



Bilge Dumping: What It Is, Why You Should Care, and What Can Be Done

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Introduction: What is Bilge Dumping?

Out of sight, beyond the horizon, lies a world of activity taking place in the sea. The ocean encompasses over 70% of the globe,¹ yet most of us only see its edges from the coasts. We've built many of humanity's largest and most advanced societies along coastal regions, yet because the ocean is so remote, much of what happens at sea remains mysterious.

You might think of crime at sea as violence (piracy), abuse of natural resources (illegal fishing), or pollution (oil spills). However, at SkyTruth, we've recently focused on combating another very troubling action on the water: a serious crime known as bilge dumping. While not as well known as pollution such as the Great Pacific Garbage Patch,² bilge dumping is a phenomenon that should not be overlooked, and yet it often is.

Bilge dumping occurs when a vessel illegally releases untreated, oily wastewater into the ocean. This wastewater, known as bilge, collects in the ship's lower hull and needs to be emptied regularly. Since the 1970's an international law known as [MARPOL](#) has required that bilge water be treated to remove the oil before the bilge can be legally discharged into the sea.³ When a vessel circumvents treatment and dumps directly into the ocean, its wastewater creates an oily slick on the water. Radar satellite imagery captures these distinctive slicks — dark and opaque — because oil smoothes the surface of the water. This dense oily slick lingers in the water until it's broken apart by wind and wave action, dispersing toxins and globs of oil that can harm coastal communities and marine ecosystems. Vessel operators probably commit this crime as an act of convenience: to save money or time cleaning up after themselves, imposing on others the negative consequences of their pollution.

This report is based on a series of blog posts that first appeared on the SkyTruth website from February through May 2020 (you can access the series at: <https://skytruth.org/category/bilge-dumping/>). It explores bilge dumping in some depth, including why you should care, how this pollution continues to occur, and what can be done about it. It is our first attempt to understand a problem that has received limited attention from the global environmental and maritime communities to date. We drew on our own observations using radar satellite imagery, as well as documentation from news stories, government agencies, the scientific literature, and other sources, to provide meaningful context for understanding how widespread a problem bilge dumping is, its likely adverse impacts, and opportunities for addressing it. We compiled this information to raise

¹ [National Oceanic and Atmospheric Administration 2020](#)

² [The Ocean Cleanup n.d.](#)

³ [Kaushik, M. 2019](#)

awareness about an apparently chronic, overlooked source of oil pollution at sea, and to help guide our development of Cerulean, an automated program designed to scan the globe every day and detect illegal bilge dumping. Our ultimate goal is to stop oil pollution at sea.

What SkyTruth Has Discovered About Bilge Dumping

SkyTruth has observed likely bilge dumping incidents around the globe many times since 2007. But in 2019, we started seeking out these incidents more systematically. We focused our daily monitoring efforts on some of the world's major shipping lanes and on areas where we've found problems in the past, cataloguing every incident of bilge dumping we found through imagery. Our intent was to better understand the scope of this recurrent problem. We found that when we looked for oily slicks, we always discovered more! Unfortunately, we began to expect to see them; they were occurring somewhere within the areas we monitored almost every day. And our monitoring only covered a small part of the ocean.

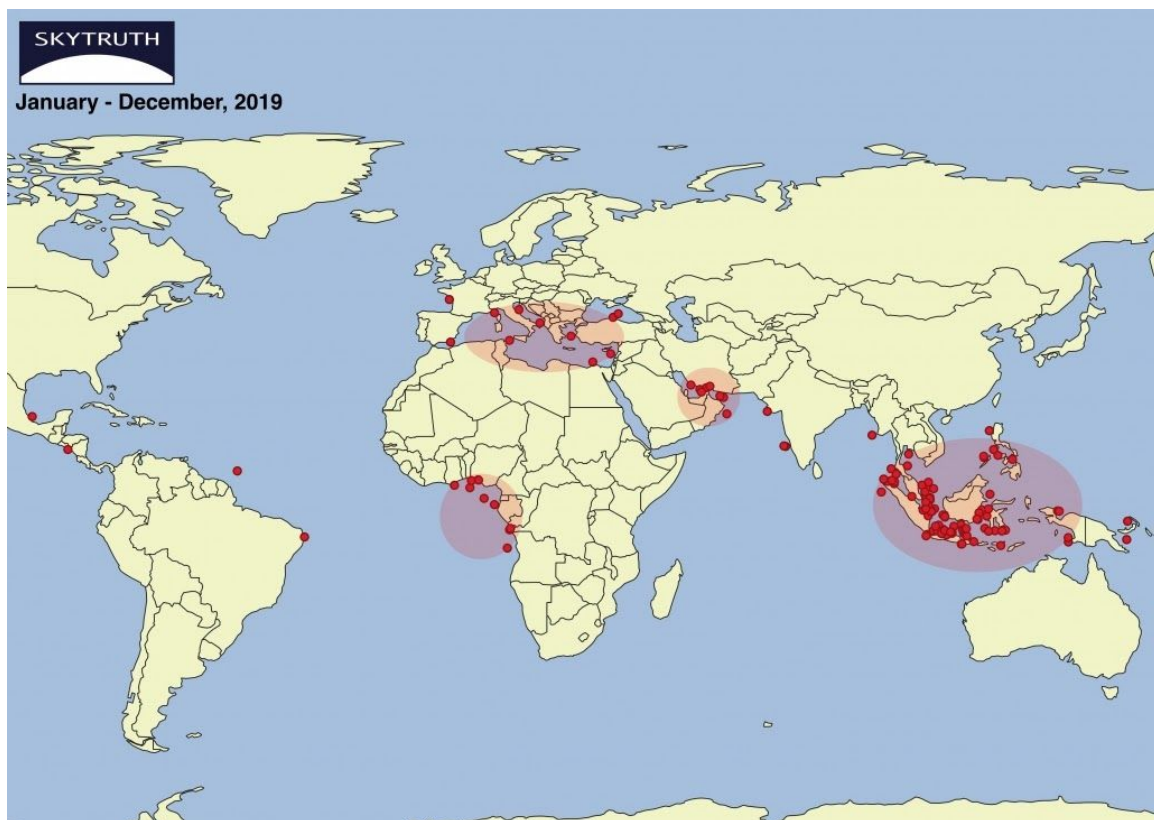


Figure 1: Likely bilge dumping events identified by SkyTruth in 2019.

In total, between January and December 2019, we identified 163 slicks averaging 56 kilometers (almost 35 miles) in length. We usually found bilge slicks using Sentinel-1 imagery: high-resolution C-band Synthetic Aperture Radar satellite data made available by

the European Space Agency. Although this imagery is sparse over the open ocean, it is collected regularly in coastal areas and provided coverage of several regions we considered likely to experience bilge dumping.⁴ The figure above documents each bilge dumping incident we discovered, identified as red dots (note that because our monitoring did not cover the entire ocean, the lack of red dots in many areas on this map doesn't necessarily mean those areas are free from bilge dumping).

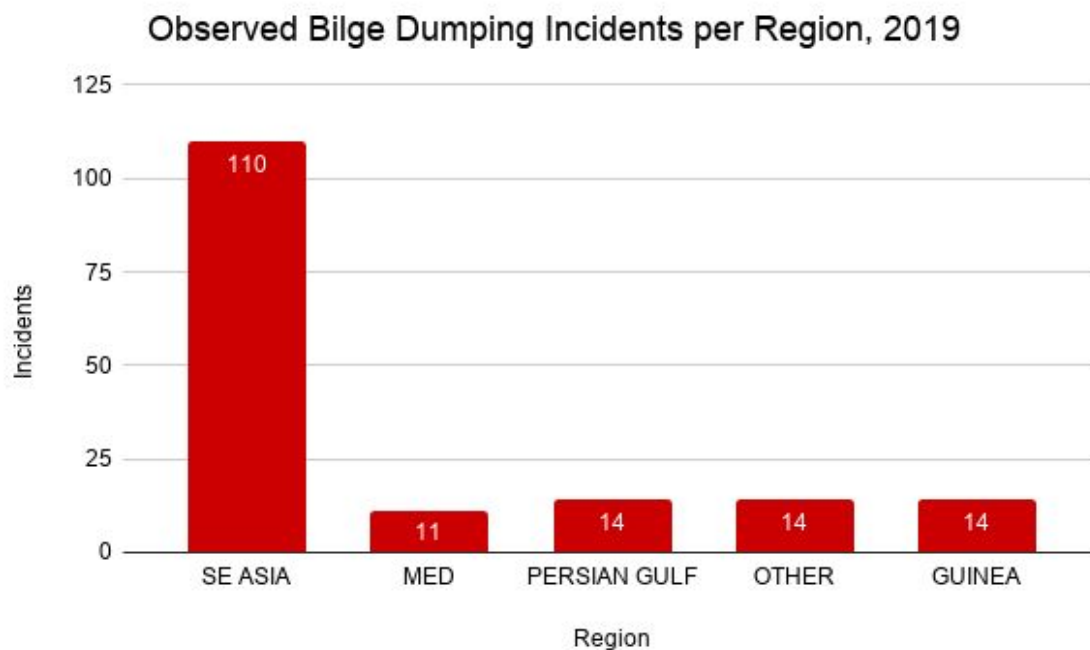


Figure 2: Likely bilge dump incidents identified by SkyTruth in 2019 by region.

Our work suggests that bilge dumping isn't sporadic: we repeatedly detected this illegal behavior in shipping lanes across the world, usually surrounding areas with significant energy development or active commercial ports, and often in areas with a chokepoint of marine traffic congestion.⁵ We commonly saw bilge dumping in Southeast Asia,⁶ the Persian Gulf, and the Gulf of Guinea. Less frequently, but notably, we discovered it off the coast of Brazil,⁷ in the Mediterranean Sea,⁸ and in the Gulf of Mexico. In some cases, we have been able to identify the polluters⁹ by correlating Automatic Identification System (AIS) radio broadcasts (used to prevent collisions) from ships, with the time and location of oily slicks.

⁴ [SkyTruth 2018](#)

⁵ [MI News Network 2019](#)

⁶ [SkyTruth 2019](#)

⁷ [SkyTruth 2019](#)

⁸ [SkyTruth 2019](#)

⁹ [SkyTruth 2019](#)

Why You Should Care About Bilge Dumping: Environmental and Socioeconomic Impacts

Because it happens out at sea, bilge dumping traditionally has been an enigmatic source of pollution and challenging to consistently monitor. Although SkyTruth is working to change that, so far the negative effects of bilge dumping are sparsely documented. To explore the potential impacts of frequent bilge dumping worldwide, we can start by considering the contaminants oily bilge waste contains. Oily bilge waste water is the byproduct of operating ocean-going vessels and, according to the Environmental Protection Agency,¹⁰ contains contaminants such as lubricants, grease, and cleaning fluids, as well as harmful or toxic metals such as arsenic, cadmium, chromium, lead, and selenium, some of which are known or probable carcinogens.¹¹ Other harmful substances in bilge can include organic chemicals such as benzene, chloroform, hexachlorocyclohexane isomers, and naphthalene.¹²



¹⁰ [United States Environmental Protection Agency 2011](#)

¹¹ [American Cancer Society n.d.](#)

¹² [United States Environmental Protection Agency 2011](#)

Photo: Exxon Valdez oil spill [photo courtesy ARLIS, Alaska Resources Library & information Services]

The size of tankers and container vessels that dump their waste can help us understand the amount of pollution they are emitting. Commercial marine vessels are some of the largest machines in the world, with some measuring 131 meters (143 yards) in length; comparable to the size of a small skyscraper. The engines in these vessels can be as large as three buses and have up to 333 times more horsepower than the engine of a midsize car.¹³ Their large size makes cargo vessels very efficient for transporting goods; but if the waste from these massive engines routinely ends up in the oceans, their environmental impact can be substantial. Even two decades ago, researchers reported that ocean-going vessels generated millions of tons of waste annually.¹⁴ A 2003 report by the nonprofit conservation group Oceana estimated that in European waters alone “illegal dumping and routine operations of vessels account for between 666,000 and over 2.5 million tons of hydrocarbons of marine pollution per year.”¹⁵ That amount is up to 70 times greater than the *Exxon Valdez* oil spill and is likely even greater today.¹⁶ Over a 20 year span from 1992 to 2012, the amount of ocean-going traffic has grown by 300%, increasing the likelihood of even more vessel pollution.¹⁷

A collaborative research project published by The National Academies Press (2003) found that between 1990 and 1999 vessels (in contrast to pipelines or facilities) in U.S. waters produced the largest oil spills.¹⁸ Additionally, this study reported that 12% of the total petroleum hydrocarbons found worldwide in the oceans were from “accidental spills and operational discharges of cargo oil occurring during transportation of petroleum products.” This accounted for 160,000 tonnes of oil annually; the equivalent of four *Exxon Valdez* oil spills every year.

The negative effects of bilge dumping can be seen in the United Arab Emirates.¹⁹ In 2017, one of the emirates, Fujairah, experienced three oil spills in just two months. Locals reported that this contributed to a significant decrease in local hotel bookings and left dead fish and black oil on the shores. Last year, nine Brazilian states and 132 beaches experienced multiple mysterious incidents of oil washing up onshore.²⁰ The cause of these incidents still has not been determined, but one possibility is a series of bilge dumping

¹³ [The Maritime Executive 2018](#)

¹⁴ [United States Environmental Protection Agency 2011](#)

¹⁵ [Oceana 2003](#)

¹⁶ [Exxon Valdez Oil Spill Trustee Council n.d.](#)

¹⁷ [Tournadre, J. 2014](#)

¹⁸ [Transportation Research Board and National Research Council 2003](#)

¹⁹ [Haza, R. 2017](#)

²⁰ [SkyTruth 2019](#)

incidents. The impact occurred in multiple biodiverse tourism areas, specifically in Brazil's oldest national park.²¹

SkyTruth also continues to find oil offshore Nigeria,²² in the Gulf of Guinea. And while this oil is mostly a consequence of energy infrastructure, we suspect it stems from bilge dumping as well. Nigeria's Niger Delta,²³ which drains into the Gulf of Guinea, experiences periodic water contamination from heavy metals due to extensive energy development, so much so that the delta has been called the "oil rivers." Over a 38 year timespan, 12,000 oil spills were reported in the delta.²⁴ Communities often use this untreated water for cooking or drinking, as well as for local agriculture and fish farming.²⁵

Recently, an environmental activist and resort director contacted SkyTruth after repeatedly discovering remnants of oil and tar washing up on beaches near Singapore and the Strait of Malacca, one of the world's busiest shipping lanes. This local activist continues to report regular incidents that he believes may be the result of bilge dumping.



Photo: Heavy oil has been sullyng the beaches of northeastern Brazil since early September. The cause remains elusive. [Photo courtesy tvBrasil via Creative Commons license]

²¹ [Escobar, H. 2019](#)

²² [SkyTruth 2012](#)

²³ [Adebayo, B. 2019](#)

²⁴ [Chinedu, E., & Kelechukwu Chukwuemeka, C. 2018](#)

²⁵ [ibid.](#)

When oil washes up onshore, our Southeast Asian source states that it sometimes can be small and relatively easy to clean up, but at times, when it's a bad spill, "it can be barrels full of it, or it can be thick tar balls, sometimes five to six inches across — so large that they look like they came out of a pipe," he told us. The oil releases a "distinct petroleum smell" and "if it gets in amongst the rocks it can take months to clean out," he told us. "If it washes up on a beach at high tide, it melts in the sun and is terribly messy to clean up." Most incidents happen during the northeast monsoon season when the region gets stronger winds; however, outside of this season oil still lingers. "I can almost always walk down a beach and find some," he told us.

Studies from oil spills suggest that oil at sea disperses over a period of days to weeks,²⁶ and some of this oil can wash up on coastlines, potentially harming ecosystems and soiling beaches.²⁷ Vessel bilge dumping incidents typically receive less attention than large oil spills: They are much smaller-scale events, but occur more frequently and potentially can have a significant cumulative effect. The substantial scientific literature analyzing the effects of large-scale historical oil spills — most notably BP's Deepwater Horizon and the *Exxon Valdez* — could help shed light on the potential impacts of bilge dumping.

The impact of oil on a community's natural environment can be very prominent,²⁸ and it varies. When a slick disintegrates, its components can weather into dense tar balls which pile up on shores, as well form a messy sludge coined chocolate mousse.²⁹ Well-protected clean-up teams are needed to carefully remove oil from coastal areas.

One unsettling outcome from oil in the water is its effects on marine life — from acute to progressive diseases. After the Deepwater Horizon oil spill, dolphin deaths from lung and adrenal lesions increased,³⁰ and reproduction decreased, which scientists believe could be linked to exposure to oil. In addition, a multi-state natural resource damage assessment estimates that as many as 102,000 birds were killed or harmed during the Deepwater Horizon spill.³¹ Mangroves and coral reefs in Brazil,³² Panama³³ and Singapore³⁴ have been harmed by oil in the water. Human health can also be affected. One survey from an oil spill in Pakistan in 2003 found that those who lived near the coastline experienced eye, skin, and respiratory health symptoms, from "fumes and a mist of oil in the air."³⁵ Far worse, years

²⁶ [Alves, T. M., Kokinou, E., Zodiatis, G., Radhakrishnan, H., Panagiotakis, C., & Lardner, R. \(2016\).](#)

²⁷ [National Oceanic and Atmospheric Administration n.d.](#)

²⁸ [Dajani, H. 2018](#)

²⁹ [United States Environmental Protection Agency 2016](#)

³⁰ [Jacobson, L. 2017](#)

³¹ [Regalad, N. 2016](#)

³² [Phillips, D. 2019](#)

³³ [Cubit, J. D., Getter, C. D., Jackson, J. B., Garrity, S. D., Caffey, H. M., Thompson, R. C., . . . Marshall, M. J. \(1987\)](#)

³⁴ [Ministry of Foreign Affairs of Japan 1997](#)

³⁵ [Janjua, N. Z., Kasi, P. M., Nawaz, H., Farooqui, S. Z., Khuwaja, U. B., Hassan, N. U., . . . Sathiakumar, N. \(2006\)](#)

after an oil spill offshore Spain, some cleanup workers of the spill showed signs of genetic mutations in their blood,³⁶ potential catalysts for more serious disease.

Lastly, oil spills have triggered social and psychological distress. After the Deepwater Horizon disaster, some impacted individuals were found to have high oil related stress and Post Traumatic Stress Disorder related symptoms.³⁷ This discomfort led to lengthy lawsuits and ongoing political protests by citizens who felt that the energy company responsible,³⁸ BP, was not taking full responsibility.³⁹

Bilge dumping is unlikely to trigger such large-scale reactions. However, based on what SkyTruth has documented over the past year, we believe that bilge dumping could be the stealthy, less recognized cousin to large oil spills, that cumulatively leads to large amounts of oil in ocean waters and coastlines. Perpetrators often evade prosecution and accountability,⁴⁰ leaving communities to bear the impacts and costs.

Although scientific research on bilge dumping per se is limited, harmful impacts of oil pollution on marine life, human health, and coastal communities are well documented. Given the dozens of likely bilge dumping incidents SkyTruth has revealed over the past year, and the concerns expressed to us by coastal residents, we believe bilge dumping could be a sleeper source of oil pollution in the sea. It's time to do something about it.

Why Bilge Dumping Still Happens: Penalties and Incentives

Today, 90% of international trade relies on global shipping.⁴¹ From commercial to passenger vessels, the world's global fleet exceeds 95,400 ships plus around 2.8 million fishing vessels.⁴² International regulations exist to ensure shipping practices are environmentally sound. The International Maritime Organization (IMO) is considered the global regulator of shipping; its regulations apply to 99% of the world's merchant tonnage.⁴³ Its convention — the International Convention for the Prevention of Pollution from Ships

³⁶ [Watson, I. 2010](#)

³⁷ [Osofsky, J. D., Osofsky, H. J., Weems, C. F., Hansel, T. C., & King, L. S. \(2016\)](#)

[:Mong, M. D., Noguchi, K., & Ladner, B. 2012](#)

³⁸ [Susman, T., & Cruz, N. S. 2010](#)

³⁹ [Langford, C. 2019](#)

⁴⁰ [Oceana 2003](#)

⁴¹ [International Chamber of Shipping n.d.](#)

⁴² [United Nations Conference on Trade and Development 2019; Taconet, M., Kroodsma, D., & Fernandes, J. A. 2019](#)

⁴³ [International Maritime Organization n.d.](#)

(known more commonly as MARPOL) — has six annexes regulating several types of vessel pollution; everything from dangerous cargo, garbage, and noxious emissions, with one specific annex dedicated entirely to the treatment of oily waste mixtures,⁴⁴ including oily bilge, and standards for operational or accidental discharges.⁴⁵ Currently, vessels are allowed to return dirty water to the ocean, but can only discharge oil concentrations of no more than 15 parts per million (ppm),⁴⁶ a limit that requires the use of machines called oil-water separators to reach. This is a strict requirement in the annex. Large vessels over 10,000 gross tonnage are required to install alarms and automatic stopping devices if the wastewater exceeds 15 ppm.⁴⁷ When vessels discharge untreated or insufficiently treated bilge, they circumvent this crucial step in the disposal process.

With options to properly treat oily wastewater, and costly deterrents for breaking the law, it can seem confounding that vessels continue to deliberately pollute the ocean. Penalties for breaking the law include criminal felonies such as obstruction of justice, fines up to \$40 million,⁴⁸ probation of the shipping company and its operating vessels,⁴⁹ as well as prison sentences for those directly responsible.⁵⁰ Fines can support environmental compliance programs as well as community service and remediation funds.⁵¹ Under the U.S. Act to Prevent Pollution from Ships (APPS), up to 50% of the value of these fines provide compensation for whistleblowers involved in the prosecution.⁵² When whistleblowers report wrongdoings they are risking their employment and face potential retaliation and abuse.⁵³ Appropriate compensation is an important incentive for whistleblowers to continue to take these risks, especially since whistleblowers are responsible for a large number of successful convictions.⁵⁴ However, compensation can be uncertain since it depends on how useful a court deems the information whistleblowers provide. It is questionable whether incentives to whistleblowers are strong enough, especially considering many cases aren't heard or fail to result in prosecution. In 2016, 23 corporations were convicted of bilge dumping in the United States.⁵⁵ However, Marine Defenders, an educational program to reduce oil pollution in U.S. coastal waters, predicts that 5,000-7,500 vessels discharge untreated bilge around the world annually.⁵⁶

⁴⁴ [MARPOL Training Institute n.d.](#)

⁴⁵ [International Maritime Organization n.d.](#)

⁴⁶ [International Maritime Organization n.d.](#)

⁴⁷ [Marine Environment Protection Committee 2003](#)

⁴⁸ [Associated Press 2016](#)

⁴⁹ [Almeida, R. 2013](#)

⁵⁰ [U.S. Department of Justice 2015](#)

⁵¹ [Parry, W. 2019](#)

⁵² [National Whistleblower Center n.d.](#)

⁵³ [The Outlaw Ocean n.d.](#)

⁵⁴ [National Whistleblower Center n.d.](#)

⁵⁵ [Ready, T. 2019](#)

⁵⁶ [Marine Defenders n.d.](#)

Vessel operators are required to maintain an oil logbook that contains all cleaning and disposal events — whether intentional or accidental, legal or illegal. When accusations of bilge dumping appear in court, they often uncover false logbooks or inaccurate records of discharged pollutants at sea.⁵⁷ This can reveal that the vessel is using bypass equipment or tampering with the oil-water separator to avoid appropriate treatment. Logbooks can be verified through vessel inspections, or sometimes with the help of whistleblowers. It is often these false logbooks that lead to large fines. Under the APPS, vessel owners face the largest fines.⁵⁸ Additional fines and sentences can be given to individuals directly responsible for the crime — usually the vessel operators or engineers.⁵⁹



Photo: The Marshall Island-flagged Ridgebury Alexandra Z. The Cyprus shipping company was penalized with a \$2 million fine for bilge dumping.⁶⁰ Photo courtesy of Vessel Finder.

But some vessels might not see the value in complying with MARPOL requirements if the savings of simply dumping oily wastewater into the ocean outweigh the potential risks. It is costly for vessels to treat their wastewater and requires they either invest upfront in an on-board treatment system or pay for treatment at a port facility. Both of these options can cost tens of thousands of dollars a year depending on the amount of travel and fuel used.⁶¹

⁵⁷ [U.S. Department of Justice 2017](#)

⁵⁸ [Marine Defenders n.d.](#)

⁵⁹ [Schuler, M. 2019](#)

⁶⁰ [gCaptain 2019](#)

⁶¹ [Organisation for Economic Co-operation and Development 2003](#)

Operators,⁶² officers,⁶³ and engineers⁶⁴ have all been found to bypass expensive treatment or avoid operating costs, allowing vessels to gain a competitive advantage. Officers can receive bonuses if environmental compliance budgets are maintained.⁶⁵ Some players in the shipping industry have been reported to treat crew members poorly,⁶⁶ and crew members can be threatened with job loss or lost wages if they fail to follow orders.⁶⁷

In some cases, vessels without oil-water separator equipment that need to empty their hull of oily waste might choose to avoid the extra travel needed to reach a port facility with the appropriate equipment, and instead dump the wastewater into the sea on route. However, there is no shortage of port reception facilities. IMO reports 3,253 facilities to treat oily bilge water in over 80 member states in its Global Integrated Shipping Information System,⁶⁸ and the majority of these port facilities are conveniently located along common shipping routes. Some of these vessel operators might assume they have a low probability of being caught, and perhaps are unaware of how closely they can be monitored by Global Positioning System (GPS), satellites and nearby aircraft or other vessels. Operators who fear being caught sometimes illegally alter or turn off their AIS and “go dark” at sea. AIS is a radio frequency broadcast equipped with GPS that is mandatory on almost all large oceangoing vessels, to help promote safety at sea. Ships can communicate through AIS and avoid collisions in high traffic situations.

Another incentive for illegal bilge discharge: An overwhelming number of illegal ocean dumpers go unpenalized for their crimes in many different countries. Vessels can control the level of enforcement they face by registering to sail under a flag that is different from the country in which the vessel is owned.⁶⁹ Often this means a vessel from a developed state is using the flag of a developing state; Panama, Liberia and Marshall Islands currently flag the world’s largest fleets.⁷⁰ More than 70 percent of the world’s merchant vessels are registered under a different flag state.⁷¹ By choosing a flag of convenience, vessel operators, without a genuine link to their country of ownership, can find advantageous loopholes depending on a flag state’s national laws.⁷² They can shop for lower registration fees and taxes and can choose a registry that allows them to remain anonymous.⁷³ They can also recruit a foreign

⁶² [Gutierrez, A. 2013](#)

⁶³ [Margetta, R. 2011](#)

⁶⁴ [Blenkey, N. 2016](#)

⁶⁵ [United States Coast Guard 2008](#)

⁶⁶ [Urbina, I. 2015](#)

⁶⁷ [The Outlaw Ocean n.d.](#)

⁶⁸ [International Maritime Organization 2018](#)

⁶⁹ [NGO Shipbreaking Platform n.d.](#)

⁷⁰ [HG.org. n.d.](#)

⁷¹ [United Nations Conference on Trade and Development 2019](#)

⁷² [Zwinge, T. 2011](#)

⁷³ [Alderton, T., & Winchester, N. 2011](#)

workforce at lower labor costs.⁷⁴ Essentially, some developing states prioritize economic development over environmental enforcement.⁷⁵

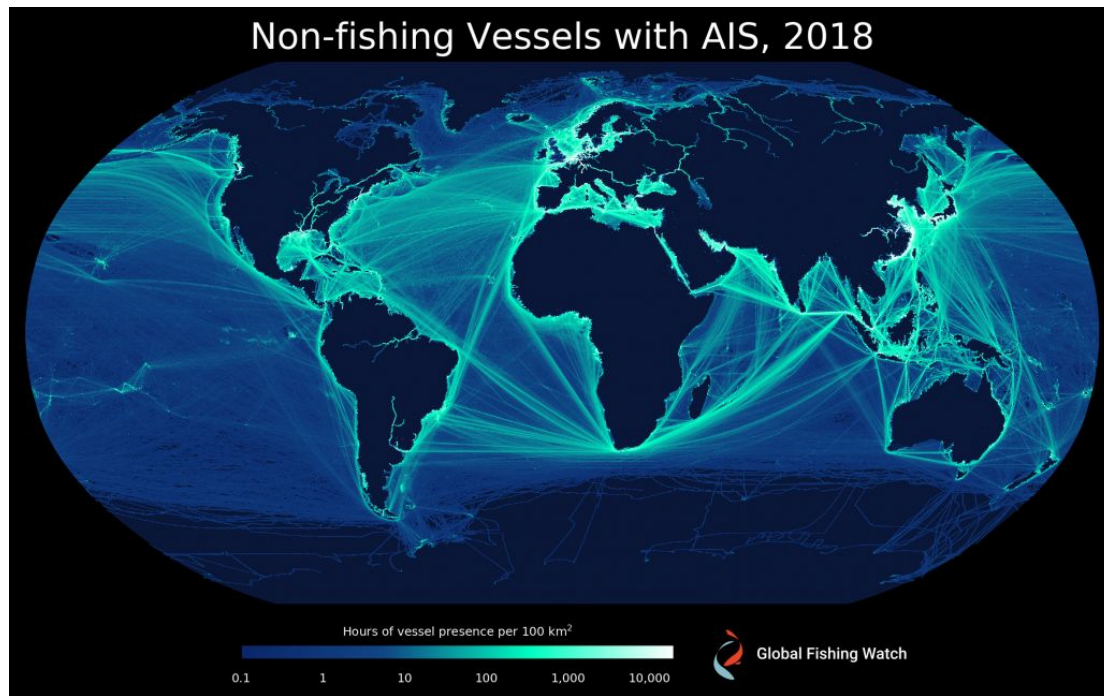


Figure 3: Major shipping lanes revealed by a year's worth of AIS broadcasts from non-fishing vessels. Map courtesy of Global Fishing Watch.

The United Nations Convention on the Law of the Sea (UNCLOS) is the legal framework states use to adopt international laws for the world's oceans. It differentiates rights in territorial seas near each state's coastlines, and non-territorial or high seas.⁷⁶ Since individual states have jurisdiction to adopt ("in conformity with generally accepted international regulations") and enforce their own national laws,⁷⁷ prosecution for environmental harm such as bilge dumping varies in leniency. UNCLOS specifies that flag states have exclusive jurisdiction over their ships on the high seas. Exclusive jurisdiction means vessels abide by flag state laws and are subject to flag state prosecution. Additionally, flag states issue vessels their compliance certifications by approving the vessel's equipment and crew.⁷⁸ These certifications can be used by vessels when passing through other states' territorial waters, making it difficult for port or coastal states to pursue noncompliance of other flag state vessels within their territorial waters. It is only in territorial

⁷⁴ [BBC News Services 2014](#)

⁷⁵ [Abdulla, A. A. 2011](#)

⁷⁶ [United Nations Conference 1982](#)

⁷⁷ [Ibid.](#)

⁷⁸ [Abdulla, A. A. 2011](#)

waters and under good reason that a foreign state can make a hot pursuit on vessels neglecting the law.⁷⁹

It can seem confounding why enforcement is so infrequent globally given that, under UNCLOS, each flag state should have at least minimal legislation. SkyTruth spoke with John Kostyack, executive director of the National Whistleblower Center to answer this question.⁸⁰ Kostyack told us “The concept behind treaties like MARPOL is that domestic legislation then implements them. But most countries have either not passed legislation, or they have legislation that is not enforced consistently.” Kostyack notes that fines are imposed in some countries, including the U.S., but the level of penalties are nowhere near sufficient, stating “dumping oily waste illegally is seen by these companies as a risk worth taking because they don’t see a significant threat of prosecution. Even when penalties are imposed they are not steep enough to change behavior. This is a recipe for continued pollution.” Ultimately, Kostyack feels the primary reason vessels are bilge dumping is because it is cheaper to occasionally pay modest penalties than to pay to treat their own waste.

What SkyTruth and Others Are Doing to Stop Bilge Dumping: Cerulean and Green Shipping Initiatives

Using radar satellite imagery, SkyTruth can observe and measure oil pollution in the ocean. Making a conservative assumption about an oil slick’s thickness, we can estimate the volume of oil,⁸¹ an indicator of the severity of an incident. The legal limit for discharging oily wastewater under international law outlined by MARPOL is 15 parts per million (ppm) for most cargo vessels and tankers.⁸² Trained observers on aircraft can see oil at concentrations of 50 ppm and above.⁸³⁸⁴ It’s possible that under favorable sea-state conditions, radar satellite imagery is capable of revealing oil at lower concentrations, so we’ll be able to spot more potential violations. In a resolution to MARPOL specifying visibility limits of oil discharges, the Marine Environment Protection Committee “urgently requests authorities to consider the principle that a visible trace of oil is one element of proof that the 15 ppm discharge standard of Annex I of the MARPOL Convention may have

⁷⁹ [United Nations Conference 1982](#)

⁸⁰ [National Whistleblower Center n.d.](#)

⁸¹ [SkyTruth Oil Spill Reports n.d.](#)

⁸² [International Maritime Organization n.d.](#)

⁸³ [Vidas, D. 2010](#)

⁸⁴ [Bonn Agreement Aerial Operations Handbook 2016](#)

been violated.”⁸⁵ Similarly, under the U.S. Clean Water Act,⁸⁶ oil discharges that cause a visible sheen are encouraged to be reported and are classified as potentially harmful to public health or welfare.

Using advanced remote sensing techniques, SkyTruth often can determine a likely source of pollution, whether from a vessel, a natural oil seep, or energy infrastructure like pipelines, drill rigs and production platforms.⁸⁷ This kind of information can help oil-spill response efforts: If responders know the location and source of oil pollution, they are better able to take action and reduce the impacts of the pollution. In addition, if the pollution is from a vessel, near-real-time monitoring can help authorities catch a perpetrator who might still be nearby, or take administrative action when that vessel comes into port. Prosecuting criminal offenses for environmental crime requires robust evidence connecting a culprit to the crime. Satellite imagery can help: It collects evidence remotely, potentially providing an efficient way to prosecute ocean offenders.

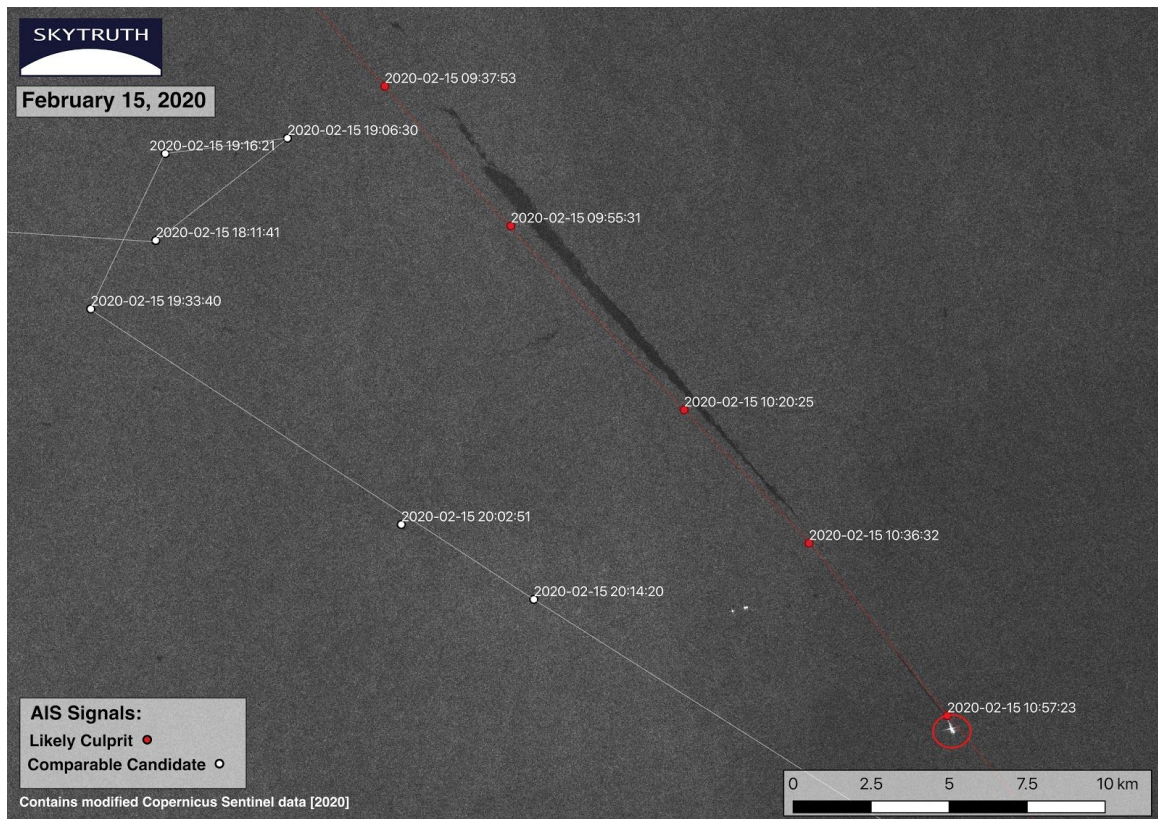


Figure 4. Sentinel-1 radar satellite image of suspected bilge slick (black streak) in the Java Sea on February 15, 2020. AIS signals are shown for two potential sources. The likely source vessel is circled in

⁸⁵ [Marine Environment Protection Committee 1993](#)

⁸⁶ [United States Environmental Protection Agency n.d.](#)

⁸⁷ [SkyTruth 2019](#)

red, with its AIS track (red) closely matching the slick in space and time. The other nearby vessel's broadcasts (white) did not match the time and location of the slick.

To demonstrate this potential, in late 2019 SkyTruth began developing project Cerulean to automate the detection of oil slicks on the world's oceans and identify likely sources. Cerulean applies a machine learning technique⁸⁸ called Deep Learning (a type of Artificial Intelligence) to make it possible to analyze thousands of satellite images every day to detect slicks and sources. We compare these slicks with public Automatic Identification System (AIS) vessel tracking data in order to identify the likely sources of this pollution (you can read more about our process [here](#)).⁸⁹

Satellite data such as that provided by Cerulean could potentially help prosecutors convict oil polluters if it is approved for use in court. Remote sensing evidence is a relatively new tool in court cases. It must be authenticated and checked for integrity regarding the collection and storage of the data to ensure its validity. In the United States, cases using satellite evidence have not been widely published since many decisions about whether evidence is admissible can be made orally or pretrial.⁹⁰ Because of this, we do not have a good estimate of how frequently satellite imagery is accepted as evidence. However, we do know that if the remote sensing technology is not new or novel it is more easily admissible.⁹¹ When trying to prove a fact, an expert witness with specialized knowledge can explain the reliability of the technology used and the data presented.⁹² In describing the detection of an oily slick, for example, an expert might need to explain a variety of factors that are considered in the analysis of ocean imagery, including weather conditions such as rain and wind speed, atmospheric and oceanographic features, and differentiating a vessel from ocean infrastructure in order to demonstrate the admissibility of image-based evidence.

Satellite imagery has been used as evidence of other environmental crimes such as deforestation and illegal fishing.^{93,94} However, it is uncommon for imagery alone to provide conclusive evidence,⁹⁵ or to prove guilt beyond a reasonable doubt in prosecution for environmental crime.⁹⁶ Satellite imagery has provided corroborating evidence that has led to prosecutions of pollution at sea.⁹⁷ However, we have found no cases where it provided conclusive (dispositive) evidence, meaning it alone is usually not enough to link a crime to a perpetrator, or even prove that a crime occurred at all. Currently, eyewitness reporting is more often used as evidence for prosecution of bilge dumping. Whistleblowers and vessel

⁸⁸ [SkyTruth 2019](#)

⁸⁹ [SkyTruth 2019](#)

⁹⁰ [Purdy, R., & Leung, D. 2012](#)

⁹¹ [District Court of Appeal of Florida 2005](#)

⁹² [Legal Information Institute n.d.](#)

⁹³ [Hance, J. 2011](#)

⁹⁴ [Google n.d.](#)

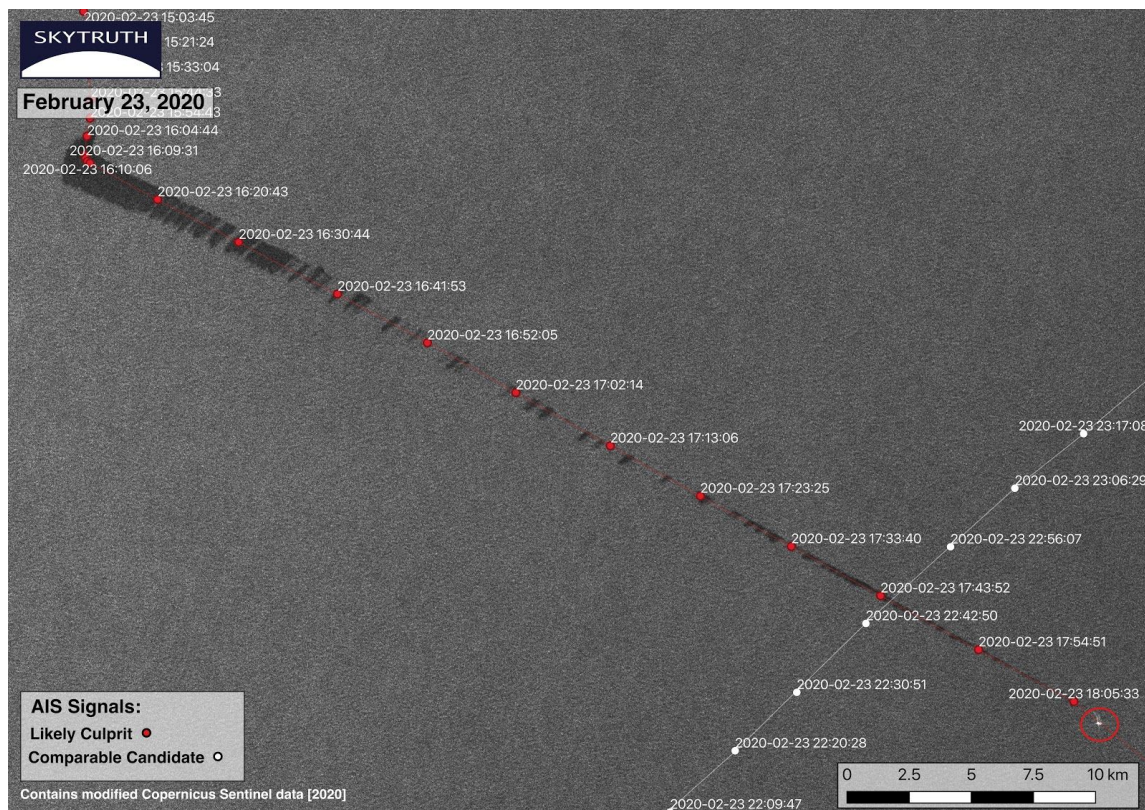
⁹⁵ [Wang, B. Y., Raymond, N., Gould, G., & Baker, I. 2013](#)

⁹⁶ [Kroker, P. 2015](#)

⁹⁷ [European Maritime Safety Agency 2012](#)

inspectors have been a common catalyst for prosecution. For example, between 1993 and 2017, 76% of prosecuted cases under the U.S. Act to Prevent Pollution from Ships came from whistleblowers.⁹⁸ Overall, there are no restrictions on satellite imagery's power to serve as evidence in court as long as the technology has been proven valid and trustworthy.

Europe currently has an ocean monitoring service called the CleanSeaNet that has led to several prosecutions using satellite imagery in combination with on-ground evidence, in which fines were imposed.⁹⁹ The European Union Directive 2009/123/EC specifies types of prosecution for ship-source pollution.¹⁰⁰ However many courts still rarely prosecute. Often they require official inspection on site where the pollution occurred and on the vessel in order to connect the evidence to the crime,¹⁰¹ which can be challenging when collecting on-ground evidence is time sensitive. (Oil can disperse within 12 hours, and ships can easily be long gone by then.) Additionally, the European Maritime Safety Agency states “(r)esolution of cases can take many years, and in some countries privacy issues prevent the full details being disclosed publicly.”¹⁰²



⁹⁸ [National Whistleblower Center n.d.](#)

⁹⁹ [European Maritime Safety Agency n.d.](#)

¹⁰⁰ [Official Journal of the European Union 2009](#)

¹⁰¹ [European Maritime Safety Agency 2018](#)

¹⁰² [Ibid.](#)

Figure 5. Suspected bilge slick in the Gulf of Guinea on February 23, 2020. The red AIS signals closely follow the linear slick to the likely source vessel (circled in red). Another nearby vessel's broadcasts (white AIS signals) were also analyzed; however, this vessel was moving nearly perpendicular to the slick and is not a likely source.

But law enforcement agencies and citizen-activists aren't the only stakeholders concerned about clean oceans. Companies have market-based incentives to be recognized as sustainable and socially responsible businesses, and they are accountable to their stakeholders to uphold promises of corporate social responsibility.¹⁰³ While the shipping industry produces ocean oil pollution, it is also the most energy efficient method for transporting goods.¹⁰⁴ Such a large and fast-growing industry requires effective environmental regulation and enforcement.¹⁰⁵

The International Maritime Organization's (IMO) theme for 2020 provides a unique opportunity for the shipping industry to clean up its act. The theme is "Sustainable shipping for a sustainable planet."¹⁰⁶ For example, part of this includes the IMO's 2020 sulphur cap on ships' fuel oil.¹⁰⁷ In transitioning to lower sulphur fuel, some shipping companies must adjust their current operations and infrastructure,¹⁰⁸ which requires financing. By choosing cleaner ships that meet current and future environmental standards, investors, banks and other stakeholders consider Environmental, Social, and Governance (ESG) criteria. ESG concerns have led to efforts such as the Sustainable Shipping Initiative (SSI),¹⁰⁹ an international partnership that promotes sustainability between its members, from ship owners to insurers to NGOs. SSI's "Save As You Sail" program partners ship owners with financial providers in order to update vessels with more efficient emission-reducing technology and save on fuel costs.

Additionally, vessel companies can voluntarily use grading initiatives such as the Swedish Clean Shipping Index (CSI) to hold themselves accountable.¹¹⁰ CSI scores a vessel company and its operations from its supply chain to emissions to operational discharges, allowing investors, clean tech providers,¹¹¹ and other stakeholders, such as freight forwarders, to partner with responsible vessels who can be trusted to comply with international standards. A similar program exists in North America called Green Marine.¹¹²

¹⁰³ [Amariles, D. R., & Waeyenberge, A. V. 2017](#)

¹⁰⁴ [World Shipping Council n.d.](#)

¹⁰⁵ [Organisation for Economic Cooperation and Development n.d.](#)

¹⁰⁶ [United Nation n.d.](#)

¹⁰⁷ [International Maritime Organization n.d.](#)

¹⁰⁸ [Knight, P. R. 2019](#)

¹⁰⁹ [The Sustainable Shipping Initiative Limited n.d.](#)

¹¹⁰ [Clean Shipping Index n.d.](#)

¹¹¹ [Clean Shipping Index 2018](#)

¹¹² [Green Marine n.d.](#)

The Environmental Ship Index (ESI) is an international scoring option that provides vessel-specific scoring and offers incentives such as discounts on port dues and bonuses to clean ships.¹¹³ Its index currently evaluates over 7,000 ships globally.¹¹⁴ To help support responsible ships and shipping practices, investment frameworks such as The Poseidon Principles provide banks around the world with principles that align ship financing with climate interests.¹¹⁵ Several large European banks such as the European Investment Bank (EIB) are committed to providing green investments through Blue Economy Finance Principles.¹¹⁶ These principles were created by the EIB to uphold the United Nations Environment Programme's Sustainable Development Goal "Life below water."¹¹⁷ In 2018, two banks, EIB and ING, agreed to provide 300 million euros of financing to support green shipping in Europe.¹¹⁸ These initiatives provide evidence that sustainability and a blue economy aren't mutually exclusive.

Cerulean aims to support international clean sea initiatives as well as stakeholder interests by providing a platform for stakeholders to directly monitor oily discharges from vessels. Companies and coalitions like those listed above can use Cerulean to help ensure a greener supply chain. Scoring indexes can use Cerulean to make sure vessels hold true to their ratings, allowing investors and insurers to be more confident in their partnerships. Widespread transparency of activity in the oceans encourages vessel operators, owners, and crew to operate responsibly in order to continue to receive support from their clients and other stakeholders, as well as to avoid criminal penalties.

¹¹³ [World Ports Sustainability Program n.d.](#)

¹¹⁴ [ibid.](#)

¹¹⁵ [Poseidon Principles n.d.](#)

¹¹⁶ [European Commission n.d.](#)

¹¹⁷ [United Nations Environment Programme n.d.](#)

¹¹⁸ [European Commission 2018](#)



Figure 6. These bright lines, compiled from dozens of radar satellite images, reveal heavy vessel traffic through the Strait of Malacca, one of the world's busiest shipping lanes, over the course of several months in 2019.

Our conversation with the resort director in Southeast Asia suggests Cerulean will support citizen activists as well. This resort director reached out to SkyTruth to share some of his experiences with bilge dumping.¹¹⁹ He has regularly found oil and tar washing ashore on beaches near Singapore and the Strait of Malacca for several years. He believes that part of the reason ship operators act irresponsibly is that they don't really understand that they can be monitored, and don't realize that their AIS broadcasts can be collected by the public. As an environmental activist whose livelihood depends on a clean coast, he would like to make vessel operators more aware of the transparency of their behavior and is interested in doing more personal monitoring of the sea surrounding his property. He believes Cerulean can help him, stating "(i)t is super compelling to pair satellite data with AIS." Knowledge of potential oil slicks nearby, even at night, allows citizens to prepare for when oil hits the land and can alleviate some of the clean-up. "It would be useful to know if a slick is coming," he said. "We could get people organized to stop it. If we had a warning -- even 30 minutes, it would give us enough time to make a difference."

While the first version of Cerulean won't provide continuous monitoring of the ocean (because the satellites now in orbit only cover a portion of the earth every day), it would allow insight into ocean pollution every several days and will build a one-of-a-kind record of incidents over time. One key objective of Cerulean is to establish a scalable pipeline that

¹¹⁹ [SkyTruth 2020](#)

can process more and more images as new satellite constellations are launched and cover our oceans more continuously.

Cerulean is currently under development, and we hope to have an operational product by 2021. Once up and running, Cerulean will be free and open to the public, providing a user-friendly interface that allows anyone, without any technical expertise, to monitor their areas of interest for oily slicks. Users can receive near real-time alerts for oil detected in their area of interest along with insights into who might be responsible for the pollution. Cerulean will identify features such as a slick's location, date, time, and length, in addition to specific vessel characteristics such as a vessel's ID number, destination, owner, operator, and flag country. We hope Cerulean will provide more insight into hotspots -- where bilge dumping is particularly common -- as well as track repeat offenders to enable more robust prosecutions. We anticipate Cerulean will be a useful tool for fleet owners, shipping companies, and international merchandise retailers that choose to be environmentally responsible: they'll be able to use Cerulean to track the performance of their fleet and incentivize operators and crew to stay in compliance with ocean law. Additionally, law enforcement can use these near real-time alerts to catch perpetrators in port and in coastal waters. Finally, we hope it will be a tool that empowers citizen watchdogs, nongovernmental organizations and journalists to keep an eye on what's happening at sea, report wrongdoings, and ratchet up pressure on governments and businesses to do a better job protecting our ocean.

At SkyTruth we work as space detectives — investigating meticulously from above, revealing as much as we can down to the most pressing and actionable details. As we increase monitoring, automate the detection of offshore pollution with the use of machine learning, and raise public awareness, polluters will learn that they are being watched. We believe that more transparency leads to better behavior, better management, and better outcomes for planet Earth. At SkyTruth, we are working to stop this illegal pollution by giving it the scrutiny it deserves.

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