



Outer Cape Environmental Awareness Newsletter

SafeHarborEnv.com

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A word from OCEAN's Editor:

GORDON PEABODY

This environmental education e-newsletter is written, with no advertisements or solicitation.

In this issue I recommend the 3 video links you will discover, documenting a degree of inspiration we can all use. When it comes to drinking water, Cape Cod is spoiled, with some of the cleanest, sand filtered rainwater in New England. That being said, Researcher Lindsey Stanton discovered the unpleasant truth about the footprints of a "Miracle" firefighting chemical we use. New England sea water spends the entire year, within a very narrow temperature range. It takes a lot of energy to alter sea water temperature, so when news came in about "Our" ocean heating up, we asked Researcher Eliza Fitzgerald to look into it. Our articles are kept short, with references and links for more information. Thank you to our readers for their support in sharing **OCEAN**.

Keep Healthy, Stay Informed

OCEAN has been keeping readers updated with current information to optimize health and awareness for Cape Cod residents. Massachusetts is ending 2021 on a high note.

Vaccinations are up and cases are down; things are finally looking up. Despite the optimistic outlook, it is important to continue the health precautions we have all grown familiar with. The holidays are upon us and while many are starting to celebrate with family and friends it is important to stay updated on recommendations and continue utilizing masks, distancing, and vaccinations to maintain good health.

OCEAN continues to share local updates and recommendations with our community. For the most updated information on COVID-19, including vaccinations, boosters, data, reopening, and news, please visit the [Massachusetts Department of Public Health](#). Detailed data can also be found through the MA DPH [COVID-19 Dashboard](#). Additionally, residents of Cape Cod can find local information and resources on the Barnstable County Department of Health [website](#). The following graphic includes the recent COVID-19 data for Cape Cod and most recent information can also be [found online](#). We hope our readers will use this update to stay informed and safe on Cape Cod this holiday season!



Photo Credit: MIT News

Further information:

- <https://www.mass.gov/info-details/covid-19-response-reporting# covid-19-interactive-data-dashboard>
- <https://www.mass.gov/covid-19-updates-and-information>
- <https://www.barnstablecountyhealth.org>

Are Our Feet Heading into the Fire?

THANK YOU TO **OCEAN**
RESEARCHER LINDSEY STANTON

This has been the hottest year ever... and not in a good way. Temperature recordkeeping began about 142 years ago, and July of 2021 is the new record holder for the world's hottest month ever. In July the land and ocean-surface temperatures were 1.68 degrees above the 20th century average. This reveals a disturbing trend, the previous record for highest temperature was broken in July of 2016 and tied again in 2019 and 2020.

The implications of this warming are troubling. As the average temperature of the world increases, the overall climate begins to change. This can potentially result in extreme weather. Some potential consequences include droughts and longer drought durations, flooding, and worsening health impacts. If droughts become more commonplace this could lead to shortages in available food and supplies. Sea levels are rising and becoming warmer due to rises in the global temperature. This in turn threatens coastal communities and may result in an uninhabitable environment for humans and marine life alike.

There have already been cases of more extreme weather including hurricanes, tornadoes, and monsoons. As we have recently seen, more severe weather can result in disastrous fires, which, in addition to burning down large areas of land, can lead to poor air quality in the surrounding area and haze across the country. There is no one simple answer to this complex problem, but we as a species must do something before the damage is irreversible.

Further Information:

- <https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts>
- <https://www.bbc.com/news/world-us-canada-58208792>
- <https://www.worldwildlife.org/threats/effects-of-climate-change>
- <https://www.sfchronicle.com/bayarea/article/California-wildfires-are-climbing-higher-up-16418967.php>



Photo Credit: SF Chronicle

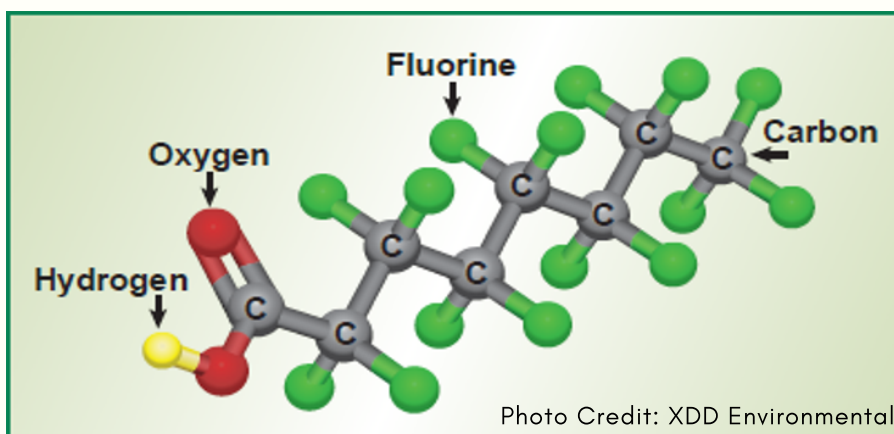
Know What we are Drinking

THANK YOU TO **OCEAN**
RESEARCHER LINDSEY STANTON

On October 2, 2020, the Massachusetts Department of Environmental Protection published a new standard for acceptable levels of PFAS in drinking water. PFAS are Per- and Polyfluoroalkyl Substances, which are a family of substances that have been widely used since the 1950's. These substances have historically been used in non-stick products as well as certain types of firefighting foam. PFAS are problematic because they take a very long time to break down and, in some cases, can accumulate in the environment. PFAS have been linked to various cancers, low birth weights and potential suppression of the immune system.

Since the new rule has passed scientists at Harvard University have found up to 40 times the amount of allowable number of PFAS in multiple watersheds along the upper Cape and Mashpee in Massachusetts. In terms of drinking water this is especially concerning because PFAS are water soluble and difficult to detect. Additionally, the EPA tests for about 25 known chemicals, but because many of the PFAS have been created by private companies it makes it extremely difficult for regulatory agencies to detect them.

In response to finding elevated levels of PFAS, the Mashpee water district responded by taking two of the seven pumping systems offline. The district is now using a filtration system at one of the pump stations. Recently elevated levels of PFAS have been found in Barnstable, and in response the area is looking for new sources of drinking water. In the coming months it is likely that more areas will be found to have been contaminated. Contaminated water can be treated, but it is extremely costly - it will likely take an extended period of time until we know the full extent of the contamination. In situations like this the easiest solution is to avoid any contamination to begin with.



Further Information:

- www.bostonglobe.com/2021/03/08/metro/forever-chemicals-pervade-drinking-water-sources-cape-cod-study-finds/
- <https://www.capecodtimes.com/story/news/2021/09/03/barnstable-ma-hunts-new-drinking-water-sources-pfas-forever-chemicals-contamination-affects-search/5662996001/>

Small Stuff, Big Problem

THANK YOU TO **OCEAN**
RESEARCHER LINDSEY STANTON

For years, if not decades, it has been known there have been plastics and microplastics congregating within the oceans and even along the beaches. It has been suspected that these plastics were in other areas such as salt marshes, but information was limited. A recent study by Woods Hole scientists has now shown a clear relationship between development of an area and the accumulation of microplastics within salt marshes. The reason this information is so startling is that salt marshes play an important part in ecosystems.



Photo Credit: Yale Climate Connections

Salt marshes work to filter a variety of nutrients, decrease carbon dioxide, increase biodiversity and help to prevent erosion. The larger concern with microplastics accumulating within the salt marshes is the effect that it can have on the ecosystem as a whole. Many of the animals that are first impacted by microplastics are the “filter-feeders” which can have serious implications farther up the food chain. This means there is a potential for humans in turn to ingest microplastics which can result in bioaccumulation if enough is ingested. Though more research needs to be done the study focuses on two types of plastics – fragments and fibers. As expected, the number of plastic fragments were directly related to the number of people in the surrounding area. The fibers, however, did not have a direct relationship with the number of people in the surrounding area. This led scientists to believe that the plastic fibers depend on the people living in the region as a whole; and begs the question, how are all of the plastic fibers getting into the salt marshes? There is still a lot of work for scientists to do in order to answer this question and many more, but the work has already begun.

Further Information:

- www.capeandislands.org/local-news/2021-06-18/study-microplastics-infiltrate-regions-salt-marshes
- www.sciencedirect.com/science/article/pii/S2666765721000314
- www.medicalnewstoday.com/articles/plastics-in-seafood#health-risks

Quiet Fisherman on Cape Cod

Save Baby Scallops

THANK YOU TO **OCEAN**
RESEARCHER TESS HOLLAND

Argopecten irradians, more commonly known as the Blue-Eyed Bay Scallop is a sought-after delicacy in many coastal New England towns. To protect themselves from predators, baby Blue-Eyed Bay Scallops attach to Eel Grass, just far enough up to avoid the ever-dangerous Green Crab's claw (Peabody, 2021). However, only last winter an unexpected predator wreaked havoc on the marine species in Provincetown; **a powerful coastal storm** proved to not only harm beachfront property, but the baby Bay Scallops as well. The storm surges tore the Eel Grass and baby Scallops from the bottom of the Harbor, sloshing them onto shore, exposed on the beaches (Peabody, 2021).

Provincetown resident Josiah Mayo and his friend Captain Flaherty observed what had happened to the baby Scallops and decided to put their resources to use. In fish totes, they collected thousands of washed-up scallops and used Captain Flaherty's boat to return them to the Harbor, then returned a few days later to monitor their progress and determine whether or not they successfully survived after near total destruction and death. Without the determination and benevolence of Josiah Mayo and Captain Flaherty, the Bay Scallop population might have looked much different (Peabody, 2021).

With the impending threat of climate change on Cape Cod, we can expect to see more tropical storms and Nor'easters of such high intensity. According to Glen Gawarkiewicz of Woods Hole Oceanographic Institution, "waters off Cape Cod and in the Northwest Atlantic are warming rapidly, faster than just about any other ocean" because of "warm-core rings" that travel from the Gulf Stream (Fraser, 2021). Furthermore, as a result of melting glaciers and increasing global temperatures, Gawarkiewicz explains that "we are starting from a higher (sea level) base if there is a storm" (Fraser, 2021). Although he explains it is unclear how much humans have contributed to the increasing intensities of storms, these two factors are good evidence that climate change is influencing the weather and ocean temperatures on Cape Cod and pose threats to marine species, as well as the many coastal communities that dot the Cape. However, if people simply follow in Josiah Mayo and Captain Flaherty's footsteps, we can all work together to preserve and protect Cape Cod and its environment to the best of our ability.

Further Information:

- www.capecodtimes.com/story/news/2021/08/20/cape-cod-scientists-not-sure-how-climate-change-effect-intensity-of-atlantic-ocean-hurricanes/8106311002/
- www.youtube.com/watch?v=q-PQJb6xqKs



Click here to watch a video
"Saving Baby Scallops"



Stranded Scallops, 2021
P-town, MA, photographer unknown

Atmospheric CO₂ Entering Oceans

THANK YOU TO **OCEAN**
RESEARCHER TESS HOLLAND

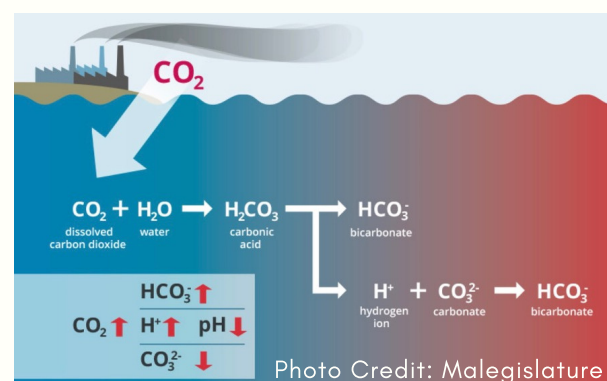
Atmospheric carbon dioxide levels are the highest they have been in nearly 800 years, creating ocean acidification, which harms Cape Cod shellfish and threatens the shellfish industry. In the past 200 years, world oceans have absorbed nearly 30% of carbon dioxide, slowing the effects of global warming caused by greenhouse gases (Doug, 2021). However, this absorption makes the oceans more acidic given that Hydrogen ion levels increase when more CO₂ is present (see graphic to understand the chemical breakdown). According to the 2021 Massachusetts Ocean Acidification Report, the average pH of the ocean has decreased from 8.2 pH units in the 1700's to 8.1 pH units today, equaling a 30% increase in Hydrogen ions (Massachusetts Ocean Acidification Report, 2021).

If the oceans continue to become more acidic, shellfish on Cape Cod will face challenges early in their life cycle when developing their shells. Species that have calcium carbonate shells are especially vulnerable. When there is an excess of Hydrogen ions in the ocean, more carbonate ions bond with the Hydrogen, leaving less available for crustaceans and other shellfish to use (Massachusetts Ocean Acidification Report, 2021). This interference at such an early developmental stage can result in serious long-term effects, most notably deformed or weak shells, and even the possibility of their shells dissolving (Doug, 2021). Given that many coastal communities and companies rely on shellfish as their main source of income, a shortage of these species will have serious economic effects. The shellfish industry brings in nearly \$400 million a year (Fraser, 2021).

In order to protect the health of our shellfish and keep the shellfish industry vibrant, we must be diligent in reducing our carbon footprint, as well as promoting the preservation of marine wetlands. Salt marshes, for example, absorb excess nitrogen, phosphorus, and carbon dioxide, which helps reduce the effects of ocean acidification (Massachusetts Ocean Acidification Report, 2021). If we can combine organic methods of mitigation with our own efforts in our daily life, both shellfish and fishermen will be happy as clams.

Further Information:

- www.capecodtimes.com/story/news/2021/02/10/study-shows-impacts-ocean-acidification-shellfish-industry/4448522001/
- malegislature.gov/Commissions/Detail/364/Documents
- vimeo.com/517370143?utm_campaign=COAST%20BCLIMATE%20Monthly&utm_medium=email&utm_source=Revue%20newsletter



Can we Bring Back the Herring?

THANK YOU TO **OCEAN**
RESEARCHER TESS HOLLAND

Published nearly a year ago in OCEAN 53, [A New River is on The Way](#), updated readers on the progress of the Herring River Restoration project, the largest tidal restoration project in New England. The project aims to repair and restore the marshland damaged by the inefficient Chequessett Neck Dike constructed in 1907, created in an effort to reduce mosquitos and develop more farmland (Hay, 2021). The dike has imposed many ecological threats on the 1,100-acre marshland such as reduced sea levels and the blocking of diadromous fish from passing through (Hay, 2021) (Mass.gov).

Necessary to complete this project is \$62 million dollars in funding, of which only \$8 million has been generated over the past 10 years (Bragg, 2021). Towards the end of August, Senator Ed Markey visited project supporters at the dike to promote two bills in Congress that if passed would provide an opportunity for the Herring River Restoration project to apply and receive the necessary funding to complete the project, an exciting prospect for the future of the river and surrounding ecosystem (Bragg, 2021). Markey explained that “a vision without funding is just an hallucination,” and emphasized the importance of solving this ecological disturbance given that Cape Cod is in the “crosshairs of climate change” (Bragg, 2021).

If funding is approved for the project, this would make the construction of a new bridge and dike the highest priority. Rebuilding these structures to be more efficient and productive would raise tidal levels, thus allowing more fish to access the river to spawn and improving the water quality (Bragg, 2021) (Hay, 2021). The restoration and revival of this historic and ecologically important area is crucial to the environmental health not only of Truro and Wellfleet, but all of Cape Cod.

Further Information:

- www.wickedlocal.com/story/provincetown-banner/2021/08/25/sen-markey-touts-infrastructure-bill-help-herring-river-marsh-repair-funding/5575403001/?fbclid=IwAR2t0eoPMVINZyvDWxl6vWZL4CJ4n_pFP6S-B_2SV5N4w2acmA8VGPxFHTg
- www.capeandislands.org/in-this-place/2021-08-12/remembering-wellfleets-historic-herring-run.
- www.mass.gov/service-details/herring-river-restoration-project-wellfleet-ma
- <http://www.herringriver.org/Videos>



Photo Credit: National Park Service



Click here to watch a video
of Friends of Herring River

Will Maine Shrimp Sink or Swim?

THANK YOU TO **OCEAN**
RESEARCHER ABIGAIL EILAR

Maine fisheries play significant role in the state's economy, including over a million pounds of northern shrimp harvested annually. However, in 2012, the Gulf of Maine (GOM) experienced a marine heatwave resulting in the collapse of shrimp populations and the moratorium of shrimp season since 2013. This was the most extreme event experienced in the last 30 years, causing increased water temperatures resulting in earlier spring temperatures and prolonged summer temperatures. Events like this affect the success of northern shrimp due to their temperature sensitivity, potentially affecting their growth rates, timing of larval hatch, early life survival, and recruitment.

Although the temperature is likely a component of shrimp population depletion due to their cold-water preferences, researchers have found another likely culprit causing decimation to their population and success. The longfin squid is an opportunistic predator that becomes more prevalent in the GOM in the warm summer months. Typically, brooding female shrimp move nearshore in the winter and spring months, returning offshore with males in the summer. This allows for little spatial overlap of the shrimp and their predator, the longfin squid. Increased overlap in their populations due to early warm temperatures allows longfin squid more opportunity to feed on shrimp, further depleting at-risk populations. Additionally, squid biomass has been generally high since 2012 which may explain why populations as of 2019 have not recovered.

Previously, when shrimp populations declined, they could recover by cooler years following heat events which has not occurred since the 2012 event. However, climate change will likely continue to play a role in the stress imposed on crustaceans such as increasing susceptibility of disease, creating unsuitable habitats, and increasing predator prey interactions. This fall, there will be a discussion on if shrimping activities in Maine will reopen and how those activities will be carried out.



Photo Credit: Bangor Daily News, Gabor Degre

Further Information:

- seagrant.umaine.edu/maine-seafood-guide/shrimp/
- www.necn.com/news/local/warm-waters-further-threaten-depleted-maine-shrimp-fishery/2530906/
- journals.plos.org/plosone/article?id=10.1371/journal.pone.0253914
- www.mainepublic.org/environment-and-outdoors/2021-09-30/scientists-think-theyve-found-the-reason-for-maines-prized-shrimp-fishery-collapse-they-point-to-yellowfin-squid

The Road to Recovery: The Northern Redbelly Dace

THANK YOU TO **OCEAN**
RESEARCHER ABIGAIL EILAR

The Northern Redbelly Dace (NRD) is a small minnow found through most of the Northern US and Canada and serves as an indicator species for in-stream habitat quality. Unfortunately, the Northern Redbelly Dace is endangered or threatened in many native areas such as Colorado, Nebraska, and South Dakota. In Colorado, the last natural population of NRD in 2015 was in West Plum Creek and was therefore listed as a "Tier 1: Species of Greatest Conservation Need" from the Colorado Parks and Wildlife. The NRD faces vulnerability to its populations due to human development causing loss of habitat and habitat fragmentation, predation, and non-native aquatic species.

The Northern Redbelly Dace Program was created to help expand and increase redbelly dace populations in Colorado while increasing public awareness of native species and utilizing citizen scientists and students to assist with the project. The St. Vrain Valley School's Innovation Center serves as the aquaculture center where the minnows are reared, and students and teachers are part of the process. In addition, volunteers go twice a day to carry out daily activities including the facilitation of spawning, feeding, and water quality testing.

In 2020, with the help from the Rooney family, the first redbelly dace population was released. Unfortunately, the original release into Webster Pond had to be rescheduled due the pandemic. In the meantime, Boulder County Parks and Open Space continued efforts to restore the area to create a suitable habitat for future release. More release locations are in the works by the Northern Redbelly Dace Program in addition to releases by programs such as the Left-Hand Water Shed Center. Monitoring efforts include using eDNA (environmental DNA) analysis and visual surveys to monitor the success of the released individuals.

Editor's Note: This project was brought to our attention by OCEAN Associate Editor Samantha Thywissen, who has connections to the project. Thank you Samantha!



Photo Credit: Redbelly Dace Recovery

Further Information:

- www.redbellydacecovery.org/
- www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5206788.pdf



Click here to watch a video
of Redbelly Dace Recovery

New Technology for Drinking Salt Water

THANK YOU TO **OCEAN**
RESEARCHER CATHERINE URQUHART

As more nations turn to the Ocean for their fresh water, a new technology has appeared. When you pour yourself a glass of water, you don't often think about the process of removing salt from sea water or brackish water, known as "desalination," that ensures your drink is clean. The current method for removing salts from water, known as reverse osmosis, uses a membrane with small pores like a strainer, allowing the water to filter through while keeping the salts on the other side. To push the water through the membrane, reverse osmosis desalination uses heavy-duty pumps to apply consistent pressure on the salt water. These pumps account for 44% of the total costs of desalination and consume a large amount of energy compared to the amount of clean water they produce (Lesics, 2020).

Unlike reverse osmosis desalination, scientists from the Manchester Institute of Science and Technology have discovered a more natural solution for cleaning water, using graphene—a thin sheet made up of Carbon atoms in a hexagonal pattern. These graphene sheets are stacked on top of each other at the perfect distance from each other to create natural tunnels which are too small for salt molecules to pass through (Joshi et al., 2014). Unlike the powerful pumps from reverse osmosis desalination, graphene is naturally hydrophilic, meaning it acts as a chemical magnet for water, pulling it through the filter (Abraham et al., 2017). Graphene desalination is a much more time and cost-efficient solution for removing salts from water, removing over 97% of salts from water, compared to the 90-95% of salts that reverse osmosis removes (Lesics, 2020). On a planet where only 2.5% of water is fresh and 14% of people are predicted to experience water scarcity by the year 2025, technologies such as this one could aid in creating a more sustainable, healthy future (Competing for Clean Water Has Led to a Crisis, 2010).

Further Information:

- doi.org/10.1038/nnano.2017.21
- www.nationalgeographic.com/environment/article/freshwater-crisis
- doi.org/10.1126/science.1245711
- www.youtube.com/watch?v=tAN0QNQFDbg

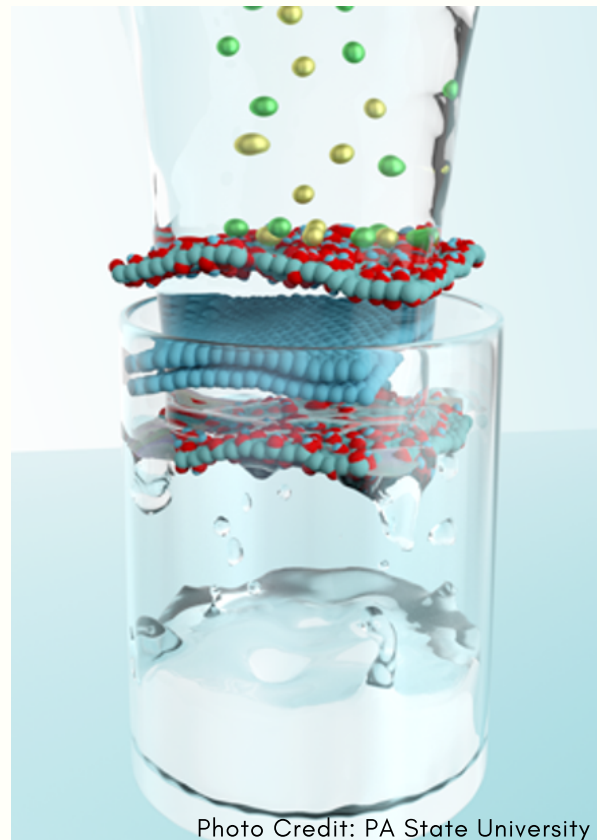


Photo Credit: PA State University

Innovative Ecosystem Research on Light

THANK YOU TO **OCEAN**
RESEARCHER CATHERINE URQUHART

Until recently, little was known about the impacts of blue-white light on our ecosystems. Douglas Boyes noticed that cities in England switched their streetlights from yellow light to bright white lights and was inspired to understand the impact of this change on nocturnal moths. When comparing areas with different types of light, Boyes discovered that there were about half as many moth caterpillars in areas with streetlights compared to those with no light, and of all the areas with light, those with blue light were the worst. Boyes also found that caterpillars in blue-light areas were larger, exhibiting a typical stress response for the species. (Boyes et al., 2021)



Photo Credit: University of York

As for why caterpillars are dying in blue-light conditions, Boyes predicts that female moths are less likely to lay eggs because they are tricked into thinking it is daytime, and nocturnal moths wouldn't otherwise lay eggs during the day. He notes that the bright light makes it much easier for moth predators, such as bats, to see the insects in the night. Despite their small size, moths are at the bottom of the food chain, meaning their disappearance could have a large impact on our ecosystems and the animals that eat them. Solutions to the problem could include dimming streetlights in the early morning or implementing color filters to cut out harmful wavelengths of light. (Gill 2021)

Further Information:

- doi.org/10.1111/icad.12447
- www.bbc.co.uk/sounds/play/m000z0r1

Editor's Note: Our Researcher wanted to dedicate this article to Douglas Boyes, the researcher who discovered this information, who passed away unexpectedly right after publishing his research.



Tropical Fish Found in Massachusetts Area

THANK YOU TO **OCEAN**
RESEARCHER ELIZA FITZGERALD

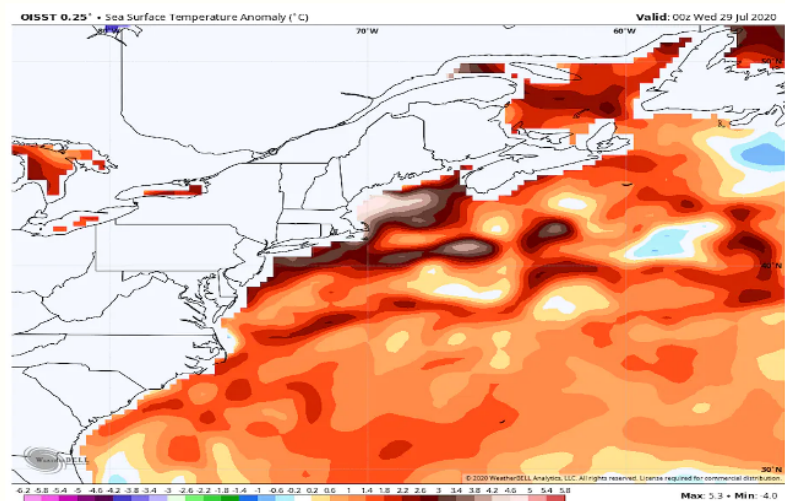
For the past few years fishermen and scientists have noted unusual fish in the waters off of the coast of New England. Off the coast of Nantucket during the summer of 2020, a Nantucket fisherman caught a houndfish, a subtropical species commonly found in Caribbean waters. The houndfish was the first of its kind to have been caught in Massachusetts, but one of many sightings of exotic or unusual marine species off of the coast of Massachusetts and in the Gulf of Maine over the past few years (Samenow and Freedman 2020).

The frequency of unusual, warm-water fish in New England waters is a symptom of marine heat waves. Marine heat waves, or MHW, occur when ocean temperatures exceed expected temperatures for a long period of time. MHW are correlated with changes in currents and overall rising global sea surface temperatures attributed to anthropogenic climate change (Samenow and Freedman 2020). They have significant and visible impacts on marine ecosystems.

A MHW off of the west coast of the U.S. in 2014, nicknamed “the Blob” caused harmful algal blooms, seal strandings, and a series of declared disasters at fisheries (NOAA 2019). In 2021, sustained high temperatures over land warmed surface waters enough to kill an estimated 1 billion sea creatures on the coast of Vancouver (Shivaram 2021). The Gulf of Maine in particular is warming faster than 99% of the Ocean (Poppick 2018). These marine heat waves may bring about unusual and exotic species, but more importantly they threaten the regional and local marine life and the overall health of these vital ocean ecosystems.

Further Information:

- www.fisheries.noaa.gov/feature-story/new-marine-heatwave-emerges-west-coast-resembles-blob
- eos.org/features/why-is-the-gulf-of-maine-warming-faster-than-99-of-the-ocean
- www.washingtonpost.com/weather/2020/07/31/marine-heat-wave-hurricanes/?fbclid=IwAR2cyF2o8WIFTXfFsDmJs3mx7IcL9KzMwaiCDkxIDvPUXEII-wqZX45p4c
- www.npr.org/2021/07/09/1014564664/billion-sea-creatures-mussels-dead-canada-british-columbia-vancouver.



Sea surface temperature anomaly map shows waters 3-5 degrees C warmer than average in the Gulf of Maine in July of 2020. Photo Credit: Samenow and Freedman 2020

Thank you!

Editor's Final Words:

These are tricky times but we have learned to navigate them together. The written word, in my opinion, has re-emerged as a significant tool for education, communication and connection for all of us. I appreciate the efforts of our Research Coordinator Jessica Hillman and our Associate Editor, Samantha Thywissen, to make OCEAN everything you see before you today. We will have a short article on changes in both of their lives in the next issue. This issue of OCEAN would not be possible without Interim Editor, Catherine Urquhart.

-Gordon Peabody

Check out our website for other free publications:

www.safeharborenv.com/ocean-newsletter

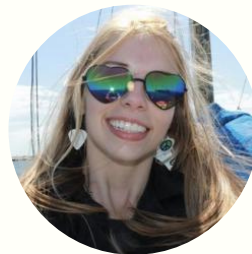
Thank you for your support!



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Research
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Samantha
Thywissen,
Associate Editor



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