UNITED STATES SUBMARINE VETERANS

CRASH DIVE BASE
Lake Bluff, IL

"To Honor Those Who Serve, Past, Present & Future"

July 2022 Volume 23, Issue 07

## Lest We Forget —
## "The USSVI Submariner's Creed"

**To perpetuate the memory of our shipmates who gave their lives in the pursuit of their duties while serving their country. That their dedication, deeds, and supreme sacrifice be a constant source of motivation toward greater accomplishments. Pledge loyalty and patriotism to the United States of America and its Constitution.**

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# News Brief

1. **Next Meeting**: At 1100, third Saturday of each month at the Knollwood Sportsman's Club. Mark your calendars for these upcoming dates:
   a. **July 16**
   b. **August 20**
   c. **September 17**
2. Duty Cook Roster:
   a. July – Frank Voznak, Jr.
   b. August – Chris Gaines
   c. September – Maurice Young
3. **July Birthdays**: Cris Pascual 24th; Herman Mueller 31st. Happy Birthday, Shipmates.
4. Remember **SubFest 2022** – July 4, Wisconsin Maritime Museum, Manitowoc, WI. See https://www.wisconsinmaritime.org/programs-and-events/subfest/. Be sure to visit Submariners Pub at 4220 Memorial Drive in Two Rivers.

## Crash Dive Meeting Minutes
## June 18, 2022

1) Call to Order
2) This meeting was a cookout at KSC. No business was conducted.

# Lost Boats

| | | |
|---|---|---|
| USS S-28 | (SS-133) | 07/04/44 |
| USS Robalo | (SS-274) | 07/26/44 |
| USS Grunion | (SS-216) | 07/30/42 |

# Navy approaches industry about installing hypersonic weapons aboard surface warships and attack submarines

May 12, 2022

Navy wants an ability to strike targets hundreds and even thousands of miles away with hypersonic munitions in a matter of minutes.

John Keller, https://www.militaryaerospace.com

**WASHINGTON –** U.S. Navy surface warship and submarine weapons experts are approaching industry for ways to install hypersonic weapons aboard the navy's Zumwalt-class land-attack destroyers and Virginia-class fast-attack submarines.

Officials of the Navy Strategic Systems Programs office in Washington issued a sources-sought notice on Tuesday (N00030-24-R-1025) for the Conventional Prompt Strike Weapon System Development And Integration project.

Additionally, Strategic Systems Programs will continue joint all-up round missile development for the U.S. Army's Long Range Hypersonic Weapon. This is a sources-sought notice requests capability statements from potential contractors and is not yet a request for proposals.

Navy experts are trying to compile a list of prime systems integrators that could provide technical program management, integration, coordination, and system engineering in integrating the Conventional Prompt Strike hypersonic missile onto Zumwalt-class destroyers and Virginia-class submarines.

The Conventional Prompt Strike program is developing a non-nuclear hypersonic weapon to enable precise and timely strike capability in contested environments with hypersonic weapons that can fly faster than five times the speed of sound and can maneuver at varying altitudes.

The goal is an ability to strike targets hundreds and even thousands of miles away in a matter of minutes. The missile will be fielded by the Navy and Army for service-specific weapons and launchers tailored for use from land and sea.

The Navy Conventional Prompt Strike program is developing a common hypersonic glide body and booster, and a sea-based weapon system and launcher.

From industry, the Navy wants to know which companies could provide Conventional Prompt Strike systems architectures, subsystems, components, and test requirements for a hypersonic missile larger than 30 inches in diameter.

Companies should be able to support Army-unique canister development and integration, which is to remain common with the Navy and realize economies of scale for missile production supporting training, test, and tactical deliveries.

Navy officials want the Conventional Prompt Strike missile to come in a three-pack configuration to support the Zumwalt-class surface warships and Virginia-class submarines.

Companies interested should email 10-page white papers no later than 25 May 2022 to the

Navy's Emily Thomas at emily.thomas@ssp.navy.mil, with Conventional Prompt Strike Weapon System Development and Integration- Army and Navy Requirements in the subject line.

White papers should include company name; CAGE code; unique entity ID; company address; point of contact (POC); POC title; POC email address; POC phone number; size status; capabilities; experience; place of performance; period of performance; and estimated project cost.

More information is online at https://sam.gov/opp/d4ded1d51d7740929fcec08a8af8dca2/view.

## The Navy doesn't want nukes on ships, despite interest from some combatant commanders

By Megan Eckstein, www.defensenews.com
May 13, 04:20 PM

An unarmed Trident II missile launches from Ohio-class ballistic missile submarine USS Maine (SSBN 741) off the coast of San Diego on Feb. 12, 2020. (MC2 Thomas Gooley/Navy)

WASHINGTON — The U.S. Navy remains opposed to buying ship-launched nuclear weapons, even though some in the Pentagon have pushed back.

Chief of Naval Operations Adm. Mike Gilday told House and Senate lawmakers this week forcing surface ships or attack submarines to haul around nuclear-tipped missiles would be feasible but a burden as they have more pressing missions.

The Trump administration planned a Sea-Launched Cruise Missile-Nuclear program to develop weapons that could be launched from surface combatants or attack submarines. Traditionally, the sea-based leg of the nuclear deterrence triad is sub-launched missiles on ballistic missile submarines (SSBNs), whose sole mission is to stay hidden in the depths of the ocean.

The Biden administration's fiscal 2023 budget request zeroed out the program ahead of the release of an updated Nuclear Posture Review but in coordination with the review's conclusions.

In some of the first hearings following the budget release, Republicans expressed their concern over the cancelation — and so did the heads of U.S. European Command and U.S. Strategic Command.

EUCOM Commander Gen. Tod Wolters said he wanted the SLCM-N because "having multiple options exacerbates the challenge for the potential enemies against us," while STRATCOM Commander Adm. Chas Richard wrote in a letter to the House Armed Services Committee "the current situation in Ukraine and China's nuclear trajectory convinces me a deterrence and assurance gap exists."

Specifically, Richard said in a later hearing with the Senate Armed Services Committee, SLCM-N would give the U.S. "a low-yield, non-ballistic capability that does not require visible generation," as a means of countering the kinds of low-yield nuclear weapons Russia has threatened to use in its ongoing war with Ukraine, for example.

During hearings this week on the Navy's budget request, Gilday told lawmakers SLCM-N "has been offered as a single-point solution" to manage the tactical nuclear capability of Russia and China.

"There are others to think about, including low-yield nuclear weapons that we deploy right now and had support of the Congress," he said, as well as non-nuclear deterrent weapons like hypersonic missiles.

Gilday said he wants continued research and development work to support a potential future SLCM-N capability, adding that a "modest" amount of funding would

ensure "we don't lose that capability in the workforce and in our labs that's actually proceeding at pace right now."

Based on that effort and more information about Russia's and China's nuclear weapons development and fielding, the Pentagon could then "make informed decisions about whether or not we want to invest a significant amount of money in that capability."

Today, though, he said it doesn't make sense to rush into procurement of the weapon, given an already too-small and heavily worked fleet.

The attack submarine fleet sits at 50, despite the Navy requiring 66 to 72 boats. These submarines could take on a variety of missions, from lurking close to enemy shores to tap into communications cables or project kinetic or non-kinetic effects ashore to searching the open ocean for enemy submarines. The destroyer fleet is busy working alone or as part of carrier strike groups to provide air defense, surface strike, sub-hunting and other missions across the globe — and they'll be more strained as cruisers leave the fleet in the coming years.

"Having served on a nuclear-capable surface ship in the late 1980s, that mission does not come without a cost. There is a significant amount of attention that has to be paid to any platform that carries that type of weapon in terms of training, in terms of sustainability, in terms of reliability, in terms of the force's readiness to be able to use and be able to conduct that mission," Gilday said.

As Russia increases its submarine activity, including sending submarines across the Atlantic towards U.S. shores, Gilday said the attack submarine fleet is "dealing with a higher threat" than in the late 1980s, when nuclear-tipped Tomahawk missiles were retired from service.

He pointed to hypersonic missiles as a preferable avenue for sea-based deterrence. The Navy is already working with the U.S. Army on a conventional prompt strike hypersonic missile the Army will field in fiscal 2023 and the Navy will field on its Zumwalt-class destroyers in FY25 and its attack submarines in FY28.

Gilday said the ship- and sub-based hypersonic missile efforts are still on track, and that the sea service also requested research and development dollars in its unfunded priorities list — a wish list if more funding were available — for an air-launched hypersonic missile.

## General Atomics to provide propulsor equipment for Columbia-class subs

**General Atomics Electromagnetic Systems (GA-EMS) announced on 10 May that it has been awarded a sole-source delivery task order from Naval Surface Warfare Center, Carderock Division (NSWCCD) to provide structural hardware for the propulsor of the U.S. Navy's new Columbia-class submarine.**

US Navy image

Naval News Staff 11 May 2022

*General Atomics press release*

The delivery task order is part of a broad Indefinite Delivery Indefinite Quantity (IDIQ) Propulsor Demonstration Hardware (PDH) contract to develop and deliver critical components and hardware for installation on current and future U.S. Navy nuclear-powered submarines.

"This is one of several task orders awarded to General Atomics Electromagnetic Systems under the PDH contract that applies our advanced engineering and manufacturing expertise to deliver essential hardware components supporting existing and future submarines and other undersea vehicles," stated Scott Forney, president of GA-EMS. "From engineering Virginia-class bearings to developing new propulsion techniques for the next submarine design, we facilitate the use of new

techniques, unique materials, precision machining, and extensive test procedures to deliver equipment that meets exacting specifications and the highest quality and reliability standards to support the warfighter."

"This task order involves the precision machining of components to extremely tight tolerances and demanding material specifications, and the delivery of approximately ten thousand pounds of hardware that will affix the Propulsor Bearing Support Structure, already provided by GA-EMS, to the submarine. The delivery will meet the shipyard's schedule for the installation of critical components onto the first Columbia-class submarine currently under construction, and it will provide the manufacturing template for these structures in follow-on ships of this class."

*Scott Forney, president of GA-EMS*

The hardware is scheduled for delivery in early 2023. Engineering is underway at GA-EMS' San Diego and Tupelo, MS facilities, with all manufacturing occurring in Tupelo.

# How Shipwrecks Shape the Seafloor

Sunken vessels can influence the structure, chemistry and biology of marine ecosystems, even decades after they occur

Madison Goldberg
May 12th, 2022

Shipwrecks can become sources of contamination, nutrients and shelter in equal measure. Here, a diver investigates a sunken submarine near Midway Atoll. National Oceanic and Atmospheric Administration

In late October of 1937, a tank barge called the Argo got caught in a storm on Lake Erie. It was on its way back from a Canadian port, packed full of crude oil and a fuel product called benzol, when the winds picked up. No lives were lost, but the vessel was. That week's issue of the Sault Ste. Marie Evening News declared that the Argo, with its 1,500 tons of oil and benzol, "lies at the bottom of the lake, in 40 feet of water."

78 years later, the National Oceanic and Atmospheric Administration got a call from the U.S. Coast Guard. A group of divers called the Cleveland Underwater Explorers had come across a wreck in Lake Erie that looked suspiciously like the sunken barge. And it was actively leaking.

"We've known about the Argo for a long time, but we didn't know exactly where it was," said Doug Helton, regional operations supervisor with NOAA's Emergency Response Division. As large vessels go, tank barges are pretty generic. "It's not as if you're going to dive down and see a big nameplate on the side of it saying 'Argo,'" he said. "It's going to be finding a box: a big steel rectangular structure that's in about the right spot."

NOAA had been on the lookout for several potentially-polluting wrecks, which it compiled in 2013 as part of a project called "Remediation of Underwater Legacy Environmental Threats," or RULET. Given its considerable cargo – much of it assumed to still be onboard – the Argo won the unfortunate award for the most severe environmental threat among shipwrecks in the Great Lakes.

Responders work on remediation of the tank barge Argo, which sank in Lake Erie in 1937. Kurt Kollar, Ohio EPA/U.S. Coast Guard

It certainly deserved the title. Sheens of oil had been known to collect around the wreck site, and things were even worse beneath the surface. As divers investigated the newly-located wreck – part of a cleanup process that involved NOAA, the U.S. Coast Guard and Canadian authorities, among others – they encountered a benzene leak so concentrated that it ate away at their dive suits and masks.

Benzene, which was seeping from the barrels aboard the *Argo*, is highly flammable and can cause cancer over long periods of exposure. "You could've had a pretty hazardous situation, had it been released catastrophically," said Helton, who helped coordinate the emergency response. In the end, using a pumping system designed to remove liquid without collapsing the ship, responders managed to extract almost 50,000 gallons of contaminated water from the wreck.

Ill-fated giants like the *Titanic*, which sank 110 years ago this spring, tend to loom large in shipwreck lore. But sunken or otherwise abandoned vessels can be found across the world's oceans, lakes and waterways. Among them are all kinds of craft, from World War II-era steam tankers to fishing trawlers to sailboats. Some, like the *Argo*, were buffeted by storms and came to rest far beneath the surface. Others ran aground in shallow water, or broke free of their moorings and drifted into estuaries. NOAA has logged roughly 20,000 sunken shipwrecks in U.S. waters alone.

A diver inspects the wreck of a sailing vessel in Lake Huron. The Great Lakes are thought to host thousands of shipwrecks. Doug Kesling, National Oceanic and Atmospheric Administration

Not all of these wrecks pose pollution threats like the Argo; on the contrary, some shipwrecks can serve as habitats for thriving marine communities. They're sometimes even dropped to the seafloor on purpose to aid in restoration projects. And according to NOAA, most of the shipwrecks in their database don't represent severe pollution risks.

What has become clear is that the life of a ship is not over when it sinks, runs aground or drifts away. Research has shown that shipwrecks can intensely affect the structure, chemistry and biological makeup of marine ecosystems, even decades after they occur. While every ship is different, and there's a lot left to learn, they serve as yet more proof of humanity's mind-boggling planetary fingerprint – even in the deep, dark places that most of us will never see up-close.

## Chemical wrecks

Regardless of the reason that a vessel strays off-course, the amount of damage it causes has a lot to do with where it ends up. Just the physical impact of a ship can scour coral reefs, crush mangrove roots or erode seagrass beds, especially if it scrapes back and forth with the waves.

Even in sensitive habitats, Helton said, "A fishing boat is usually a pretty small footprint. But as it starts to fall apart, you can have a debris field that extends hundreds of yards around the vessel."

Pieces of the ship, along with whatever it was carrying, can tumble and drift into the seabed. Take the MV Rena, which in 2011 ran aground on Ōtāiti, a reef off of New Zealand. The container ship – which, at 774 feet long, was a force to be reckoned with even when it was intact – eventually broke in two. Fuel oil, containers of cargo and other debris scattered. Researchers have reported that, three years after the grounding, the field of debris was somewhere near 10,000 square meters (more than 100,000 square feet) in area.

Storms often drive boats into sensitive habitats. Here, a shrimp vessel rests in a Louisiana marsh after Hurricane Katrina. Doug Helton, National Oceanic and Atmospheric Administration

There's also the issue of what's in that debris. Fuel spills are a major concern for vessels built after the early 1900s, Helton said, when the scales began to tip in favor of oil over coal to power maritime travel. But even ships that don't themselves run on oil, like the Argo, can carry it – and many other things besides.

"Any chemical you can think of is probably shipped by sea and is in a shipwreck somewhere," Helton said. A freighter that sank in 1944 off the coast of Maine, he said, went down with a cargo of glass jars, each filled with liquid mercury. Other ships sink with loads of electronics, carrying heavy metals like lead and cadmium to the seafloor. Still others contain live munitions.

Ships also need to carry whatever might be necessary to keep things running smoothly. "A ship, in a sense, is like a floating hardware store," Helton said. They're stocked with supplies like paints, cleaners, solvents, batteries and fire extinguishers; some vessels, like fish processors, carry ammonia and other refrigerants. None of these are things you want at the bottom of the ocean.

Of particular concern, Helton said, are fishing nets. A net that escapes a fishing trawler is still a net: it can drift through the ocean, entangling and killing wildlife in a phenomenon known as "ghost fishing." Derelict fishing gear has also been shown to damage corals, snagging on their branching arms as it drifts over the reef.

Divers cut through a mass of derelict fishing nets that has entangled a coral reef. Dwayne Meadows, National Oceanic and Atmospheric Administration

But even an entirely cargo-free ship – no fishing nets, no unexploded bombs, no jars of mercury – could bring some unpleasant things with it. Older ships, for instance, sometimes contain lead paint, asbestos or industrial chemicals known as PCBs, a component of plastics and rubbers that was banned in the United States in 1978. Today's vessels often have undersides coated with anti-fouling paint, which prevents animals like barnacles and mussels from attaching themselves to the boat. When this paint is stripped off, as in the case of a cruise ship that ran aground in Bermuda in 2007, it can send metals like copper and zinc into the water.

So, depending on what it's made of and what it's carrying, a sunken ship can be something of a chemical warehouse on the seafloor. Still, it seems, most wrecks are far from lifeless. In fact, they can harbor incredibly active communities as the intrepid denizens of the deep, from microorganisms on up, climb aboard.

## Microbes move in

In the northern Gulf of Mexico, more than 4,000 feet below the surface, lies a steam-powered luxury yacht.

"It's completely intact, and it's sitting upright on the seafloor," said Leila Hamdan, a marine microbial ecologist at the University of Southern Mississippi. It's the wreck of the Anona, a 138-foot vessel that sank in 1944.

To Hamdan, it seemed like a microbial paradise. "You've heard the phrase, 'If you build it, they will come,'" she said. "We have a different saying in microbial ecology:

‘Everything is everywhere, but the environment selects.’” Looking at the Anona, she wondered: which marine microbes did this defunct yacht – so different from the surrounding habitat – select for? In other words, who called it home?

She and her colleagues, armed with robots that can tolerate the crushing pressure of the deep sea, decided to find out. “We sampled the shipwreck environment, we sampled the mud environment, and we sampled everything in between,” she said. “And once we had those samples, we extracted all the microbial DNA out of them and plotted them as a function of distance away from the shipwreck.”

Hamdan and her colleagues operate a deep-sea robot as it extracts sediment samples from around a shipwreck. Leila Hamdan, University of Southern Mississippi

The pattern they saw was stunning. “It was undeniable that the closer you got to the shipwreck, the higher the microbial biodiversity got,” she said. The sunken yacht, long since relieved of maritime duty, was bustling with life.

As the researchers continued to pore over the samples of the microbiome – a potpourri of fungi, bacteria and minuscule organisms called archaea – they saw something else. The overall trend was consistent, with biodiversity increasing closer to the wreck, but there was also a spike in diversity a few hundred feet from the ship.

“What we were seeing in that peak is that we were leaving one habitat and entering another,” Hamdan said. The data seemed to reveal two separate worlds, the shipwreck and the muddy seafloor, along with an explosion of biodiversity where the two collided. “On either side of that divide, the communities were completely different,” she said. “We were able to say pretty clearly that these shipwrecks are changing the seafloor. They are creating new and unique habitats that were not there before the shipwrecks arrived.”

She and her colleagues saw similar patterns of biodiversity on other wrecks in the Gulf of Mexico. Which leads to a (colossal) question: why are shipwrecks such hotspots of microbial diversity?

“The details are as complex as the different microorganisms are,” and researchers are only beginning to untangle them, said Maria Pachiadaki, a microbial ecologist at Woods Hole Oceanographic Institution. But there are a few things, at least, that might make a shipwreck a microbial heaven.

A muddy core sample from a deep-sea wreck site. Leila Hamdan, University of Southern Mississippi

For one thing, Pachiadaki said, “They introduce substrates that didn’t exist before.” Hard surfaces, and especially ones with lots of nooks and crannies – and therefore surface area – are relatively few and far between in the ocean. That makes shipwrecks a hot commodity in the deep sea for the microbes that like to live their lives attached to something.

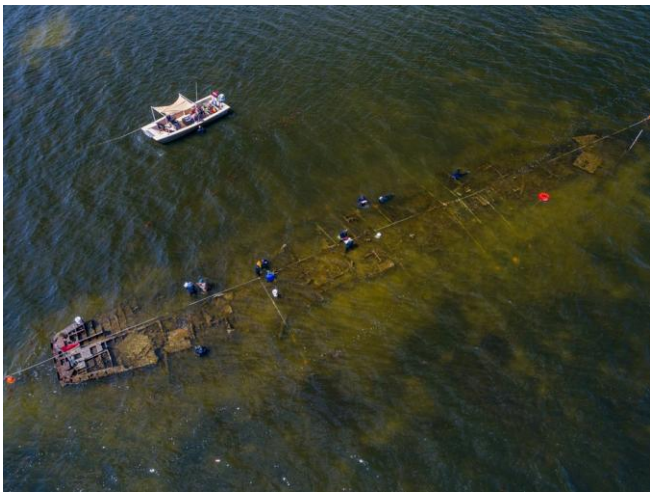
What’s more, even though a shipwreck can bring plenty of unappetizing things to the bottom of the ocean, for some marine microbes it’s like a feast. “There’s this wonderful, luxurious source of iron on the seafloor, which is ordinarily a trace nutrient,” Hamdan said.

This is part of what made Erin Field, who’s spent a lot of time studying bacteria that process iron for energy, excited about shipwrecks. “You can find these iron-oxidizing bacteria in all sorts of aquatic environments,” as long as they have access to the right form of iron, said Field, a geomicrobiologist at East Carolina University. “The surface of a steel shipwreck is perfect for that.”

Sure enough, when she and her colleagues took samples from a steel-hulled shipwreck in a North Carolina estuary, they found plenty of iron-oxidizers doing their thing. But they saw something else, too.

“The microbial communities are not the same everywhere on the wreck,” she said. “They seem to assemble in different places

depending on what is the best niche for them." There's still a lot to learn about why different microbes set up shop on different parts of a wreck, she said. But she thinks it likely has a lot to do with the ship's construction materials. Steel, packed with delicious iron, will attract the iron-oxidizers. And wood, as Hamdan's research has shown, draws the microbes that break down cellulose and other organic material.



Field and her colleagues investigated a wreck in the shallow waters of North Carolina's Pamlico Sound to determine whether different parts of the ship hosted unique microbial communities. John McCord, Coastal Studies Institute

As a microbial community cycles nutrients and reproduces on the surface of a shipwreck, it forms a biofilm: a layer of slime that acts as a protective coat. And for larger marine creatures, that slime is a signal. "The microbes are a foundation community," Field said. "They're able to make a nice environment for other organisms to come in."

## Dilapidated but dynamic

Dean Janiak has watched marine animals make themselves at home on all kinds of artificial structures. "You always start with a biofilm, and then other things will come and join the party," said Janiak, a biologist with the Smithsonian Marine Station at Fort Pierce, Florida.

Some of the earliest arrivals are larvae. Many marine species begin their lives floating in the water column but eventually need to anchor themselves in order to continue growing. In many cases, they're searching for chemical signals from biofilms to help them decide where to settle down – if someone else is making a living on this metal propeller, for instance, maybe they can, too.

Barnacles do this, Janiak said. Sensing the cues from a biofilm, a tiny flea-like larva will secure itself to the vessel. As it grows, Janiak said, "It's going to provide a little bit of refuge by slowing down the water around it. That will help other larvae escape the water current and attach themselves."

Janiak and his colleagues regularly conduct experiments using 13-by-13-centimeter "fouling panels" to monitor how organisms respond to artificial structures. This single fouling panel hosts around 30 different species. Dean Janiak, Smithsonian Institution

In many cases, this begins an ecological cascade as more and more species take advantage of the shelter and food that the new community provides. Researchers have found all kinds of species hunkering down among shipwrecks, from deep-sea crabs to stony corals to snapper. Animals like rays and tiger sharks have been known to stop by, too. There's a reason many shipwrecks are considered "artificial reefs."

Not all shipwrecks become thriving sanctuaries. Particularly in regions of the ocean where iron levels are so low that they limit organism growth, a giant serving of iron in the form of a sunken ship can be too much, too fast. Research has suggested that a shipwreck at Rose Atoll, American Samoa, caused such a spike in iron levels that the growth of certain types of algae skyrocketed. Out-competed for space and nutrients, coral in the area began to die, only to show signs of recovery when the shipwreck was removed.

To Janiak, these kinds of stories should be our cue to pay more attention to what happens after a ship sinks, whether as an accident or a restoration project. "We don't typically follow these communities long

enough," he said. Keeping an eye on them for multiple years – something that requires time and funding, Janiak acknowledged – would allow researchers to track how shipwreck communities grow and transform.

At Palmyra Atoll, part of the Northern Line Islands in the Pacific Ocean, high levels of iron from a shipwreck led to explosive growth of organisms called corallimorphs, which overwhelmed the reef's corals. United States Geological Survey

"It's a living, breathing community," Field agreed. "The organisms that are on the wreck could change." Hamdan's research, for instance, has suggested that oil spills like the Deepwater Horizon explosion in 2010 have the potential to erase the patterns of microbial biodiversity that she and her colleagues have observed at shipwrecks.

The sunken ships themselves can change, too. "We know that microbes have the ability to contribute to the deterioration of wrecks," Field said. Iron-oxidizers, for instance, are well-known culprits in the biocorrosion of metals. But there's more to the process; researchers have also suggested that biofilms can act as a slimy protective layer, shielding shipwrecks from chemical corrosion by seawater. Understanding this puzzle, she said, could improve methods for preserving culturally significant shipwrecks and other submerged artifacts.

As if there weren't enough moving parts already, climate change is also part of the story. "There are so many open questions here," Pachiadaki said. "How will increasing temperatures affect microbes' metabolism? Are microbes going to oxidize iron much faster, meaning that biocorrosion will go much faster?"

The stronger and more frequent storms induced by climate change could play a role, too. "If you have ships out there, they're going to get banged around, and they could sink," Janiak said. That, plus infrastructure like coastal walls constructed in the face of sea-level rise, will introduce more and more artificial structures into the marine world.

Shipwrecks, pipelines, oil and gas platforms, docks, sea walls and more can all leave a mark in marine ecosystems. Dean Janiak, Smithsonian Institution

That's all the more reason to keep studying how they interact with their environments.

"All you need to do is, wherever you are right now, look out your window," Hamdan said. Consider how humans have shaped the terrestrial world and the distribution of organisms within it.

"We're doing that with the seafloor as well, we just don't see it," she said. "We now know that human debris is changing the most fundamental units of life on the seabed, just by being there."

*(Think of the Clamagore and other sunken submarines. Read the original article at https://www.smithsonianmag.com/blogs/national-museum-of-natural-history/2022/05/12/how-shipwrecks-shape-the-seafloor/. Ed.)*