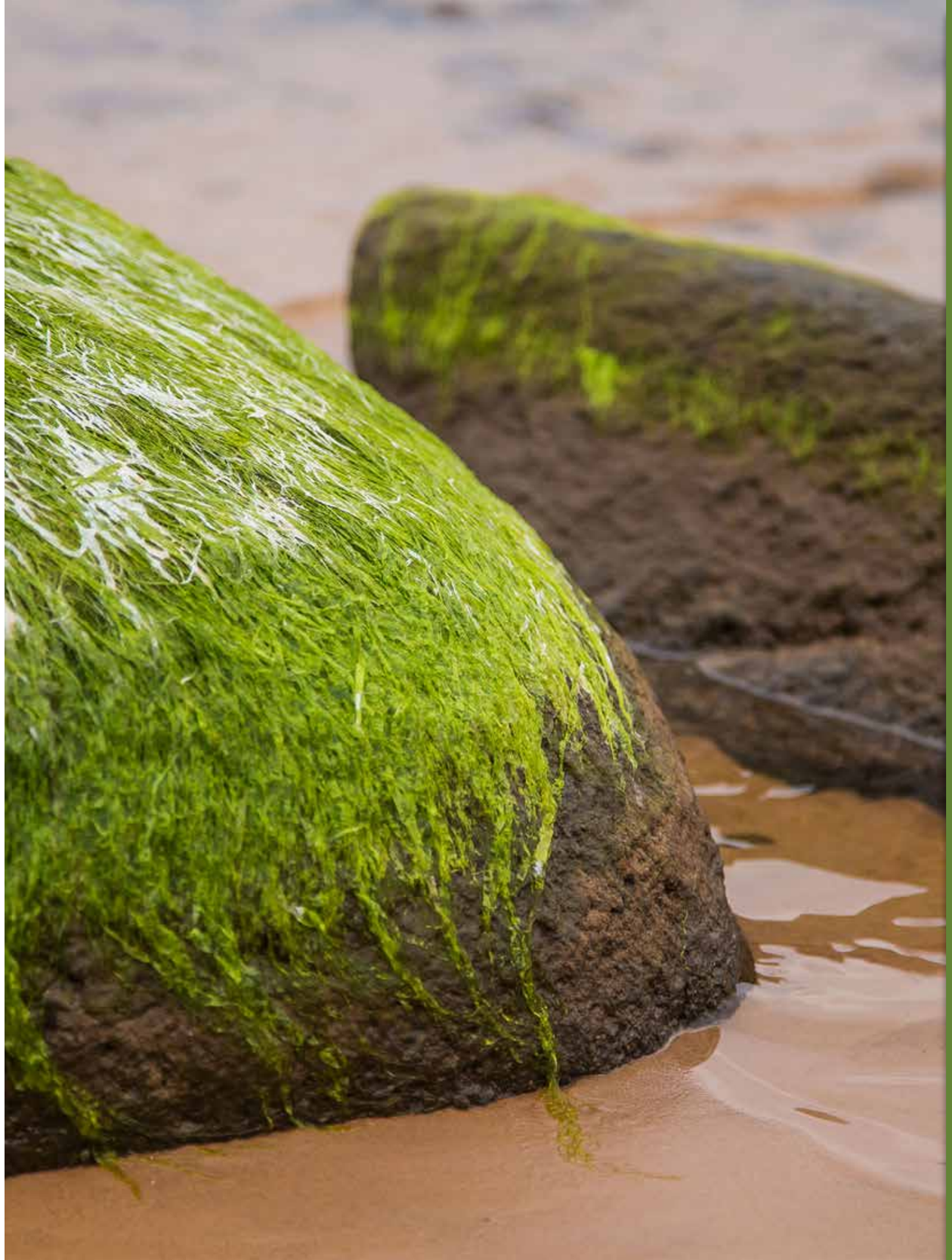
The way in which coagulan is gathered is a good example of the drawbacks of using the ocean as a medical resource. Scientists are not yet effectively able to synthesize coagulan, and as a result, horseshoe crabs are taken from their environment on a massive scale in order to harvest their blood. In an attempt to prevent the decimation of this species, the crabs are drained of a percentage of their blood before being released alive back into the ocean. However, it is thought that even so, many crabs do not survive, leading to the potential future collapse of their population. We can only speculate on the deleterious consequences other marine species may face if they're found to be of medical use. With that being said, it is likely that cures, once found, will eventually be synthesized in order to facilitate mass production and to minimize the impact on the marine environment. Our increasing awareness of the ocean as a powerhouse for curing human health issues could also prove to be a great incentive for marine conservation.

Perhaps if we start to see the ocean as the source of potential cures for cancer, Alzheimer's, AIDS, or any other diseases that affect the human race, we will be encouraged to fight harder than ever before for its protection.

Originally from the UK, Jessica Macdonald now lives on South Africa's east coast. She's a qualified PADI Open Water Scuba Instructor, as well as a keen conservationist and shark fanatic. When she's not underwater, she can be found at her computer where she works as a freelance diving and travel writer.

On the web at:
Facebook: travellersguidetoafrica
Instagram: @travellersguidetoafrica
and at goafrica.about.com

"Ocean As Medical Resource" first appeared on ScubaDiverLife.com. Reprinted here with permission.



MARINE PHARMACOLOGY

Dr. Harshad Malve, Mumbai, India

EXPLORING THE OCEAN FOR NEW DRUG DEVELOPMENTS

The marine environment is an exceptional storehouse of bioactive natural products, with structural and chemical features generally not found in terrestrial natural products. Marine organisms provide a rich source of nutraceuticals and potential candidates for the treatment of human disease. The modern day focus of marine pharmacology is on microbes.

Disease ailments are changing patterns, and new diseases are emerging due to changing environments. The enormous growth of world population has overburdened the existing resources for the drugs. Hence, the drug manufacturers are always on the lookout for new resources to develop effective and safe drugs for the increasing demands of the world population. 75% of earth's surface is covered by water but research into the pharmacology of marine organisms is limited, and most of it still remains unexplored.

The marine environment represents countless and diverse resources for new drugs to combat major diseases such as cancer or malaria. It also offers an ecological resource comprising a variety of aquatic plants and animals. These aquatic organisms are screened for antibacterial, immunomodulator, anti-fungal, anti-inflammatory, anticancer, antimicrobial, neuroprotective, analgesic, and antimalarial properties. They are used for new drug developments extensively across the world. Marine pharmacology offers the scope for research on these drugs of marine origin.

The ocean represents a source of a varied type of organisms due to the diversified environment offered by different oceanic zones. The enormous ecological resources of the sea have been exploited since ancient times and included the use of marine animals like fish and preparations from algae as sources of medicine. Fish oils are the classic example of marine-derived products in use for ages.

Marine pharmacology is a branch of pharmaceutical sciences, focusing on the substances with active pharmacological properties present in marine species of plants and animals.

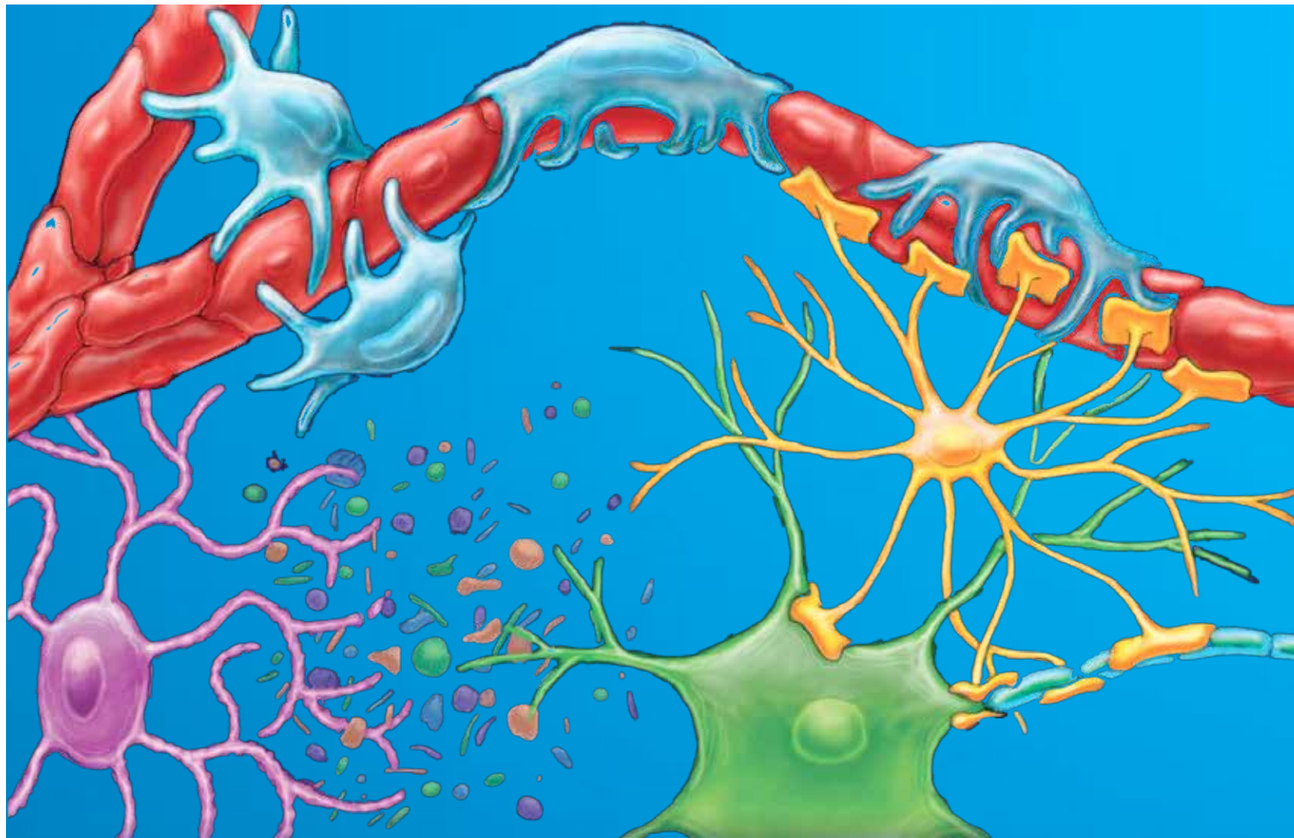
This includes the discovery of new pharmaceutical candidates from marine microbes. The ocean provides enormous opportunities to discover new compounds as it has more than 13,000 molecules described out of which 3,000 are having active properties. Marine natural products are generally secondary metabolites. They are not generated by biological or regular metabolic pathways and have no primary function associated with the development, growth, or propagation of a species. 63% of the new drugs are classified as naturally derived (i.e: modified natural product, unmodified natural product or synthetic compound with a natural product as pharmacophore.) Covering the period from 1981 to 2008, around 68% of all the drugs used to curb infection (including antibacterial, antiviral, antiparasitic, and antifungal compounds) and 63% of anti-cancer drugs were naturally derived.

BIODIVERSITY OF THE MARINE ENVIRONMENT

The marine environment is a natural habitat for a broad variety of living organisms having different physiology and capacity to adapt their environment. Out of more than 33 animal phyla known today, 32 are embodied in the marine environment out of which 15 varieties are exclusively present in the marine environment. Such genetic diversity renders chemical diversity, a promising new drug development.

Oceans contain more than 80% of diverse plant and animal species in the world. Marine organisms such as sponges, tunicates, fishes, soft corals, nudibranchs, sea hares, opisthobranch Molluscs, echinoderms, bryozoans, prawns, shells, sea slugs, and marine microorganisms are sources of bioactive compounds (viz. oils and cosmetics). The first biologically active marine natural product was formally reported in late 1950 by Bergmann. In late 1970, it was established that marine plants and animals are genetically and biochemically unique. Approximately 15,000 of such unique natural compounds have been described, and out of them 30% have been isolated from sponges. The remarkable discovery of unusual arabino- or ribo-pentosyl nucleosides in marine sponges was the first illustration that a naturally occurring nucleoside could contain sugars other than ribose and deoxyribose. It was also observed that molecules of marine origin can be accepted by humans with minimal manipulation.

There are some reports on the characterization of the antimicrobial activity of marine macroorganisms collected from the Indian Ocean coastline have appeared. Streptomyces sp. has been the most widely studied microbial species from the Indian Ocean coastal waters as a source of antibiotics. In a study, 75 bacterial strains from 4 species of marine sponges were isolated, out of which 21% of the isolates have shown good antibacterial activity, with some of the strains showing species specificity. The study



indicated the diversity of antibiotic-producing marine bacteria and also established that sponges are a rich source of bacteria capable of producing novel pharmacologically active molecules.

MARINE PHARMACOLOGY

Marine drugs can be broadly classified based on their actions (i.e: antibacterial, anti-inflammatory, neurprotective, anti parasitic, antriviral, anticancer, analgesic, antimicrobial, antimalarial, etc.) To date, the three FDA-approved marine-derived drugs currently used in the United States are cytarabine (Cytosar-UW), DepocytW), vidarabine (Vira-AW), and ziconotide (PrialtW). Various marine drugs are in different phases of clinical trials.

CHALLENGES AND FUTURE TRENDS

There are certain challenges to deriving drugs from marine sources. Variable environmental conditions could result in the production of different metabolites from the same organism. A major challenge sometimes faced is that the microorganisms residing in the marine animal, and not the invertebrate marine hosts, actually produces the bioactive molecules. Sustainable supply of isolated and identified lead compounds sometimes pose a problem because the lead compound is present only in low quantity. Or technically it becomes difficult to isolate such compounds. For any intended use (drug, cosmetic, etc.) of the compound, the required quantity may vary from a few grams needed for pre-clinical drug development and safety studies to quantities in kilograms required for clinical study in different phases and many of tons of cosmetics. And the availability of lead compounds in such abundance can be a key issue.

There are limiting factors for marine drug developments. Lack of sustainable supply of the candidate compound has sometimes held back R&D of many extremely potent marine novel compounds. Attempts have been made to surpass this challenge by increased development of synthetic or hemisynthetic analogues—derivatives with desired and customized properties, or designing a pharmacophore of lower complexity with an easier synthesis method. Identification of a bioactive compound synthesized or hemisynthesized must be done with the reference to the compound derived from the biological source. The structural complexity of the isolated compound and meager yield, generally faced with marine compounds, may lead to wrong assignment of chemical formula of the compound, its real constitution (planar connectivity), configuration of intramolecular bonds, configuration entirity, and incorrectly assigned one or multiple stereocenters. To overcome the issue of regular supply, the use of natural resources should be under control and need to favor the growth of marine organisms in their natural environment by farming: known as Mariculture. Another option is to culture the marine organisms under artificial conditions by the process known as aquaculture.

Martins et al. have very well elucidated the commercial and market issues that are relevant and mostly overlooked in the developmental process of new natural products. Some of the points that need to be addressed from the very early development phase are as follows: (i) What are the potential industrial uses of the product and need of that particular activity of the compound in the market? (ii) What will be the final cost per kilogram for the final bioactive material? (iii) What is the desired formulation and preferred route of administration of the compound? (iv) What process of manufacture is being used and is the supply is sustainable? And finally (v) How will the product reach the market chain?

Some limitations of marine drug development include the development of universal expression systems for biosynthesis of small molecules with high-yield, development of genetic tools to access the in vivo potential of cultured marine microorganisms, and the regulatory arousing of silent biosynthetic pathways for small molecule discovery.

The subsequent levels of development of marine drugs comprises in vivo evaluations of safety and efficacy in animal models, determination of the mechanism and site of action, development of structure/activity relationships, and the formulation and characterization of pharmacokinetics parameters and pharmaceutical properties including improvements through the use of medicinal chemistry.

Initial efforts in marine natural product chemistry have largely focused on collecting metabolites

British seaweeds: an introduction to the study of the marine algae of Great Britain, Ireland and the Channel Islands (1867). Wikimedia Commons.

from most easily collected species. Minor metabolites present in very small quantities are a challenge for analytical and biological evaluations. In silico screening programs can be useful to understand the natural scaffolding of these minor drug candidates better. Scientists are making efforts to improve access to minor metabolites through technological advancements, such as increasingly widespread use of NMR microcryogenic and capillary flow-probes. Another area of improvement in marine drug discovery programs is the biological assay methods of extracts, fractions, and pure compounds. Assay-based isolation design for marine natural products has the potential for automation that may result in dramatic improvement in the way that different classes of natural products are discovered in nature.

Looking at the vast potential and leads, there are several institutes in India and around the world that are concentrating on research and training in the marine pharmacology field. Most of the research institutes are concentrating on the discovery of potential novel compounds from marine organisms, extraction/isolation, their safety and efficacy assessment and large-scale commercial production. A list of some of the institutes doing research and universities imparting training on marine pharmacology is available in table 33 in the full article, available at www.ncbi.nim.nih.gov.

CONCLUSIONS

Marine environment has become a promising source of natural products, molecules, and drugs of therapeutic use. Having enormous variety with a high diversity of organisms and marine life, the prospects of yielding more novel products from the sea is enormous. The curiosity of science and industry has established the oceans as a prospective source for new potential drug leads. Scientists have come up with drugs of various categories out of which anticancer, anti-inflammatory, analgesics, and antivirals are the most important to mention. These lead molecules are in different stages of pre-clinical and clinical testing stages around the world. Many drugs from marine sources have a promising effect on several chronic and still unknown diseases such as cancer. They may prove to open up a new chapter of making the treatment of chronic diseases less expensive and more successful.

After identification, extraction, and large-scale production of promising marine natural products of therapeutic uses, their marketing and commercial exploitation of potential is dependent on the results of pre-clinical and clinical data. The current screening for active natural products should be increased along with a large and rapid random screening method. Several research institutes and universities are working in this field to develop new modalities and to train people to work in this area. The technology should be targeted optimally for drug research, approvals, and launches. The medical pharmacologist from India and elsewhere in the world should consider taking up further research in marine pharmacology to help with new drug developments. The evolution of marine pharmacology will help to optimize the use of rich marine resources—in India and in countries around the world—that are blessed with vast coastlines.

Read the report in its entirety by visiting the US National Library of Medicine, National Institutes of Heath.
Online at www.ncbi.nim.nih.gov.

Dr. Harshad Malve is Lead Medical, Asia Pacific Region, Ferring Pharmaceuticals Pvt. Ltd., Elphinstone (West), Mumbai, India

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GENOME MINING AND DNA SEQUENCING

Scripps Institution of Oceanography at UC San Diego

Unraveling the Mystery of Powerful Chemical Compounds

Researchers find bacteria living in marine sponges that produces a toxic flame retardant-like compound. What other marine organisms are producing similar toxic aggregates, and why?

A Scripps Institution of Oceanography at the University of California San Diego-led research team discovered for the first time that a common marine sponge hosts bacteria that specialize in the production of toxic compounds nearly identical to man-made fire retardants.

The new findings put the research team one step closer to unraveling the mystery of this powerful group of chemical compounds, known as polybrominated diphenyl ethers (PBDEs), in the marine environment. PBDEs are a subgroup of brominated flame retardants that are combined into foam, textiles, and electronics to raise the temperature at which the products will burn. These man-made industrial chemicals are powerful endocrine disruptors that mimic the activity of the human body's most active thyroid hormone.

Vinayak Agarwal, a postdoctoral researcher at Scripps, picked up a cold case first started nearly 50 years ago by Scripps chemist John Faulkner, an early pioneer in the study of natural products from the sea, to continue the investigation into the source of these toxic compounds that are found in large quantities in the world's oceans. "For the first time we were able to conclusively show that genes and enzymes produced in bacteria from sponges are responsible for the production of these compounds toxic to humans," said Agarwal, co-first author of the paper along with Scripps PhD student Jessica Blanton.

The study was part of the National Science Foundation / National Institute of Environmental Health Sciences-funded Center for Oceans and Human Health research being conducted at Scripps.

In 2014, Agarwal and colleagues at Scripps Oceanography were the first to discover that unrelated free-living marine bacteria produce these fire retardant compounds naturally, albeit in very small quantities.

In this new study, the researchers employed two modern-day techniques—genome "mining" pioneered by Scripps marine chemist Brad Moore and an environmental DNA sequencing approach pioneered by Scripps biologist Eric Allen—to take the investigation a step further and identify the specific genes and enzymes involved in the overproduction of the toxic molecules in sponges.

Marine sponges obtain food and oxygen by filtering seawater through the pores and channels in their bodies. This constant water flow means that these immobile animals host many bacteria, viruses, and fungi in their complex microbiomes.

The research team collected 18 sponge samples for the study during two research expeditions to Guam. They then isolated the various components of this complex mixture of organisms from the sponge's tissues to identify the specific genes and enzymes that code for the production of PBDEs. "For many years scientists were finding clues that suggested nature was making these compounds," said Bradley Moore, a professor at the Scripps Center of Marine Biotechnology and Biomedicine and the Skaggs School of Pharmacy and Pharmaceutical Sciences at UC San Diego, and a senior author of the study. "Now that we understand how they are produced in the marine environment, we are exploring why they exist, and the human health concerns associated with them."

Moore's genome "mining" approach along with Allen's metagenomic sequencing gives scientists a way to connect the natural chemicals produced by organisms back to the enzymes that construct them. The study, which appears on the cover of the May issue of the journal Nature Chemical Biology, was a unique collaboration among chemists and biologists at UC San Diego and elsewhere.

"This study is a powerful combination of chemical, biological and environmental research," said Henrietta Edmonds of the NSF's Division of Ocean Sciences, which supported the research. "It has the potential to help us understand the production, fate and health consequences of natural and pollutant compounds in the marine environment."

"We care about naturally produced PBDEs because they end up in the food chain," said Frederick Tyson, Ph.D., of the NIEHS, which helped to fund the research. "Preliminary data from this research team suggest that some naturally occurring PDBEs may be even more toxic than those that are man-made, so we need to develop a better understanding of these compounds."

These ocean-dwelling microbes have been found in habitats as diverse as sea grasses, corals and whales.

The next step of the investigation is to mine the genes and enzymes in other marine hosts to find out what other organisms are making similar toxic compounds and why.

Co-authors from Scripps Oceanography include Sheila Podell, Michelle Schorn, Julia Busch, and Paul Jensen. Researchers who also contributed to the study include Arnaud Taton and James Golden from UC San Diego's Division of Biological Sciences; Jason Biggs from University of Guam's Marine Laboratory; Zhenjian Lin and Eric Schmidt from the University of Utah; and Valerie Paul from the Smithsonian Marine Station.

To learn more about the Scripps Institution of Oceanography at UC San Diego, visit scripps.ucsd.edu. Media contact: Robert Monroe

Credit: Jason S. Biggs, University of Guam

THE INCREDIBLE FISH VALUE MACHINE

Thor Sigfusson, Iceland Ocean Cluster

The accompanying illustration is inspired by the "The Incredible Bread Machine", a text written by R.W Grant in 1966. The book had an accompanying poem entitled "Tom Smith and His Incredible Bread Machine." The Tom Smith poem is about a man who invents a machine for producing bread very cheaply, and thus the world is fed.

The *Incredible Fish Value Machine* displays how Icelanders have produced "an industry fishing machine" which takes pride in the fact that no other whitefish nation is utilising more of each fish than Icelanders. While in typical North Atlantic fisheries the head, gut and bones of every cod are discarded, in Icelandic fisheries we have become used to making money out of many of these by-products. Analysis done by the Iceland Ocean Cluster indicates that Icelanders utilize 80%+ of each cod while many neighbouring countries make full use of only around 50%. The study indicates over 500 thousand tonnes of cod are discarded into the sea or as waste in the Barents Sea region and across the North Atlantic from Newfoundland to Norway.

There is no single explanation for this huge difference in utilization. Partly it may be explained by the fact that unlike the year-round fishery in Iceland, many fishing nations have short fishing seasons with massive amounts landed over a few months, making it difficult to process such raw material efficiently. Secondly, the integration between fishing and processing in Iceland through common ownership is not usually the case among other seafood nations. Finally, and maybe most importantly, the seafood industry is often located in marginalized places and is not in touch with R&D, investors, accelerators etc. Steve Case writes in *The Third Wave:* "Over the next two decades we will see cities that were once marginalized become entrepreneurial powerhouses." Case points out that "there is appeal to putting down roots where industry ecosystems already exist". But even in areas where R&D, Universities and investors are close to the seafood ecosystem we still do not see all the dots connecting. This lack of ties is probably the most important reason why so much seafood protein is used for landfill in many countries. The key to creating the "incredible fish value machine" is to build the bridge between these important parts of the seafood cluster.

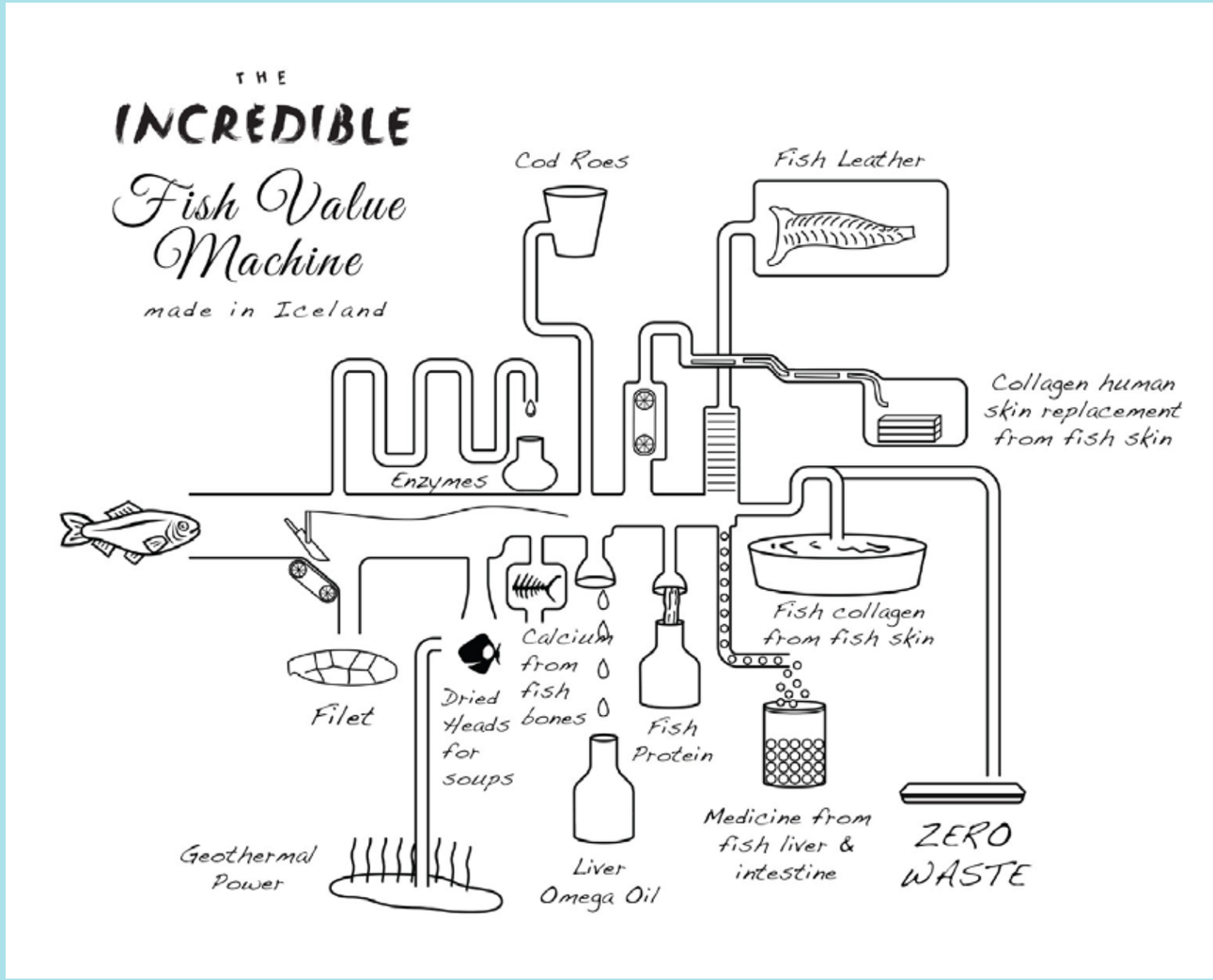
I am confident that it is only a matter of time when fisheries will stop discarding out value and more people join the 100% movement. As more companies join the by-product market and the market develops further, the prices will continue to increase and the incentives for fisheries to get value from their by-products are also set to increase.

Icelanders have long taken pride in their efficient fisheries. There is no one explanation for why Icelandic fisheries have for the most part been more efficient than others. I believe there is, as is often the case, a very pragmatic explanation: Icelanders have never had the luxury of treating their fisheries lightly. As the core industry in Iceland, it cannot be government subsidised. The entire cluster of seafood businesses in Iceland has, for a long time, been at the heart of the income tax base for government and not the other way around. The same applies to a great extent when examining Icelandic fish by-products; if there is value to be found in by-products, effective fisheries used to focusing on value will find opportunities to use them.

The Incredible Fish Value Machine is not hypothetical. It is very real. The Icelandic model has proved reliable and this model can be duplicated in seafood industries all around; creating new opportunities in coastal areas.

Thor Sigfusson is founder and chairman of the Iceland Ocean Cluster. Learn more at: www.sjavarklasinn.is/en

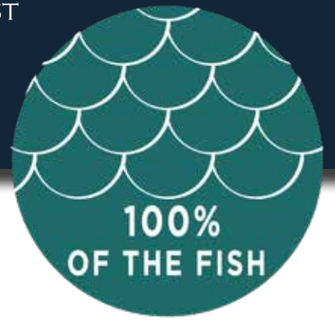
100% OF THE FISH



HEALING WITH FISH

Peter Neill

Could fish skin provide a next best cure for wounds, burns, and chronic skin conditions?



…what we have here is a turning of the circle of knowledge, the re-discovery and re-application of the healing property of fish oil, enabling new employment for fishing communities, and providing innovative, powerful treatment for injuries and conditions that can be better and faster healed by a natural process derived from the healing ocean.

Time and again in history we hear of natural treatments for breaks, wounds, and diseases. Our ancestors brewed herbal teas, treated wounds with moss and leaves, and otherwise practiced a healing system derived from natural materials at hand.

The tradition continues in the varying practices of homeopathic medicine in both East and West, and the global industry of organic supplements that offers an alternative to the synthetic and expensive methodology that characterizes the health care system in the U.S. and elsewhere. As medicine has become standardized and mechanized and arbitrated by the insurance and pharmaceutical industries, we have lost some of that historical wisdom and its healing effect.

We speak often at World Ocean Observatory of the innovative and effective innovations and organizations in Iceland, a small country with a big heart, big ideas, and a powerful natural environment that provides not only its energy and food requirements, but also a basis for adaptation and invention of natural products and processes to drive its 21st century economy and culture.

As Iceland relies heavily on fishing in its mix of finance and labor applications, it must stay competitive against larger, industrialized fishing nations by maximizing the value of its fish products, using 100% of the fish. This seems obvious, but in the U.S. for example, our industry wastes more than half of discarding by-catch, harvesting only specialized high-cost species, and failing to capture the added economic opportunity of such limited application and interest.

In a June 2017 article in Bloomberg *BusinessWeek*, Lois Parshley reports on the emergence of a remarkable iteration of this approach – the development of a fish skin based, FDA approved treatment for chronic wounds and infltammation. 100% of the fish indeed. The only hint of its origin is a scale-like grid that provides a binding matrix around which new, healthy skin can grow.

I had seen this product in Reykjavik, but it was not yet approved by the U.S. Food and Drug Administration until late last year. Called Omega 3 Wound, the product is produced by Kerecis Ltd, a small company located in Ísafjörður, Iceland, a town of 3,000 inhabitants with a limited economy based of fishing and small scale tourism. Kerecis Ltd. is a new employer at work in Ísafjörður. According to Fertram Sigurjónsson, CEO of Kerecis Ltd, the product has taken nine years to develop and test successfully, using the skin of locally caught cod fish that are cleaned, dried, sterilized, and packaged locally for treatment of chronic wounds, burns, oral cancer, internal, cosmetic and reconstructive surgeries, and other applications for the reduction of inflammation and pain.

The market implication is large. According to Parshley's article, "Some six and a half million Americans suffer from chronic wounds, whether related to vascular disease, diabetes, or complications from normal procedures. The five-year survival rate is 54%… and treatments cost more than $25 billion a year."

Parshley continues, "The U.S. Department of Defense is on the lookout for better burn treatments because of the increase in service wounds from IEDs (improvised explosive devices.) In a study conducted by the U.S. Army Institute of Surgical Research, the fish skin bested the healing rates of cadaver skin, a common military treatment for burns. The Army has also funded several further studies, showing that unlike rival products, fish skin can ward off bacteria and reduce bleeding."

So what we have here is a turning of the circle of knowledge, the re-discovery and re-application of the healing property of fish oil, re-branded Omega 3, harvested as a value-added product from a traditional food product, enabling new employment for fishing communities and providing innovative, more powerful treatment for the injuries of modern war and of many other conditions that can be better and faster healed by a natural process derived from the ocean.

That is the true message here – that the ocean has such an enormous, known and unknown, implication for human health. When we fail to use it well, or worse, when we despoil or exhaust it, we are depriving ourselves and our children from its healing properties – in a simple bandage, a new medicine, or the purity of the food we eat, the water we drink, and the air we breathe.

The sea connects all things.

"Healing with Fish" first appeared as a World Ocean Radio audio broadcast. Learn more at worldoceanobservatory.org/world-ocean-radio.

CODLAND: MAKING THE MOST OUT OF THE CATCH

Thor Sigfusson, Iceland Ocean Cluster

TRADITIONAL CODFISH PROCESSING FOR A HEALTHIER OCEAN AND A HEALTHIER FUTURE.

100% OF THE FISH

In the Icelandic tradition, a company is utilizing 100% of the byproducts of traditional codfish processing.

In Icelandic, there is a word to describe a person who utilizes things to the fullest: *n´ytin*—a word that best describes (and most appropriately sums up) the value-added approach to the tradition of the Icelandic fisheries industry and a growing network of companies pushing the limits of what is required for the future health of global fisheries: making the most out of any single resource; in this case, 100% utilization of the catch.

The Iceland Ocean Cluster (IOC) mission is to create value and discover new opportunities by connecting entrepreneurs, businesses, and knowledge in the marine industries. The Iceland Ocean Cluster serves their mission by providing a range of services and by investing their resources in new maritime spin-offs and projects. Fisheries have always been of utmost importance to the health and maritime culture of Iceland. The IOC facilitates the networking of seafood companies, leading to unexplored new business relationships and to the creation of entirely new spin-off companies. Based in Reykjavik's Old Harbour, the IOC has gained considerable attention and interest in recent years as they serve their maritime community and branch out into other cluster projects, including the New England Ocean Cluster in Portland, Maine and the newly-formed cluster in Bedford, Massachusetts.

The IOC is on a mission to drive growth and innovation in marine industry by strengthening networks between people, businesses and entrepreneurs. They have been a prime mover in stressing Iceland's ability to sensibly and sustainably manage marine resources. The companies in the Ocean Cluster House put their minds together to create more value from each fish, utilizing the potential of external economies of scale to provide entrepreneurs with access to resources within the cluster network. This has been an incredibly valuable model for creating business opportunities, facilitating technical development, generating start-up and spin-off companies, and supporting their overall growth process.

THE CODLAND PROJECT

Codland represents one such growth opportunity: a mature spin-off project of the Iceland Ocean Cluster. Founded in 2012 when the IOC brought together several fishing and ocean related companies, they set out to use 100% of the fish, thereby dramatically increasing its value. One of Codland's newest products is Alda, a lemonade health drink that provides the benefits of marine collagen, known to strengthen joints, improve skin health, and reduce wrinkles. Collagen is the most abundant protein in the human body, providing strength and durability for our daily activities. As we age, natural collagen production slows, resulting in looser skin and the appearance of fine lines and deeper wrinkles. Icelandic marine collagen contains peptides and amino acids—the building blocks the body uses to maintain health and to promote general well-being.

Marine collagen is a fibrous protein extracted from the scales and/or skin of saltwater fish, including cod and salmon. This collagen of the sea has antioxidant properties that have been used in skin care products and to repair the damage done by environmental factors such as UV exposure and the natural processes of aging. According to a study done by Beijing University School of Public Health and published in the Chinese Journal of Preventative Medicine, researchers reported that test animals (mice) given oral doses of marine collagen peptides showed significant thickening of the epidermis. Research also showed a sharp increase in the number and activity of fibroblasts in the skin of mice treated with the marine collagen. Fibroblast cells play a significant role in the creation of new connective tissue.

Back to Alda, the marine collagen lemonade made by Codland. Using the model of creating maximum value from each fish caught: Alda represents a scalable model of products used to improve human health and well-being from a fish byproduct that might otherwise be discarded. Responsibility. Utilization. Maximum value. Collaboration. Codland and other Iceland companies are working within these tenets as they strive to innovate new biotechnical solutions for a healthier human race and a sustainable ocean future.

ICELAND OCEAN CLUSTER
REYKJAVÎK, ICELAND

Creating value and discovering new opportunities by connecting entrepreneurs, businesses and knowledge in the marine industries.
On the web at:
Facebook: /sjavarklasinn
Twitter: @oceancluster
www.sjavarklasinn.is

CREATIVE COLLISIONS

The New England Ocean Cluster

Fostering Collaborations and Incentivizing Innovation for a Sustainable 21st Century and Beyond

MAINE AND THE OCEAN

For thousands of years, the ocean has connected the world. Trade, economic development, and cultural traditions have been catalyzed through exploration of the resources the ocean offers and the network of exchange and relationships it represents.

In New England, our ocean heritage remains at the core of our economic identity. It's a shared resource for countless entities and organizations, with functions ranging from fishing to boat building to shipping to biotechnology. For us, the ocean continues to serve as a means for business, the exchange of products and ideas, and innovative development.

HARNESSING THE POWER OF CONNECTIVITY

The energy generated by this ocean network is immense. The constellation of businesses that draw on the ocean as a resource – including the core firms that interact directly as well as the service firms that support them – are becoming more interdependent and connected to one another as shipping and communications technology more closely connect our world.

CREATIVE COLLISIONS

The New England Ocean Cluster recognizes that people are very frequently the most powerful resource we possess. Knowing this, why is it that networking is restricted at worst to hour-long meet-and-greet events, or at best, in a collaborative workspace? Everything comes down to relationships. We feel that the moments of casual conversation and brainstorming yield powerful ideas. We call these *creative collisions*.

The productivity of those moments – the creative collisions – is dependent on the resources available to make it happen. In New England, our ocean economy and resources make us well-poised to capitalize on the creative collisions the NEOC seeks to catalyze. In Maine, there is US$450 million in seafood landed each year, the third-highest total in the U.S. (*Maine Seafood Study*, CEI, 2015). Commercial saltwater fishing supports over 1.5 million jobs in the nation. (*Fisheries Economics of the United States 2011*, NOAA, 2011). Local clusters already exist in boat building, water transportation, and fishing (*Maine, US Cluster Mapping Initiative*, 2013). Maine alone possesses 8 prominent laboratory spaces, 6 business incubators, a variety of support services for start-ups, and 19 colleges and universities. Additionally, there are 130,000 workers specializing in research, testing, and medical laboratory subsectors within the state (*Maine Life Sciences Guide*, MITC, 2014), contributing to a growing biomedical and life sciences cluster.

The context for creative collisions includes relationships, varied backgrounds, and a common, uniting thread. For the New England Ocean Cluster and its members, that common thread is the ocean.

COOPERATION PLATFORM

The NEOC is harnessing the power of connectivity to build a cooperative platform for entrepreneurs and experts to connect with others, uncover solutions to common problems, develop their ideas, and capitalize on unexplored opportunities. Fostering and enabling these collaborative efforts creates value for the entire cluster, both locally and nationally. Our goal is to act as a switchboard for those connected by our common thread of the ocean. The key is to not only maintain a robust network, but to utilize it to its full potential with the objective of achieving new growth and improvement. Developing a shared vision to identify the products and services that are most important, relevant, and necessary in the ecosystem are essential to garnering collective support for those ideas. The work of the NEOC is to promote dynamic relationships within marine industries, to increase the competitiveness of member firms, facilitate relationships between complementary activities and ideas, foster collaboration, and spur innovation.

The New England Ocean Cluster had three ongoing workgroups in 2017: Lobster Utilization, Aquaculture, and Retail: making use of 100% of the fish and realizing greater economic opportunities within the marine economy.

WORKGROUPS: AT THE CORE OF THE NEOC MODEL

Workgroups are how we plan to achieve that – for NEOC members to think and solve common problems, identify low-hanging fruit, and propel projects forward. Workgroups are at the core of the NEOC mode – it's where companies are engaged; it's where ideas are born. It's where all the action happens.

Each workgroup brings members together around initiatives to advance common goals or group needs around ocean development. The workgroups have a curated launch event – they are open to the public, and include a formal panel and roundtable discussion. These discussions are aimed at driving product innovation and identifying where gaps in the economic ecosystem exist. Attendees outline individual goals, establish common objectives, and deliberate on practical next steps.

This approach is both a top-down and bottom-up practice. The workgroup discussions are facilitated so that the big picture isn't lost, but that obtainable and incremental next steps can be captured and achieved. These roundtable-style discussions are formalized in a report, which informs the identification of potential projects and areas of ocean economy interest. The reports become springboards for monthly meetings that are designed for Ocean Cluster members.
The next step is to formalize a core group of people focused on advancing a specific topic identified in one of the reports. These groups then attend the monthly meetings to explore ways to launch projects with critical importance to Maine's ocean economy.

The role of the NEOC is to facilitate dialogue between members and the companies they represent. The meetings are guided by questions directed at uncovering how existing ocean resources can be leveraged to bring innovation to existing products or develop new product categories.

A common question for this model is often, "well, isn't the networking and dialogue something that we could just make happen for ourselves?" Truthfully, the answer is yes, absolutely. People connect with others all the time in various, completely unstructured ways. However, one thing that Thor Sigfusson, founder of the Iceland Ocean Cluster and co-founder of the NEOC, has noticed is that a company or individual may know most of the right people and have the right network, but often are not utilizing those connections to the highest potential. Moreover, the collaborative efforts that might come from these networks often lack intentional direction, regular inspiration, and targeted facilitation. In this way, from this absence, the goal of the Ocean Cluster workgroup model is to be a platform so that networks can be effectively leveraged to achieve the desired results that members establish for themselves and the entire cluster. Encouraging the cluster to think outside of the walls of their own company and work together to realize a shared vision for the ocean economy is the mission of the workgroup model.

NEW ENGLAND OCEAN CLUSTER
PORTLAND, MAINE, USA

Creating value and discovering new opportunities by connecting entrepreneurs, businesses and knowledge in the marine industries.

Find them online at:
Facebook: / newenglandoceanclusterhouse
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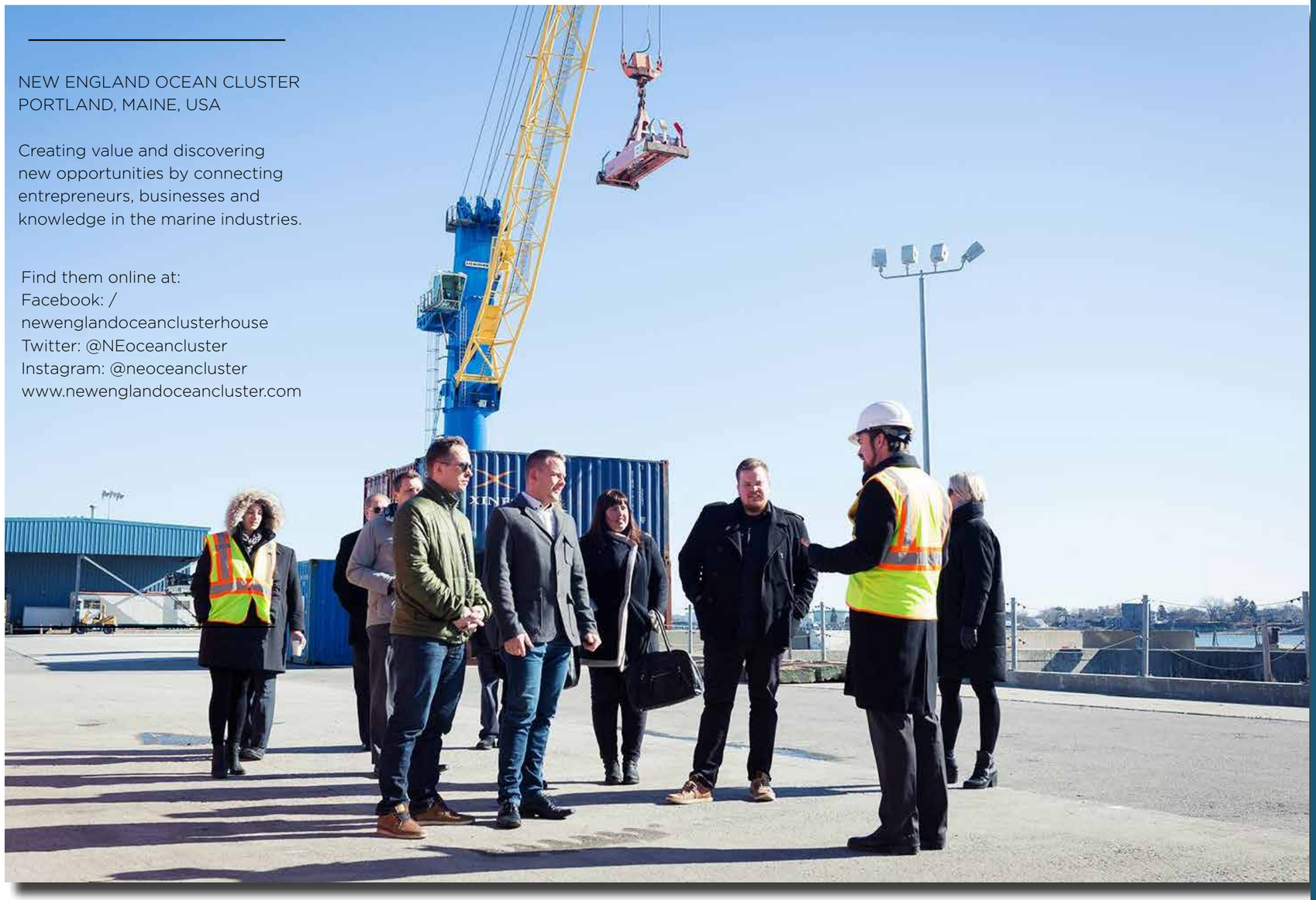
Instagram: @neoceancluster
www.newenglandoceancluster.com



WASTE TO WORTH

Iceland Ocean Cluster & New England Ocean Cluster

Crustacean Utilization: High Margin Value from Lobster Waste

Chitin and chitosan, made from crustacean shell waste, is proving to be a high value (and highly versatile) byproduct.

Despite the global market for chitosan and the recognition of crustacean shells as a prominent source of chitosan, the United States seafood industry is mainly discarding shells from its lobster, shrimp, and crab fisheries, with the majority of the waste ending up in landfills. Is there a way to create more value (and jobs) from crustacean shells?

Thanks to innovative research and entrepreneurship within the Iceland Ocean Cluster, a multitude of innovative and high value products have been developed from fish by-product, traditionally viewed as waste. The products range from cosmetics and skin care to pharmaceutical applications and biomedicine, greatly contributing the overall value of each fish landed in Iceland. Prior to the start of this initiative, estimates show that 30-40% of the entire Icelandic fish was being wasted. Within only a few years, the Icelandic seafood industry is now defining 100% high value oriented fish resource utilization as a reasonable target. This compares to 45-50% utilization in most countries around the North Atlantic.

Shells and shell-related parts represent 30% or more of the live weight of crustaceans. When processed, these shells and shell parts are partly or wholly separated and thereafter considered waste. In recent years, many initiatives have focused on utilizing the waste for highter value purposes, which vary from animal feed to fertilizer to household goods. The mentioned initiatives, though new, focus on relatively low margin, low unit goods. A thought worth considering is that crustacean shell waste can yield significant amounts of chitin and its derivative chitosan. Chitin is a glucose-based unbranched polysaccharide widely distributed in nature as the principal component of exoskeletons of crustaceans and insects as well as of cell walls of some bacteria and fungi.

HEALTH BENEFITS OF CHITIN

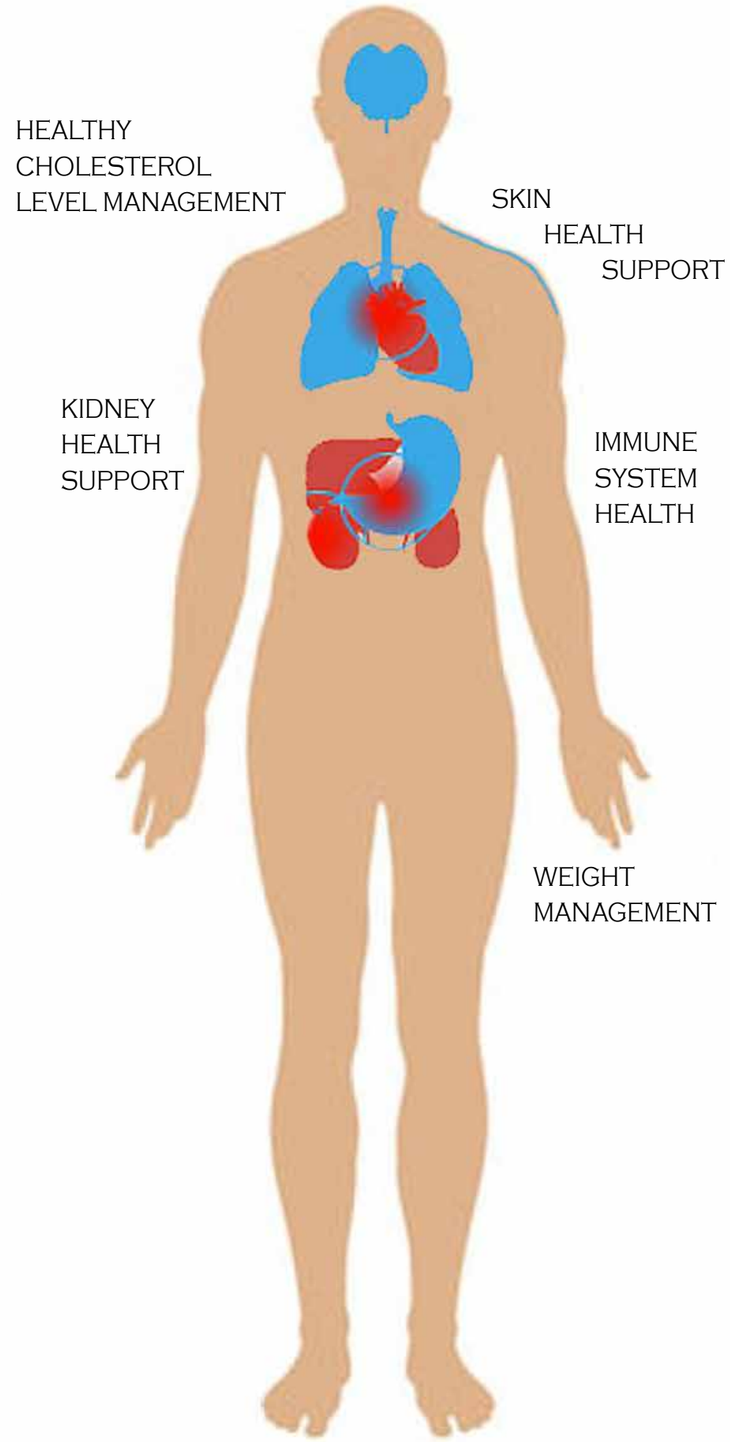
Chitin is structurally similar to cellulose. It has many commercial applications from use as a food thickener and stabilizer to use as a dietary fiber health supplement, for managing healthy cholesterol, and for support of kidney function. And due to its remarkable compatibility with living tissue, chitin has many uses related to skin health: for use in skin grafts, burn treatment, wound healing, general skin health support, and for nerve regrowth. Chitin is also sought after for high-end pharmaceuticals, weight management, and support of immune system health. Needless to say, there is much value to be gained by using this by-product. Waste becomes a benefit.

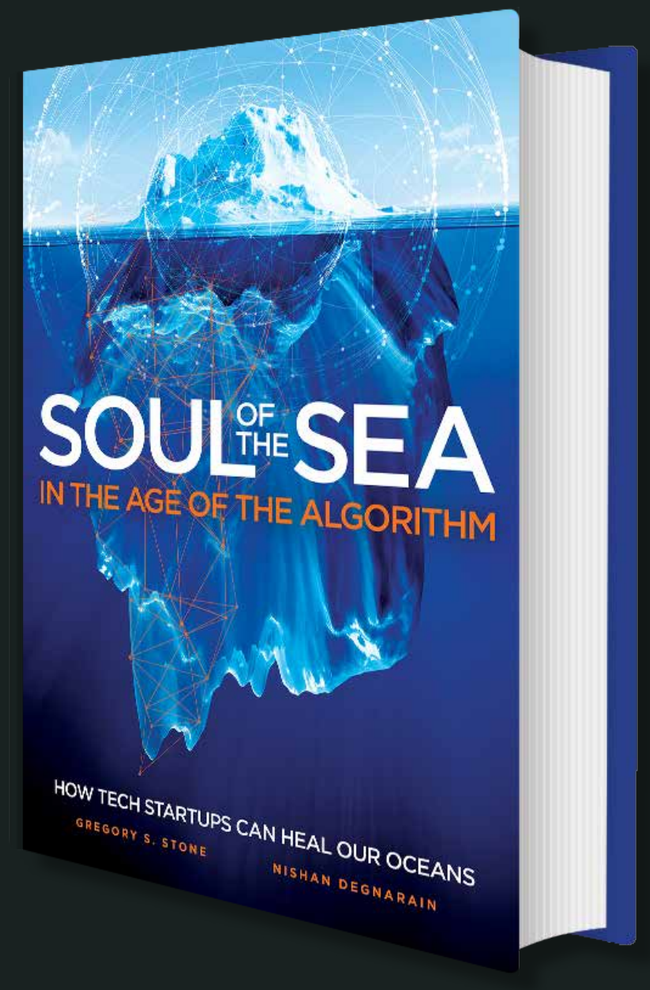
Since exploring ways to optimize the value of crustacean waste in Iceland, especially related to chitin processing, the Iceland Ocean Cluster has observed multiple opportunities for high value added chitin-derived applications.

The current harvesting level of crustaceans in the North Atlantic indicates that total landings are close to 345,000 metric tons which means that as much as 110,000 metric tons of shell waste is available each year.

The Iceland Ocean Cluster and the New England Ocean Cluster are working to eliminate the crustacean shell waste paradigm, replacing it with a new paradigm focused on high value, high margin by-products, The New England Ocean Cluster is focusing on increasing collaboration with companies in the Maine marine sector and neighboring regions, while recognizing growth opportunities and the communities involved.

BENEFITS OF CHITIN





SOUL OF THE SEA IN THE AGE OF THE ALGORITHM: HOW TECH STARTUPS CAN HEAL OUR OCEANS

by Dr. Gregory Stone & Nishan Degnarain

with a foreword by Ambassador Peter Thompson

President, UN General Assembly

192 pages

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Leete's Island Books

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Soul of the Sea in the Age of the Algorithm is at once a manifesto for a healthier ocean, a roadmap to a more prosperous co-existence with our planet, and a call for a new generation of systems leaders. The lessons here are not just for our oceans but guidance for how we can govern all our Global Commons for the benefit of the entire planet, both current and future generations. For the first time, the authors lay out clearly and succinctly what actions business, government, and individuals can take to overcome these planetary challenges, thereby restoring the soul of the sea, and redeeming our own. An excerpt from the book follows, with special thanks to the authors.

THE OCEAN AND OUR COLLECTIVE SOUL

Gregory Stone and Nishan Degnarain

AN EXCERPT FROM *SOUL OF THE SEA IN THE AGE OF THE ALGORITHM*

Mermaid statue
Dongbaek Island, Busan

Whenever we look to our past or present-day cultures that have uninterrupted links to a sustainable relationship with the ocean, we see that wherever we look, the ocean and water has always had a special significance to them. Even some Pacific Islanders refer to islands and dry land as *holes in our ocean*. The ocean forms the basis for the entire planetary 'hydrosphere': Water on Earth is locked in a perpetual cycle of evaporation from the ocean as pure distilled water, transported in clouds for redeposition on land and sea. The water that flows on land then rejoins the ocean along with the minerals and salts of which it becomes so richly comprised. When you view the water cycle in this grandiose way, the ocean starts in the clouds, extends down every mountain and river and into the sea. And the magic ingredient is the remarkable water molecule. Water, the universal solvent, is capable of dissolving more different things than any other known liquid, and it is the only substance that exists in all three of its 'phase' states (solid, liquid and gas) on Earth.

These remarkable qualities of water did not go unnoticed by ancient humans who, throughout the course of their lives, saw how important water was. Their understanding was based on empirical experience and knowledge rather than from the scientific understanding we have today.

The high value they placed on water is represented in the dizzying array of ancient water and ocean gods found in most ancient cultures for which there is a record—from the Greek and Roman to Slavic, Hebrew, Korean, and Filipino. The Chinese, for example, had Mazu, the Fujianese shamaness and Yu-Kiang, who ruled the sea in the form of a whale with arms and legs. Australian Aboriginal mythology has Eingana, a creator goddess and the mother of all water animals as well as humans. Ezili, in Benin mythology, is the goddess of sweet water, beauty, and love. The Norse, Germanic, and Celtic peoples also all have their own aquatic connections to the metaphysical.

The biblical story of Noah and the great flood, for example, shows water as a powerful destroyer, cleansing the Earth of the evil and disobedient. Then again, water is also portrayed as a great giver of life in many beliefs and is widely considered sacred: the Ganges River in India is held to be a goddess by Hindus, her waters making the land fertile and washing away the sins of humanity.

President John F. Kennedy poetically described his connection to the seas in 1962:

I really don't know why it is that all of us are so committed to the sea, except I think… it is because we all came from the sea. And it is an interesting biological fact that all of us have, in our veins, the exact same percentage of salt in our blood that exists in the ocean, and, therefore, we have salt in our blood, in our sweat, in our tears. We are tied to the ocean. And when we go back to the sea, whether it is to sail or to watch it, we are going back to whence we came.

These coincidences still remain one of the great mysteries of modern science, intertwined with the myths of origin.
Some scientists speculate that life probably originated in the ocean 3.5 billion years ago and did not come ashore for another 3 billion years after that. During this time, life became dependent on the ocean minerals and salts, so when the first animals left the oceans to occupy land they 'carried the ocean' with them, as it were, in the form of salty blood and cellular fluids.
This ancient ocean in our blood is still a vital part of us and all other animals. Humans need salt to survive for a range of biological functions.

Ancient cultures may not have known this science but had a reverence for salt. In Roman times, the barbarians would accept salt as pay for service in the Roman Army, hence the expression that a man is 'worth his salt', and it follows that the Latin root for the modern word 'salary' is

salt. It is not surprising that salt became so highly prized, and that its main source — our oceans — were so revered.

Take a deeper dive into any of these ancient or ocean-linked cultures, and you will see how deep the relationship with the ocean goes. For example, the Gilbert Islanders report a strong connection to 'Dolphin Callers' in certain communities. These individuals are said to have the ability to call dolphins into the lagoon during times of famine. After several days of fasting and meditating on the part of the caller, dolphins would strand themselves on the beach, presumably sacrificing themselves to the community.

This was described by Sir Arthur Grimble, a scholar and resident colonial administrator in the early 20th century, in his popular autobiographical book *A Pattern of Islands* (1952) that was lauded as an important cultural account of these islands just after European contact.

Putting aside the obvious question as to the veracity of Grimble's account, the point here is that these cultures are filled with respectful legends, myths, and association with the ocean.

Similarly, the New Zealand Maori embedded a spiritual connection to whales with their oral histories, which describe how they came to New Zealand 'on the backs of seven whales'. Some anthropologists speculate whether this legend represents six waves of migration in canoes, translated over time to totem animals such as these whales. In furtherance of their attempt to capture how important the ocean is, such cultures frequently developed a belief in such totem animals, those wild creatures that connect people to the spirit world. In some ancient and modern Micronesian communities, for example, each person has a corresponding individual totem animal in the ocean. Their rules and customs were rooted in the belief that sea creatures were owed a respect and care, and violating that duty would lead to misfortune.

The Native American Iroquois people who today straddle the Canadian–United States border and are comprised of the six nations of the Mohawk, Onondaga, Oneida, Cayuga, Seneca, and Tuscarora people, developed a concept in The Constitution of the Iroquois Nation that has become known as Seven Generation Stewardship. This charter encourages long-term thinking not just on environmental issues but in every aspect of life:

In all of your deliberations in the Confederate Council, in your efforts at law making, in all your official acts, self-interest shall be cast into oblivion. Cast not over your shoulder behind you the warnings of the nephews and nieces should they chide you for any error or wrong you may do, but return to the way of the Great Law which is just and right. Look and listen for the welfare of the whole people and have always in view not only the past and present but also the coming generations, even those whose faces are yet beneath the surface of the ground— the unborn of the future Nation.

With today's demographics, this would take us to thinking 150 years into the future. Is there a way to adopt a similar system today, maybe broader and perhaps more complex, but equally thoughtful, forward looking and sustainable?

Co-authors Gregory Stone and Nishan Degnarain are also co-chairs of the World Economic Forum Special Initiative on Oceans. Stone and Degnarain are an extraordinary, complimentary team: in age, experience, and understanding of the "radically new ways of thinking and behaving" that Ambassador Thompson asserts as the requirement for the benefit of the future ocean and its essential contribution to our global future.

On the web at:
Instagram: @soulofthesea book
Twitter: @soulofthesea1
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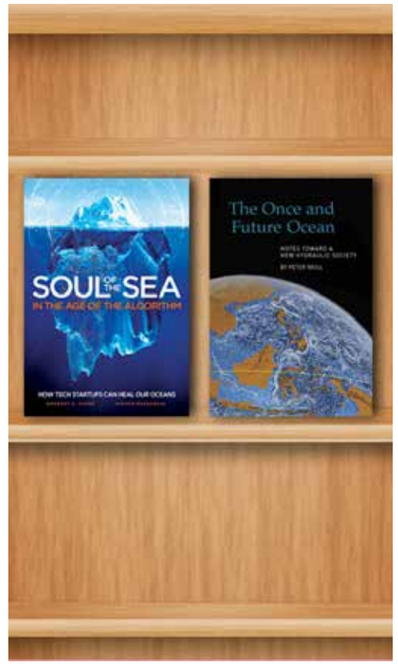
Dona Fish
Ovimbundu peoples, Angola
Circa 1955. Wood, pigment, metal, mixed media.
Fowler Museum, UCLA
Photo by Don Cole

WORLD OCEAN PUBLICATIONS

World Ocean Observatory is proud to be partnering on a series of provocative publications about the ocean, published in association with Leete's Island Books. Two books have been published to date with a third slated for 2018.

1. *The Once and Future Ocean*, Apr. 2016
2. *Soul of the Sea*, Oct. 2017
3. To be announced, 2018



On the web at:
worldoceanobservatory.org/content/world-ocean-publications

THE CALL OF THE OCEAN

Sandra Kynes

AN EXCERPT FROM *SEA MAGIC: CONNECTING WITH THE OCEAN'S ENERGY*

These are the tests of the sea:

The third wave is for courage,

The sixth wave is for perseverance,

The ninth wave is for surrender.

Lunaea Weatherstone
Celtic Mandala Journal

Many early people worshipped a mother goddess whose many roles included nurturing and sustenance. The names of some of these goddesses, and of the saints who came later, were derived from the sea: Mara, Maia, Mary, Maria, Marian, and Miriam. The Latin root word, mare, means "sea." In French la mère means "mother" and la mer means "sea."

The goddesses known as Aphrodite, Ishtar, and Venus were called Stella Maris, or Star of the Sea. This title was also given to the Virgin Mary, who was usually depicted in a flowing blue cloak and white dress, "the colors of wave and foam." It was no accident that people of the Mediterranean viewed Mary, too, as a goddess of the sea: she was beautiful, nurturing, mysterious, divine.

In addition to finding a source of food, people have been drawn by the sea's mesmerizing sight and sound; something primal in that endless rhythm calls to us. Author Don Groves noted that we have an "atavistic at-homeness" with the sea. It is unimaginably vast and at times terrifyingly wild, yet something beckons to us and we know we are tied to the ocean.

Water is symbolically associated with emotion, with inner flowing. Water is formless and yet forming. It represents transformation; we sometimes refer to this process as a sea change. The sea is a great icon for ongoing change because its own constant shifting also endlessly changes the shoreline.

The sea is mysterious; its primal call draws us and holds us spellbound. Its energy speaks to us on a level where we don't often venture, distracted as we are by our culture's superficial, materialistic ideals.

We are left hungering to find out who we are and where we belong in this world. The sea can bring us back to that state of grace where we feel awed by the beauty of life and are humbled, grateful to be part of it. The sea can help us explore self, define our inner path and lead us out into the world knowing that we each have our unique place. By allowing nature to have a hand in shaping us we can stop our haphazard chasing from one thing to another and focus on the meaningful aspects of our lives.

The beach, that ever-changing overlapping place of earth and sea, is a metaphor for those of us who are seekers. Like the beach, we are in-between, mentally and emotionally, as we search for meaning in our lives. What happens when we land dwellers connect with Mother Ocean?

We honor our primordial source.

We connect with the nurturing of the natural world — food, beauty, solace. We tap into one of the greatest powers on this planet. We acknowledge the largest portion of this earth — after all, we live on the "big blue marble," the planet that is 70 percent water.

WORLD OCEAN Observatory™

ABOUT THE WORLD OCEAN OBSERVATORY

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.

CONTACT

Post Office Box 1
Sedgwick, Maine 04676 USA
info@thew2o.net
worldoceanobservatory.org

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