GUE-BE Project *Westhinder*: Documenting and 3D Modeling a Lightship Wreck

By GUE-BE

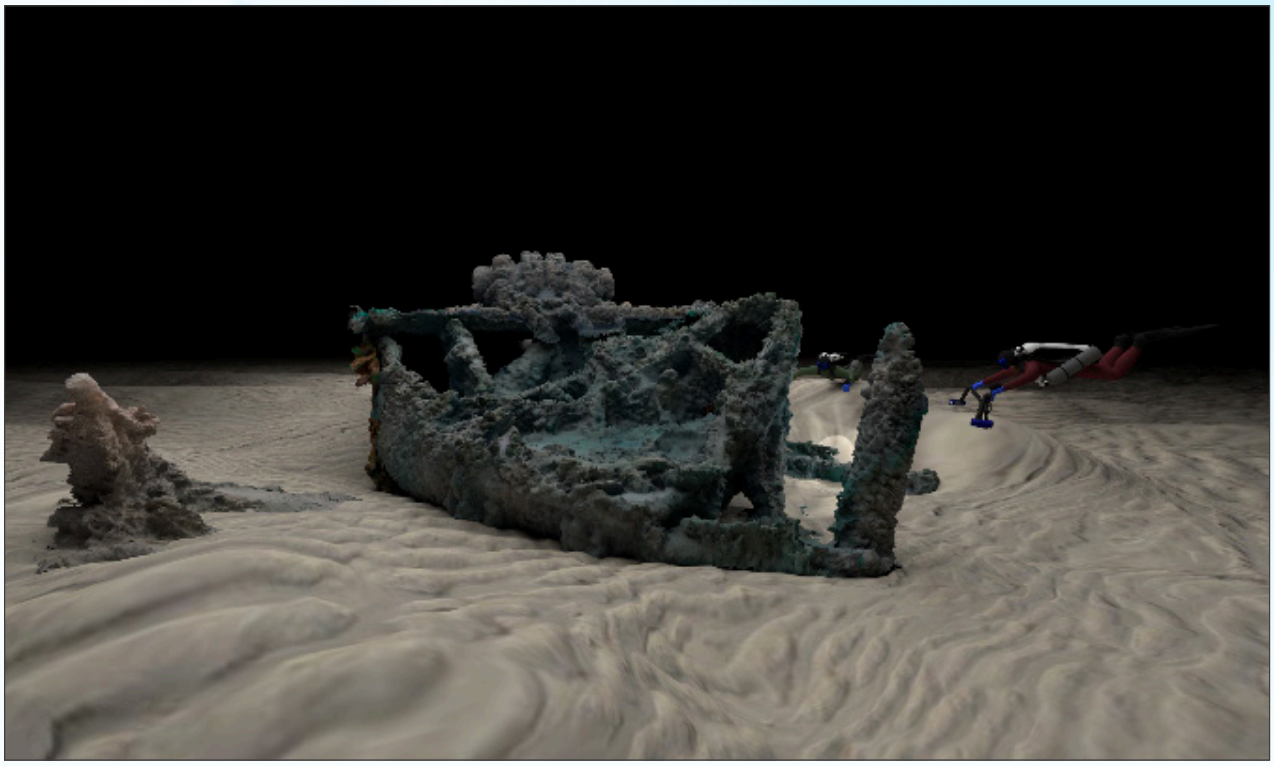
Historical image of the Westhinder *(Courtesy of GUE-BE)*

LIGHTSHIPS: THE *WESTHINDER*

In the English Channel lies the wreck of the century-old lightship, the *Westhinder*.[1] A floating lighthouse moored in the middle of the Channel at the Westhinder Sandbank, the vessel originally served to warn ships of the dangerously shallow waters and the strong currents surrounding it.

Until 1994, Belgian lightships served as navigation beacons, constructed specifically to anchor in dangerous shipping spots like submerged rocks, wrecks, and sandbanks near shipping lanes. Lightships warned approaching vessels of the danger by either a siren, bell, light, or in more modern times, by radio and radar.

[1] https://www.wrecksite.eu/wreck.aspx?1193



3D model view of the Westhinder*'s bow (Courtesy of GUE-BE)*

Marine navigation beacons have been in use since the Roman era. Candles on ships, rafts with bonfires—anything would do to warn vessels. The first real lightship, the *Nore*, was anchored off the Nore Sandbank at the mouth of the River Thames in England in 1731.[2] This practice spread across the globe, and by 1900, 750 lightships helped guide vessels in dangerous waters. Of those, 87 lightships were located in British waters, while three were in Belgian waters.

These ships were, strictly speaking, not ships. They did not have engines until the early 20th century and had to be towed to their anchoring spot. A complex scheme was developed to differentiate the light signals among the various lightships and light towers. The *Westhinder*, for example, emitted two white signals and one red signal every 30 seconds. Her foghorn, activated in foggy conditions, produced a long signal every two minutes. Towards the end of the 20th century, these lightships were replaced by automated buoys or unmanned lightships.

A typical late 19th century lightship had a crew of nine or ten: the captain, an engineer, a cook, and six or seven sailors. Crews rotated every 14 days. The crew's responsibilities included ship maintenance, operating the light beacons and horn, and adjusting the vessel's anchor based on the current. Additionally, they measured air and water temperature, salinity, current and tidal effects, and recorded the concentrations of different plankton species. Passing ships were noted in the ship's log.

[2] https://en.wikipedia.org/wiki/Lightvessels_in_the_United_Kingdom

Although this may sound like a boring job, working on a lightship was actually dangerous. Lightships in active rotation in 1912 had been previously hit five times:

- January 24, 1878: A steamship hailing from Antwerp collided with a lightship.
- February 6, 1880: Despite clear weather, the Spanish bark *Augusta* hit the *Westhinder* after leaving Antwerp.
- March 31, 1897: An English three-master on its way from Caleta Buena to Ostend hit the *Westhinder*.
- August 1899: A British trader, *C. O'Hagan,* collided with a lightship on her way from Antwerp to New York.
- May 5, 1905: The British steamer *Olive* hit the *Westhinder* on her voyage from Cardiff to Antwerp.

On the night of December 12, 1912, a nearby German steamship, *Ekbatana,* was towing the German lighter *Minnie* from Vlissingen to England and got into trouble in the English Channel during a heavy storm. As the *Ekbatana* came closer to the *Westhinder*, the strong currents gripped the *Minnie*, breaking the towing cable and slamming the lighter into the *Westhinder*. The *Westhinder*'s captain commanded the anchor be hauled in to free themselves of the *Minnie*, but that failed. The *Westhinder* capsized quickly, and though the *Ekbatana* stayed to pick up survivors despite the storm still raging, they found none. Meanwhile, the *Minnie* was adrift; it wasn't until a couple of days later that she was found and recovered near Vlissingen.

3D model view from the top of the Westhinder *(Courtesy of GUE-BE)*

The *Westhinder* now lies at 30 m and is in pretty good shape. Although the wreck is now protected under Belgian law as a National Maritime Heritage site, there is an up-to-date confirmed map available thanks to a group of Belgian GUE divers. In 2017, the divers collected underwater photos and videos and then created a 3D model using underwater photogrammetry and side scan sonar. This information is now available to the public at http://westhinder.gue-be.be/.

WRECKS IN THE ENGLISH CHANNEL

The English Channel is part of the North Sea and is the narrow bit of water between England, Northern France, Belgium, and Holland. It is the busiest shipping area in the world and is littered with thousands of shipwrecks, a good 200 of which are in Belgian territorial waters, a small stretch of just 12 by 34 nautical miles (22 by 63 km). While wooden wrecks deteriorate in a matter of decades due to strong tidal currents and *Teredo navalis* (ship worm) attack, wrecks of metal vessels, like the *Westhinder*, can last well over a century.

The Channel between England and Belgium is relatively shallow, with an average depth around 30 m and just a few spots dipping to 50 m. This is a famously dangerous shipping area. Fall and winter storms can be ferocious. The many sandbanks formed due to the combination of the sandy bottom, shallow water, and strong tidal currents often change location, size, and depth; some even surface at low tide. Because of their very nature, sandbanks are a big risk to shipping vessels. The Goodwin Banks near Kent, England, are well-known; these alone have claimed over 800 ships over the last 200 years. Along the Belgian coast, the Thorthon, Akkaert, Farye and the North-, East-, and Westhinder Sandbanks are most famous.

Wreck diving in the Channel is fascinating but comes with a few quirks. The bottom is sandy, the tidal currents are strong, and weather can turn quickly. Diving is only possible at slack tide. Visibility changes seasonally and goes from zero-viz pea soup during spring algae blooms to a comfortable 10–12 m in late summer and fall. There is an abundance of diveable commercial and military wrecks of the 19th and 20th century, especially in or near the shipping lane where it is illegal, not to mention dangerous, to dive. Here, the bulk of wrecks come from the First and Second World Wars. Every once in a while, some 15th to 18th century remnants appear through the drifting sands only to disappear again.

PROJECT *WESTHINDER*

Project *Westhinder* began in early 2017. GUE-BE and its members had participated in various projects in the past, including Project Baseline in Ekeren (BE), the Bergse Diepsluis (NL),[3] the European NETLAKE project,[4] and fishing net removal from North Sea wrecks.[5,6]

As some of those projects drew to an end, it was time for something new. A few members joined GUE's Documentation Contest in Croatia a while back, during which several international teams competed over three days to document their assigned wreck in the best way possible.[7,8] They learned that diving the same wreck multiple times in combination with historic research adds a fascinating element to the dive—understanding the history and the overall layout of the wreck, one

[3] http://www.projectbaseline.org
[4] https://www.eip-water.eu/projects/netlake-networking-lake-observatories-europe-netlake
[5] http://www.ghostfishing.org
[6] https://www.ecoduikers.be
[7] https://www.gue.com/doccon-2015
[8] http://varese.gue-be.be

NATIONAL MARITIME HERITAGE

There are more than 200 wrecks in the Belgian North Sea alone, many of them from the First and Second World Wars. Since 2014, eight wrecks have been designated as National Maritime Heritage sites. They are not to be lifted and will remain where they are with protective measures in place. Although they are still accessible to divers, activities that could damage the wreck, like anchoring, fishing, and dredging, are prohibited.

The *Westhinder*, which sank in 1912, is one of these protected wrecks. She was important to shipping at that time because of the tasks she fulfilled; she marked the safe route by indicating the position of the Westhinder Sandbank. She also functioned as a platform for marine and meteorological research, including monitoring current, wind, salinity, and plankton concentration.

discovers all sorts of interesting underwater details that otherwise go unnoticed.

We identified the *Westhinder* as the ideal wreck to apply this lesson to in our own North Sea. From a historical point of view, the *Westhinder* is one of the first wrecks to receive National Maritime Heritage status from the Belgian government. The *Westhinder* is not the deepest of the Channel's wrecks, lying straight up at 30 m, which gave us decent bottom times. Measuring only 33 by 7.5 m, the wreck is relatively small, which helped simplify the process of surveying the entire wreck in only a handful of team dives.

The project was introduced to all GUE-BE members in a kick-off meeting where it was positively received and a lot of people volunteered to take on key roles. Many of the members possessed or were eager to learn a variety of skills useful in wreck survey: team diving skills and awareness, underwater photography and videography, IT and computation skills, professional history training, and logistics planning.

Diving a Channel wreck like the *Westhinder* requires team organization, careful timing, and a masterful skipper who is intimately familiar with how the currents at a specific spot vary with the tides.[9] We typically arrived at the site about two hours before slack tide. The skipper dropped a shot on the wreck but did not anchor the dive vessel. Teams defined in advance discussed dive plans and project tasks, and rigged up their kits. The dive teams donned their dive gear and ran a final kit check. The boat headed into the current with the stern facing the shot buoy, and teams jumped in one at a time to descend along the shot and start their dive. Since the propeller was stopped for safety each time a team jumped in, the boat realigned to the shot between every jump. Our bottom times were always limited by the tidal currents. We got in the water before slack tide and got out after. We scheduled our dives around neap tide to get the longest possible bottom times. But even then, we were pretty much blown off the wreck after an hour or so, at which time we ascended, popped an SMB, and ran some oxygen deco at 6 m. We had the luxury to ascend freely and didn't have to stay with the shot; we were not near the shipping lane and our 730-HP dive vessel was plenty fast. She quickly and safely picked up the five to six teams bobbing at the surface.

Shot line ascents in the Channel can turn into solid workouts while swimming against the current. Back on board, we would wait four to five hours for the next tide, at which time we would repeat the routine for the second dive.

There was already a fair amount of historical information to be found on the *Westhinder* and her demise, but a good map of the wreck was still lacking. The team therefore decided to create a 3D model and produce a short documentary on the project's activities. This documentary was a bit of a plunge in the dark, as we didn't know how the different goals of the project would pan out; hence, the story line developed as the project progressed. Whenever possible, we tried to capture underwater footage of the wreck and the 3D photogrammetry activities, but North Sea conditions can suddenly change, and filming opportunities can quickly evaporate. Given the limited number of wreck trips, we trained several project members in handling video lights underwater. Good shots require efficient coordination between the light and camera divers, and practice makes perfect. Underwater hand-signal communication is iffy at best. So, after each dive, we reviewed the footage and provided feedback. Our images improved dive after dive, and after a couple of trips into the project, a story line emerged, and we could outline particular shots that were still missing. These scenarios were roughed out in storyboards with sketches of the desired light and camera movements relative to the wreck. This helped the teams to better understand the underwater tasks and greatly improved efficiency while filming. The short documentary can be watched at http://westhinder.gue-be.be, including some interviews on the making of it.

USING PHOTOGRAMMETRY TO MODEL THE *WESTHINDER*

Photogrammetry is a computer technique that generates a 3D spatial model of an object from conventional 2D still photos.[10]

[9] http://www.jonathan.be/jonathan/Jonathan_I.html

[10] https://en.wikipedia.org/wiki/Photogrammetry

An anchor from the Westhinder *(Courtesy of GUE-BE)*

If done correctly, the spatial model has the same dimensions as the original object. It is like a 3D map that can be turned around, explored from all sides, and zoomed in and out.

A lot of clear, sharp, well-lit images from all angles are needed to create an accurate 3D model, and there are quite a few factors that make the latter particularly challenging in the North Sea. There is not enough ambient light at 30 m to start with, a problem shared by underwater photo- and videography. The solution is the same for both—bring your own light, and lots of it. We used a pair of 10,000-lumen video lights mounted on the camera, and a light diver held an additional 30,000 lumen to ensure there was sufficient and even illumination. For comparison, your typical canister light used in technical diving produces 1,200 lumen.

To allow the photogrammetry software to stitch photos together into a 3D model, there needs to be significant overlap between consecutive images. The object must remain still to capture these images. Imagine how difficult it would be to make a 3D model of a tree swaying in the wind or a person walking; the object would not appear the same in any of the images. Of course, the *Westhinder* wreck sits still on the bottom of the North Sea, but she is overgrown with all kinds of marine life that sways in the current, and depending on the season, a lot of suspended particulate flies by like snowflakes in a snowstorm. Moreover, the marine growth varied drastically between dives. Our dive days were months apart, starting in early spring and ending in autumn. In spring, the wreck was covered completely, leaving almost no ship parts visible, while in autumn, some of the remaining wooden deck planks were clearly visible. These variations made it difficult to combine footage from the different days.

Finally, the North Sea water is not exactly crystal clear. The visibility can be quite low due to water-suspended algae and sediment, and this further complicates getting clear stills. Compare it to taking a picture of a large object in a snowstorm or thick fog. You get a vague and hazy outline from a distance, but that is useless for photogrammetry. Such conditions require you to get close, really close, 50 cm close, to capture crisp, clear images. However, in doing so, you can't capture the whole wreck in one image. We resorted to taking thousands of images from the different bits of the wreck at different angles and then carefully stitched them together. Each image overlapped with the adjacent one by 70–80% to allow reliable stitching. The *Westhinder* is not a massive wreck, but as each of our images captured only about 0.52 m, ensuring that every bit of the wreck was properly covered proved to be difficult. A second team therefore joined the 3D team in laying out a temporary grid of cave line in 1-m increments as a reference for the 3D team.

Eleven dives over five days and tens of thousands of images later, we are quite pleased with the results. We encourage you to explore our 3D model at http://westhinder.gue-be.be. The wreck model was constructed from a selection of 54,000 images and consists of 212 million points and 40 million polygon faces. The model on the website is reduced to less than 1% to keep it manageable over an internet connection. The sandy floor was modeled from existing side scan sonar images of the areas around the wreck. Even though it took several months of computation on powerful servers, a couple of iterations, and significant process tweaking, we were surprised that we got it to work given the difficult imaging conditions described above.

THANKS

The GUE-BE team would like to thank Agisoft LLC (http://www.agisoft.com) for helping us out with their photogrammetry tools.