OCEAN

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OUTER CAPE ENVIRONMENTAL AWARENESS NEWSLETTER

Our original goal in publishing **OCEAN** newsletter, was to share solutions for shared environmental problems. Our "Close to Home" article on page 3 is a successful example of our initial goal. We were pleasantly surprised this fall, when our NOAA contact informed us that the successful "Biomimicry" sand restoration system we developed on the Ocean beaches of Truro, Cape Cod, was now being used to restore Hurricane ravaged dunes in Puerto Rico! Other articles share intriguing reuse of once problematic waste in the Almond industry, why some algae becomes toxic, an in depth look at our larger storms and how to "de-orbit" space junk. **OCEAN** is the self funded, advertising free, environmental education publication of Safe Harbor Environmental, a small, interdisciplinary consulting group on Cape Cod. This is your newsletter and you have our permission to share it with others who believe in environmental education.
Thank you, Gordon Peabody, Editor.

January 2019 Issue No. 45

THE NEW ART OF "DE-ORBITING" SPACE JUNK

In our last issue, **OCEAN 44**, we learned about man-made debris that is orbiting the Earth. This debris ranges from old rockets and satellites to paint chips. All space junk poses a threat to current space missions due to the high speed in which this debris travels; even an object as small as a nut or bolt could cause severe damage to operating spaceships and stations. To make matters worse, we continue to contribute to this problem every time a rocket is launched. So, what's being done to address this issue?

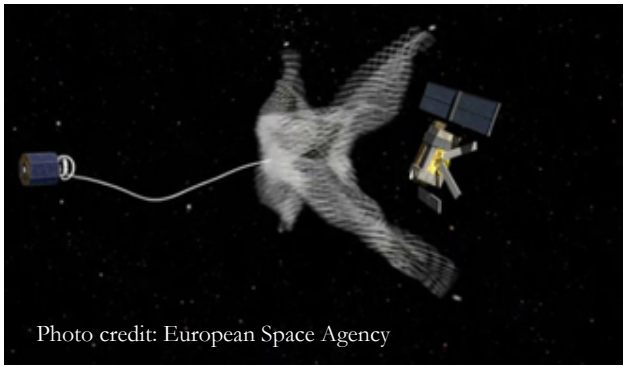


Photo credit: European Space Agency

Led by the University of Surrey, a satellite was launched to the International Space Station in April 2018. This satellite, known as RemoveDEBRIS, can be deployed from the ISS in order to observe and capture space debris and conduct experiments evaluating the effectiveness of various technologies. In September, RemoveDEBRIS successfully completed the first demonstration in history of active debris removal technology by using a net to catch a deployed target. RemoveDEBRIS also successfully tested its onboard vision-based navigation system in October by correctly predicting the distance, direction, and speed through space of a deployed target. Future plans include using a harpoon to capture space debris and attaching a dragsail to larger debris to cause it to de-orbit and burn up in the Earth's atmosphere more quickly.

According to Christopher Phillips, Astronomer and Science Communicator at the University of Washington, several other technologies are also in the development stages. These technologies involve moving hazards into a decaying orbit, causing them to burn up in the Earth's atmosphere. One technology utilizes lasers that use radiation pressure to 'push' larger pieces of junk. These lasers will be able to vaporize smaller pieces of debris. A second proposal would use micro satellites equipped with small chemical rockets. These rockets would be able to attach to and move larger pieces of debris. A third technology involves heavy satellites, or 'gravity tugs'. As a result of their mass, these tugs use gravitational attraction to attract less-heavy pieces of debris.

Unfortunately, as Phillips says, this is "a long-term problem with long-term solutions". Hopefully scientists can work to better manage this problem in the future, even if complete resolution is not possible.

More information in the links below:
https://www.surrey.ac.uk/surrey-space-centre/missions/removedebris, https://www.aerospacetestinginternational.com/news/space/space-junk-removal-trial-set-to-start-this-month.html#prettyPhoto

*Thank you to **OCEAN** Researcher Lauri Leach*

UNIQUE STORM FLOODS VENICE

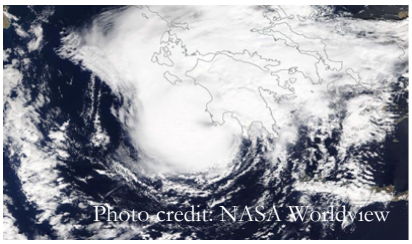


Photo credit: NASA Worldview

"The Medicane", also known as a Mediterranean Hurricane or a Mediterranean tropical-like cyclone, hit Greece, Turkey, and parts of Italy this October. Medicane's are not that unique to that region. The Mediterranean experiences medicane's about one to two times a year, usually around September and October when the Mediterranean Sea is still warm. However, these storms can occur any time throughout the year. Much like hurricanes and typhoons, these storms form over the ocean and continue to develop as winds rotate in a circular in motion until there is a clear eye at the center of the storm. To be classified a "hurricane" the storm must form over the Atlantic Ocean and have sustained windspeed of more than 74 mph.

Medicane's are usually much smaller and less powerful. For example, medicane Zorba's wind speed was around 56 mph which would make it equal to a small tropical storm rather than a hurricane. Hurricanes usually travel from east to west, while medicanes which travel west to east. For nation of a medicane requires concurrence of specific environmental conditions including a mass of cold air and atmospheric instability.


Photo credit: Giacomo Cosua/Nurphoto Via Getty Images

The region already experienced two medicanes this year, which affected countries such as Greece and Turkey and caused severe damage and even a few fatalities in Italy. These storms can produce heavy rain and wind, which can cause mudslides, flooding, etc. Even though medicanes are not as severe as hurricanes they can still be extremely dangerous if one is not well prepared for the storm. A study conducted in 2013 suggests that the frequency of medicanes will decrease in the future due to the changing climate conditions. However, the severity storms will increase resulting in a greater damage.

More information in the links below:

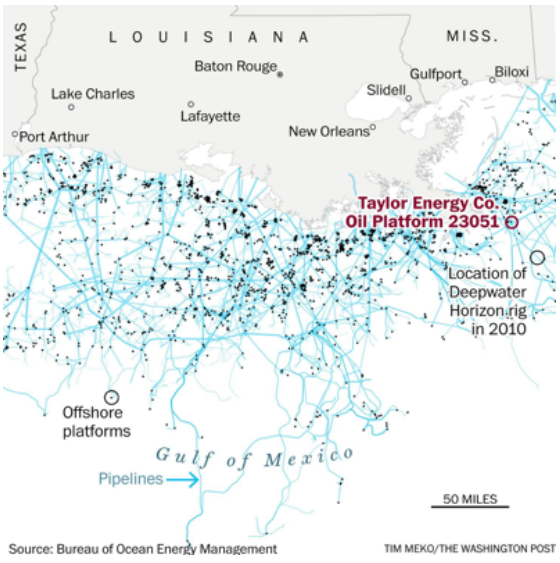
https://www.express.co.uk/news/world/1027307/Italy-weather-Mediterranean-strike-Italy-medicane-Tyrrhenian-sea-cyclone-europe, https://www.bbc.com/news/world-europe-46029302, https://www.wunderground.com/cat6/Tropical-Storm-Medicane-Hits-Greece

*Thank you to **OCEAN** Researcher Darya Lilie*

14 YEAR LONG OIL LEAK

For the last fourteen years, largely unbeknownst to the public, an oil spill has been leaking into the Gulf of Mexico. This spill has been leaking an estimated 300-700 barrels of oil each day into the Gulf of Mexico since 2004. The spill began when Hurricane Ivan triggered a mudslide sinking a Taylor Energy oil platform off the coast of Louisiana.

How has this spill stayed a secret for so long? Taylor Energy worked for years to keep the spill and their efforts to mitigate it a secret from the public. In 2010, six years after the spill started, the BP Deepwater Horizon spill occurred close by bringing some attention to the Taylor Energy Spill, however it was overshadowed by the larger spill. Further, until recently estimates for the size of the spill were much smaller, with the U.S. Coast Guard National Response Center (NRC) claiming it was releasing 1-55 barrels per day, using data from Taylor Energy.



While there have been efforts to study and mitigate this spill, with Taylor Energy making a deal to establish a $666 million trust to fund these efforts there has been little progress toward a solution. Taylor Energy has tried to recover $450 million of that trust by arguing that the spill resulted from an act of god, despite hurricanes in that area being a well-known and regular occurrence. Environmental groups, such as Earthjustice, a nonprofit legal organization, are working to make sure accurate studies and action timelines are being established in response to spills such as this one. We will continue to watch this spill and update on any progress.

More information in the links below:

https://www.washingtonpost.com/national/health-science/a-14-year-long-oil-spill-in-the-gulf-of-mexico-verges-on-becoming-one-of-the-worst-in-us-history/2018/10/20/f9a66fd0-9045-11e8-bcd5-9d911c784c38_story.html?noredirect=on&utm_term=.4e86b53211e1, https://www.washingtonpost.com/national/health-science/a-14-year-long-oil-spill-in-the-gulf-of-mexico-verges-on-becoming-one-of-the-worst-in-us-history/2018/10/20/f9a66fd0-9045-11e8-bcd5-9d911c784c38_story.html?noredirect=on&utm_term=.4e86b53211e1

*Thank you to **OCEAN** Researcher Jessica Hillman*

BEAUTIFUL BIRDS, COMPLICATED LIVES


Photo credit: Owen Humphreys/PA

Puffins, known as the clowns of the sea for their comically colorful beaks, are an attraction for tourists and scientists alike to the Farne Islands in the British Isles. Unfortunately, in recent years they appear to be declining. The National Trust studies Puffins on four of these islands and has reported a 12% reduction in breeding pairs overall in the last five years. These findings are concerning, even more so because Puffins are now listed as "vulnerable" to extinction, sparking further alarm.

A closer look at these numbers cause further confusion to scientists, while on one island Puffins have declined by an alarming 42%, on another they have increased by 18%. While closer study must be conducted into these concerning changes, it is believed that the puffin numbers might have decreased and changed because of storms and wetter than average weather in the area which may have affected the sand eel population which is their primary food source. This change in climate and food source could have altered their migration pattern of decreased their population due to starvation or changes in breeding and nesting times or locations. It is difficult to determine the exact reason for these changes however the National Trust will continue to monitor and report on the situation as it develops.

More information in the links below:
https://www.bbc.com/news/uk-england-tyne-44236755, https://www.shropshirestar.com/news/uk-news/2018/05/23/puffin-numbers-on-farne-islands-may-be-down-national-trust-warns/

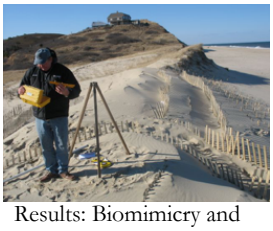
*Thank you to **OCEAN** Researcher Jessica Hillman*

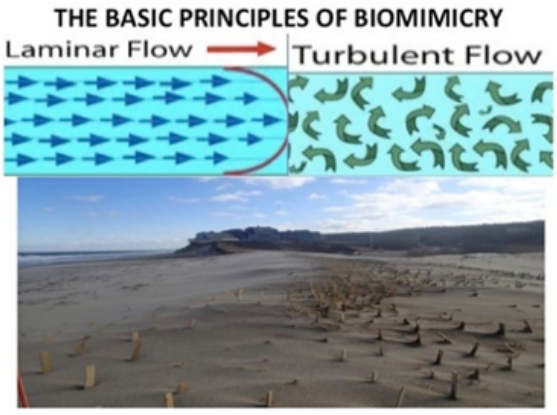
CAPE COD RESTORATION SYSTEM USED IN PUERTO RICO


Biomimicry: The system is very simple, easy to install and adjust.

Back in 2016, Safe Harbor's Director, Gordon Peabody gave a webinar presentation of his biomimicry method of using cedar shims stuck into sand to increase sand and decrease erosion on Cape Cod. This was shown on NOAA's online Restoration Webinar Series and has inspired others who viewed his presentation. Recently we were informed that a professor in Puerto Rico, Dr. Robert J. Mayer, had taken what he learned from Gordon's webinar and implemented it with his students on the island. He then gave a presentation for the same webinar series to share what he had learned by implementing this method. It is incredibly inspiring to see the effect that sharing knowledge can have globally.

Dr. Mayer's presentation is thought provoking and encouraging, as is his work with his students in Puerto Rico. Additionally, he provides insight for others who may be interested in implementing a similar technique sharing the ups and downs of the process. One interesting modification he made was instead of using cedar shims, he used something more readily available for him, wooden pallets that he then broke down into boards. While this process is certainly more labor intensive, it's a good way to use what is available and has the added bonus of decreasing the likelihood of theft. Otherwise, Dr. Mayer used the same process and has reported great success stating that "the rate of accumulation of sand in the biomimicry matrices is significantly higher than when using traditional sand fencing", further he is experimenting with finding the best distance between boards to maximize rate of accumulation. We are very excited to hear about Dr. Mayer's work and look forward to any further updates down the road.


Results: Biomimicry and 24" short fencing restored a Cape Cod dune.

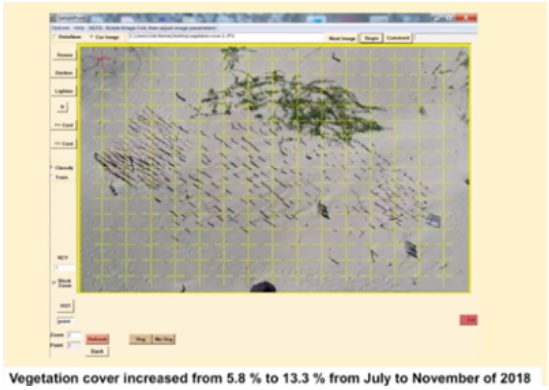


Laminar flow encountering turbulence will drop sand.

The recent NOAA Puerto Rico webinar can be viewed at:
https://training.fws.gov/topic/online-training/webinars/restoration.html

Here is the link to the original NOAA webinar we presented on Biomimicry and Puerto Rican Scientists were watching.
https://www.safeharborenv.com/safeharborblog/2017/2/21/making-land-from-air-innovative-biomimicry-sand-collection-system

*Thank you to **OCEAN** Researcher Jessica Hillman*



Vegetation improved behind Biomimicry system on Puerto Rico dune restoration.

Close to Home: MYSTERY TIDES AND TSUNAMI WARNING

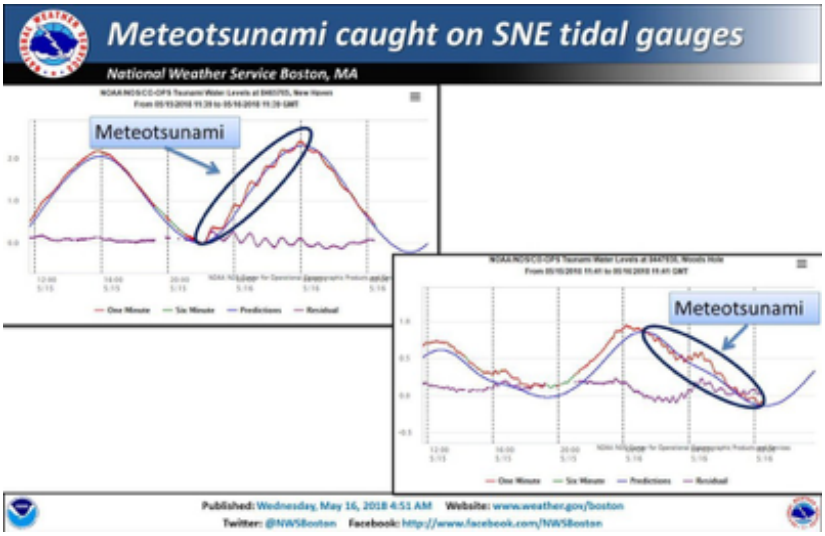


Photo credit: National Weather Service

Tsunamis have been studied for centuries. They are massive waves often caused by underwater seismic activity and can be incredibly destructive as they approach land. The Indian Ocean tsunami in 2004 killed a quarter of a million people. Tsunamis can also be triggered by fast moving air pressure disturbances, such as squall lines. These meteo-tsunamis are a recent discovery - they were described for the first time in 2006. Like seismic tsunamis, they impact the whole water column, and can be dangerous when they approach shore. They occur in the Gulf Coast, East Coast, and even in the Great Lakes. The strongest meteo-tsunami in history occurred in Croatia and created 20-foot wave heights. These waves, which are often created by passing thunder storms, can travel far past the center of the storm, meaning they can unexpectedly reach coastlines enjoying clear weather. These waves are often confused with changes in water level caused by storm surges, which occur when heavy winds cause water to pile up near the coast.

Meteo-tsunamis occur when air pressure changes very quickly and drastically. The combined pressure of the atmosphere and seawater pressing downward has to be roughly equal across space, or else winds and waves will form. When the atmospheric pressure in one place drops or rises very quickly, the surface of the water will respond in the opposite way, in order to equalize the combined pressure of water and air. For example, if the atmospheric pressure drops drastically, the water surface will rise in order to equalize the total pressure beneath it. This rising and lowering of water surface to equalize pressure is how meteo-tsunamis form.

These meteo-tsunamis have likely been occurring in New England for a long time, but since they were so recently distinguished from storm surges, the record of meteo-tsunamis in the region is not long, and thus the record of tsunami warnings in the region is not long either. In June of 2013, a meteo-tsunami occurred on the eastern seaboard, stretching all the way from North Carolina to Cape Cod. A man from Falmouth described watching the water in front of his restaurant recede and then come flushing back over the course of an hour. Residents and Oystermen reported a mystery, high speed tide, filling the Harbor at the wrong time on Christmas in Wellfleet harbor in December of 2017, and a similar event occurred in May of 2018, during which water levels rose 22 centimeters in southern New England. In May of 2018, a Tsunami Warning was issued for the region. It is likely that many more meteo-tsunamis have occurred in the past decade, though most are probably too small to notice. These weather events are not particularly rare, but since they are so newly categorized, tsunami warnings in New England still seem unusual to many.

More information in the links below:
https://www.tsunami.gov/previous.events/?p=MeteoTsunami5-15-2018 https://www.capecodtoday.com/article/2018/05/15/239474-Special-Weather-Statement-51518-906-pm, https://oceanservice.noaa.gov/facts/meteotsunami.html, https://nws.weather.gov/nthmp/documents/meteotsunamis.pdf, https://www.clickondetroit.com/weather-center/science/meteotsunamis-on-the-great-lakes-heres-what-they-are-and-how-they-form, https://theraptorlab.wordpress.com/2013/07/05/last-months-mysterious-cape-cod-tsunami/, https://www.masslive.com/weather/index.ssf/2018/05/there_was_a_meteotsunami_off_c.html

*Thank you to **OCEAN** Researcher Rae Taylor-Burns*

Close to Home: QUICK ACTING CAPTAIN SAVES A SECOND FISHERMAN

At around 7:15 AM one morning in September, 2018, the Coast Guard received an emergency call from the scallop boat, "Glutton." A 24-year-old fisherman on the crew had become entangled in fishing gear and fallen overboard off the coast of Provincetown, nearly drowning. He was able to free himself from the gear on his own and the crew assisted him back onto the boat. The fisherman was transferred to a Coast Guard boat with an EMT from the Provincetown Fire Department on board that had arrived at the scene approximately an hour later. He was then transferred to a helicopter from the Coast Guard Air Station Cape Cod and flown to Cape Cod hospital in Hyannis. Fortunately, the fisherman was conscious, stable and had no serious injuries. This same vessel had rescued a crewman from a capsized boat a few years ago.

*Thank you to **OCEAN** Researcher Izzy Bachman*

EXPERIENCING A THOUSAND YEAR HURRICANE

This past fall, the Mid-Atlantic East Coast states endured a 1000-year storm, during Hurricane Florence. Florence formed around Cape Verde as a tropical depression, and as it crossed the Atlantic Ocean it intensified to a Category 4 hurricane, but when it made landfall on the Carolina coast, it had subsided to Category 1. It landed at Wrightsville Beach, in North Carolina, and despite being only a category 1, its winds caused destruction in this region. More damaging, however, was the massive quantity of rain this storm dumped on the region. This was due partly to the moisture of the storm, but largely because the storm moved so slowly across the region - sometimes only 2-3 miles per hour, thoroughly soaking the land it crossed. During this time rivers in the region overtopped their banks, closing many major roads and highways in the region. Combined direct and indirect deaths from this storm totaled 55 people, across 4 states. North Carolina's agricultural industry was impacted as well, resulting in the deaths of many chickens, turkeys, and hogs, and in addition, manure pits across the state were damaged, causing animal waste to flow into the flooded rivers. Untreated sewage and coal ash also made their way into the flooded waterbodies.

News reports across the country called Florence a 1 in 1000-year storm - but what does this actually mean? These types of designations are created using a method called frequency analysis, that determines the statistical probability of events occurring. A 1000-year storm means that a storm of that magnitude has a 1/1000 chance of happening in a given year based off observations from past storms - not that it will only happen one time every 1000 years, as is commonly misunderstood. A storm like this can occur every year, but that is unlikely. A minimum of ten years of data is required to perform these frequency analyses, though more data is preferred. Since these titles are based off historical observations, as storm intensities change, the level of 100 or 1000-year storms will change accordingly.


Photo credit: Carolyn Van Houten/The Washington Post via Getty Images

More information in the links below:
https://www.wunderground.com/cat6/Carolinas-Struggle-Florences-1-in-1000-Year-Rains?cm_ven=hp-slot-2, https://www.cbsnews.com/news/hurricane-florence-aftermath-flooding-envelops-south-carolina-homes-death-toll-rises-2018-09-26/, https://www.washingtonpost.com/news/capital-weather-gang/wp/2018/05/29/the-concept-of-a-thousand-year-rainstorm-is-legitimate-but-limited-heres-what-you-should-understand-about-it/?noredirect=on&utm_term=.7e5133cad2a2, https://www.usgs.gov/faqs/what-a-1000-year-flood?qt-news_science_products=0#qt-news_science_products, https://www.vox.com/2018/9/20/17883492/hurricane-florence-rain-1000-year, https://water.usgs.gov/edu/100yearflood.html

*Thank you to **OCEAN** Researcher Rae Taylor-Burns*

UNIQUE NEW PRODUCT AWARD


Photo credit: Geresei/Shutterstock

In recent years demand for almond products has increased exponentially and in turn the amount of almond waste has also increased. The kernel, the part of the almond that we eat is in high demand, however the hull and shell which protect the nut during growth are often wasted and end up in the landfill. Uses for these coproducts are constantly being innovated, a few new uses for these include being converted into fuel, alcoholic beverages, and even food for bees.

In addition to reducing the amount of waste going to the landfill, feeding bees sugar made from almond hulls may be more beneficial to their health. New research suggests that feeding bee colonies high-fructose corn syrup and other honey substitutes make them more susceptible to pesticides and diseases and in turn can lead to colony collapse. The compound p-coumaric acid which is typically found in plants is thought to help with the defense against pesticides; high fructose corn syrup and other honey substitutes do not have this compound. Hopefully by converting sugars derived from almond hulls or other plant products bees will be better protected against harmful pesticides. Alternatively, sugar from almond hulls can be converted to ethanol and used in fuels or used in alcoholic beverages. Each time these products are used instead of going into the landfill helps to prevent wastefulness.

More information in the links below:
http://www.foodrepublic.com/2018/03/19/reusing-almond-shells/, https://www.smithsonianmag.com/smart-news/high-fructose-corn-syrup-may-be-partly-responsible-for-bees-collapsing-colonies-46859095/, https://www.greenmatters.com/news/2018/03/20/Z1Ogf0W/almond-shell-waste-plastic-beer

*Thank you to **OCEAN** Researcher Lindsey Stanton*

HOW ALGAE BECOMES LETHAL

During the summer of 2015, the largest harmful algae bloom (HAB) ever recorded occurred on the west coast, extending from the Alaskan peninsula to central California. This bloom, caused by phytoplankton Pseudo-nitzchia, resulted in drastic ecological and economic impacts. By the end of the summer, NOAA reported an Unusual Mortality Event after the deaths of 30 large whales were documented in the Western Gulf of Alaska. The HAB also forced fisheries to close. In Washington, for example, the razor clam industry lost approximately $9.2 million.

Phytoplankton are unicellular marine algae that are the foundation of the marine food web and account for almost half of the ocean's carbon fixation. Algae blooms are not necessarily toxic and often serve as an important food source in the ecosystem. Certain groups of phytoplankton, however, can release harmful toxins into the environment. According to NOAA, a HAB occurs when algae colonies grow beyond control while releasing toxins that impact human health and the marine ecosystem. Pseudo-nitzchia, for example, can produce the mammalian neurotoxin domoic acid (DA) that interferes with the central nervous system, causing amnesic shellfish poisoning. Symptoms of amnesic shellfish include nausea, diarrhea, confusion, and even seizures, coma and death.

Photo credit: CDC.gov

Pseudo-nitzchia has a very complex genome comprised of over 20,000 genes, and despite years of research, the genetic basis for DA synthesis was unclear until recently. Scientists at the Scripps Institution of Oceanography at the University of California San Diego and the J. Craig Venter Institute conducted a study that has uncovered the mechanism behind DA production. The authors knew that environmental factors could induce DA production, specifically limited phosphate and high carbon dioxide levels. By studying gene expression of Pseudo-nitzchia under these conditions, they were able to identify the 3 genes related to DA biosynthesis. The authors also found that the genes were clustered together, suggesting that DA is of biological importance for the functioning of this organism.

This finding is especially important considering that the ocean absorbs a quarter of the carbon dioxide released into the atmosphere from fossil fuels. Higher carbon dioxide conditions will cause more frequent and severe HABs in the future. Therefore, understanding the biosynthesis behind DA production will be extremely important for genetic monitoring of Pseudo-nitzchia and other phytoplankton in order to predict future HABs. Furthermore, increased knowledge of DA biosynthesis will open doors for future research on production of similar toxins in other groups of algae and DA's biological function for Pseudo-nitzchia.

More information in the links below:
https://phys.org/news/2018-09-scientists-genetic-basis-algal-blooms.html, https://oceanservice.noaa.gov/facts/redtide.html, https://oceanservice.noaa.gov/news/sep15/westcoast-habs.html

*Thank you to **OCEAN** Researcher Izzy Backman*

UNDERSTANDING UNWELCOME STORM SURGES

Upon making landfall, Hurricane Florence was downgraded to a Category 1 storm on the Saffir-Simpson wind scale, but the storm was no less threatening. Although wind speed decreased, wind field increased in size, leading to massive and destructive storm surge.

Storm surge is the abnormal rise in water (above predicted astronomical tides) caused by a storm. Many factors affect the maximum potential storm surge for a particular location. According to NOAA's National Hurricane Center (NHC), storm surge is often the aspect of a hurricane that poses the greatest threat to life and property along the coasts. This was certainly the case when Hurricane Florence struck North Carolina.

Hurricane Florence's expansive wind field brought storm surge that notched the third highest water level on record in Wrightsville Beach, North Carolina, and broke sea level records in Beaufort and Wilmington, two coastal locations with records going back over 65 years. But the largest storm surges from Florence occurred in Emerald Isle and New Bern, North Carolina, where the sea levels reached an astounding 10.1 and 7.0 feet above ground, respectively.

In addition to storm surge, severe flooding in North Carolina was compounded by extremely heavy rainfall. Some places received upwards of 50 inches of rain and Florence dumped about 8 trillion gallons of rain total, across North Carolina.

Over 50 deaths have been attributed to Hurricane Florence, and the cost of property damage and economic loss across the three states affected is estimated to total $17 to $22 billion. Storms this severe are extremely rare but are becoming more frequent due to human caused climate change. Warmer air holds more moisture, and therefore storms are stronger and wetter. Additionally, sea level rise from glacial melting exacerbates flooding from storms. In fact, Florence would not have broken the high-water record in Beaufort, North Carolina, had the sea level not have risen 0.7 feet since 1954, when Hurricane Hazel hit.

(continued on the next page)

UNDERSTANDING UNWELCOME STORM SURGES (cont.)

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More information in the links below:
https://www.wunderground.com/cat6/Florences-1-100-Year-Storm-Surge-Breaks-All-Time-Records, https://www.nhc.noaa.gov/surge/, https://www.vox.com/energy-and-environment/2018/10/3/17925470/hurricane-florence-2018-devastation-climate-change-flood-sea-level-rise

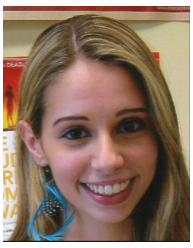
*Thank you to **OCEAN** Researcher Lauren Goodwin*

Photo credit: Jim Lo Scalzo/EPA

Happy and Healthy New Year Wishes to our readers and friends!
From Safe Harbor and our **OCEAN** team.

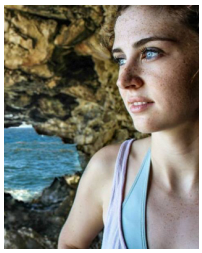
Stay tuned for our next issue **OCEAN 46**!

Where we bring you important information how fast food could be changing human fertility. We cover environmental issues such as warmer temperatures changing insect fertility and cover an innovative example of drone use; on bathing beaches to watch for sharks. We will also share some some insight into our unique research experiments to reduce whale entanglements, using seaweed gelatin and sand to create timed, dissolvable counterweights for buoys.



Thank you to Samantha Thywissen, for continuing to be passionate for her work as ***Associate Editor*** to make **OCEAN 45** a publication we are all proud of.

To Jess Hillman,
for her fantastic work as ***Research Coordinator*** keeping us all connected to bring you this issue.



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