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Cultural Organization



The Protection of the
Underwater Cultural Heritage

SCIENTIFIC COLLOQUIUM ON FACTORS IMPACTING UNDERWATER CULTURAL HERITAGE



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¹ The papers included in this document correspond to some of the contributions presented in the UNESCO Scientific Colloquium on Factors Impacting the Underwater Cultural Heritage (Royal Library of Belgium, Brussels, 13 & 14 December 2011).

Quantification of Trawl Damage to Pre-modern Shipwreck Sites: Case Studies from the Aegean and Black Seas

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Abstract: The past four years of exploration by the *E/V Nautilus* off the Aegean and Black Sea coasts of Turkey have located 40 pre-modern shipwrecks, ranging from Archaic Greek to early 19th century. More importantly, these wrecks also range in their state of preservation, due in a large part to the amount each site has been damaged by bottom trawling activities. Analysis was conducted of the damage reflected by each wreck site, the extent and intensity of trawl scars visible in side-scan sonar mapping, and the proximity of each site to the coast and other areas of fishing restrictions. In the Black Sea, these results are correlated with evidence of anoxic events caused by internal wave activity at the oxic/anoxic interface, reflected by the preservation of wooden shipwrecks. These data show areas of the Turkish coast where sites are more severely threatened or where they may have already been eradicated. Damage reflected by the dispersal of wooden timbers or by broken ceramic cargos indicates areas that may be aided by additional establishment and enforcement of marine protected areas.

Introduction

Damage by mobile fishing gear to shipwreck sites is an unfortunate result of humanity's continued exploitation of the sea. Recent exploration in the Aegean and Black Seas by the Institute for Exploration (IFE) with Ocean Exploration Trust's vessel, *E/V Nautilus*, has begun to document and quantify the damage by bottom trawls to ancient shipwreck sites. Forty shipwrecks ranging from Archaic Greek to the early 19th century have been located and documented since 2008 along the Turkish coast, comprising a catalogue of deep water sites that now allow us to discuss spatial patterns of trawl damage on the seabed and how these wreck sites fit into the submarine landscape as modern features of the seafloor. Ancient wrecks range in preservation state from consolidated, ship-shape piles of intact amphoras that have been protected in harbors, to disarticulated scatters of smashed ceramic cargos with very few whole artifacts remaining, in areas of flat seabed far from shore. The location and amount of damage exhibited by each of these forty wreck sites illustrates the extent and intensity of bottom trawling along the Turkish coastline. We plan to use these data to argue for the establishment of additional marine protected areas (MPA) and increased enforcement of trawl restrictions in key areas. The documentation of this type of damage is essential to understanding the dismantling of these sites by bottom trawling by quantifying the effects of trawls on both the seabed and on ancient wreck sites. Severe damage to many of these wrecks highlights the need for better protection of affected areas as well as more comprehensive surveys of these areas before the wrecks are damaged to the point that they can no longer be found.

Trawl damage to shipwrecks has been a topic of recent interest and debate, as commercial salvagers have begun citing such damage as a justification for removing cultural material from the seafloor (e.g., Kingsley, 2009, 2010; Sinclair, 2010). Technology to access the deep sea is now available to the private sector, removing the protection a site's depth used to provide. This only makes the role of an archaeologist more important in protecting sites, including upholding the principles of the UNESCO Convention. While *in situ* preservation of underwater sites is the primary objective, when this is not possible, they must, in every case, be excavated scientifically, conserved, catalogued, and curated, not sold off. The "scientific" approach to wreck sites must also be carefully monitored, as some commercial salvagers have begun publishing their work online, creating an "illusion of research" (Greene et al., 2011:314) that has not been peer reviewed or vetted by the archaeological or scientific communities. The threat of trawling to shipwreck sites does not change the way they should be handled, documented, or reported. Contrary to being an excuse for salvage, our work in the Aegean Sea shows that the establishment of additional marine protected areas around wreck sites and increased enforcement can do much to keep these sites protected *in situ* (Brennan et al., in revision).

Aegean Sea

We have begun quantifying trawl damage both to the seabed, through side-scan sonar mapping, and to amphora wrecks, through counts of broken artifacts visible in photomosaics. Side-scan sonar mapping has focused on depths ranging from 80 to 600 m, as well as in and around areas where trawling is prohibited, such as within 2.5 km from shore, and along a 100 m swath around submarine cables (KKGm, 2006). Post-cruise analysis of the sonar data created trawl intensity maps that show the number of scars per area, illustrating the extent and intensity of recent damage to the seabed, for example off the coast of Yalikavak, Turkey (Figure 1; Brennan et al., in revision). This figure shows the intensity of trawl scarring plotted over the shaded 2.5 km coastal boundary, and illustrates that this restricted area is clearly observed by trawlers. South of Datcha, we observed that heavy trawling is conducted parallel to submarine cables to avoid catching it, despite the prohibition. These areas, further from shore, are less easily enforced than the zones close to shore, and are therefore more likely to be illegally trawled. A number of trawled wreck sites were located in close proximity to these cables in 2009 (Brennan, 2010).

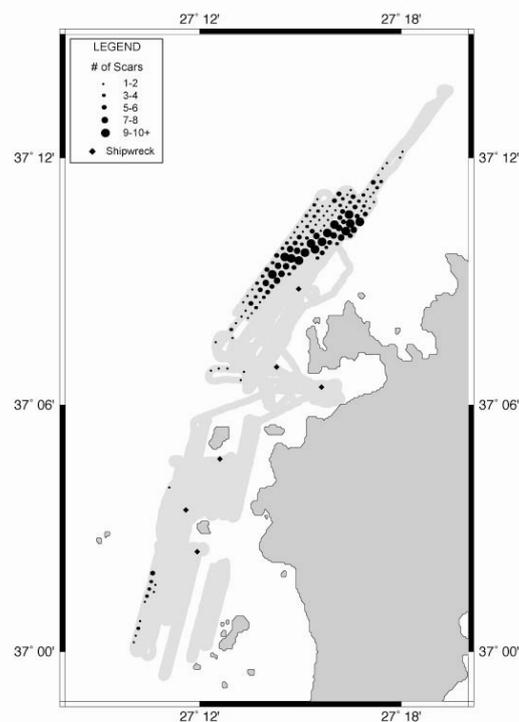


Figure 1. Map of the Bodrum peninsula and Yalikavak, Turkey, showing side-scan sonar coverage (light gray), shipwreck locations (gray circles), trawl intensity (black dots), and the 2.5 km coastal boundary (dark gray). Figure by the author.

Our work off the Bodrum and Datcha peninsulas of southwestern Turkey between 2008 and 2011 has located 31 ancient shipwrecks, of which 17 are made up of piles of amphora cargo. Photomosaic and microbathymetry surveys were conducted with the ROV Hercules for each wreck site to obtain detailed maps, dimensions, and imagery of the sites (Figure 2; Roman et al., 2010). With these high resolution mosaics, an assessment of the damage to each amphora wreck is possible, through counts of the whole and broken artifacts that comprise the site. While these are estimates based on the images and do not reflect total artifact counts, they are useful for comparing each site in regard to its location on the seafloor, the trawl intensity in that area, and the amount of damage to the site. Other ancient

wrecks in areas that have not been trawled were also evaluated for damage to determine what percentage of the artifacts should be expected to break during the sinking event. Wrecks from Skerki Bank, the coast of Israel, and the Black Sea that have not been trawled showed <5% broken artifacts. Greater damage can be attributed to trawling, especially in the Aegean, which rarely gets deeper than trawlers can operate (Brennan et al., in revision).



Figure 2. Photomosaic of Knidos C shipwreck site in the southeast Aegean Sea. Figure by Chris Roman.

The amphora wrecks along the southwestern Turkish coast show a large range in the amount of damages from trawls. For example, Yalikavak II, discovered in 1990 by INA and re-located in 2008 by IFE, lies at 50 m depth in the sheltered Yalikavak harbor and has <1% broken amphoras (Figure 3a). On the other end of the spectrum is Marmaris B, discovered in 2010 nearly 10 km from the coast in an area of flat bathymetry, which has >62% broken artifacts (Figure 3b; Brennan et al., in revision). When plotting the percentage of damage to each wreck against its distance from shore, these two wrecks form the end points of a line that the other wrecks southeast of Knidos fall along (Figure 4). This strong correlation represents the trawlers avoiding operating within the coastal restricted area 2.5 km from shore, increasing the damage to wrecks further from this zone, such as Marmaris B. Four wrecks (gray triangles) were not included in this model because they lie in significantly different environments than the group southeast of Knidos. Those located northwest of Knidos (Knidos A, Knidos B, and Knidos F) are in areas of steep bathymetry or rocky slumps and ridges where trawling is more difficult. Yalikavak I lie in shallow water (80 m) and therefore exposed to the effects of storms, which can break artifacts independent of trawl activity. This observation also correlates with the intensity of trawl scars mapped along the seabed, with a greater intensity visible further from shore and in areas of flatter bathymetry. However, along the swath of the submarine cable south of the Datcha peninsula, heavy scarring was observed, indicating that this restricted zone, further from shore, is not observed, likely due to a lack of enforcement.



Figure 3a. High definition video captures of Yalikavak II. ©IFE/OET

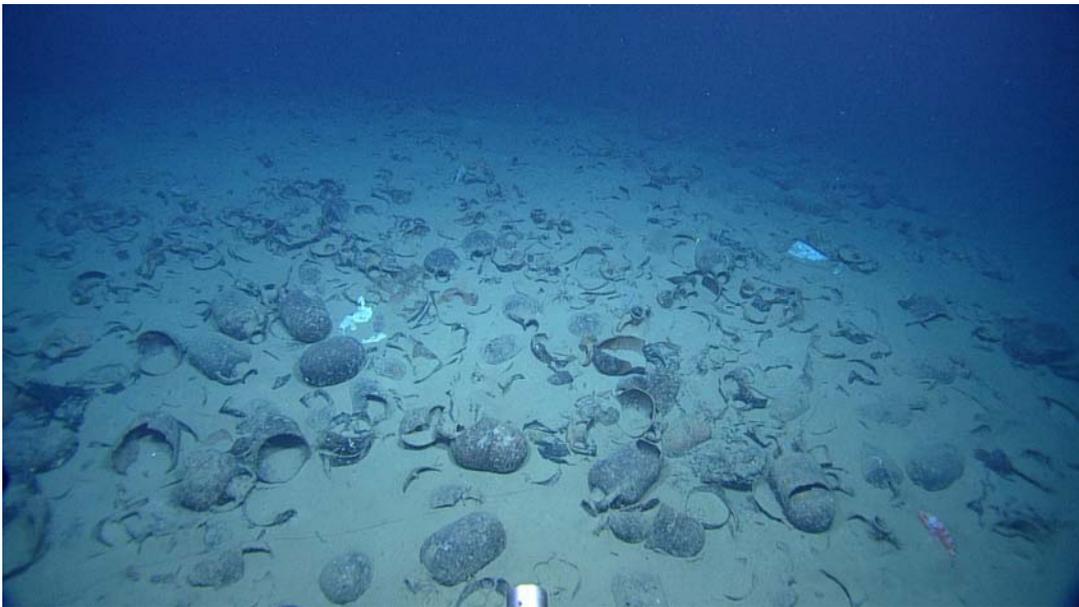


Figure 3b. High definition video captures of Marmaris B shipwreck sites. ©IFE/OET

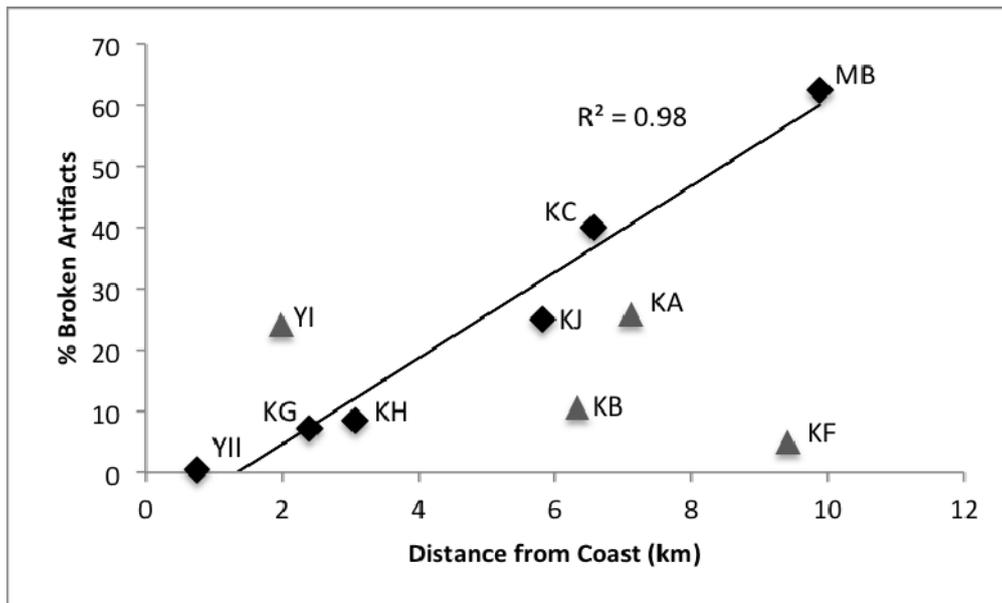


Figure 4. Plot of trawl damage by distance from shore. The black diamonds represent the amphora wrecks used in the model. Gray triangles represent wreck excluded from the model due to their location in different environments. Figure by the author.

BLACK SEA

The 2011 expedition to the Black Sea with the *E/V Nautilus* focused on mapping the coastal landscape off Turkey between 100-300 m depth to document changes across the oxic/anoxic boundary. This survey was a continuation of work conducted by IFE in 1999 and 2000 during which four shipwrecks were discovered. The 2011 expedition located an additional nine wrecks all between 100 and 115 m deep. These wreck sites are well-preserved, all with wood still visible, and some with parts of the ships' structures still standing. The preservation state of the wooden elements of the shipwrecks is due to the low-oxygen contents of the waters here. While the onset of the suboxic and anoxic zones of the Black Sea are deeper than these wrecks, density currents along the oxic/anoxic interface wash anoxic waters higher up onto the shelf, making it hard for wood-boring organisms to live there, and thereby preserving the structures of the ships (Duman et al., 2006; Trembanis et al., 2011).

However, the preservation of the wreck sites is also heavily dependent on trawling along the northern Turkish coast. Heavy trawl scarring was observed with side-scan sonar during the surveys down to about 100 m, although small numbers of scars were seen as deep as 200 m. In a few cases, it appeared that trawl activity may have even caused some of the slope failures from the shelf down into the basin. Some of the wrecks show evidence of trawl damage, while others do not. We revisited the Sinop A, B, and C wrecks, discovered in 2000 (Ward and Ballard, 2004), and these wrecks, between 95 and 105 m, also appear to have been trawled. Figure 5 shows a photomosaic of Sinop A from 2011, where trawl scars that have swept through the site are visible. While the damage to the amphora wrecks in the Black Sea can be quantified and related to the extent and intensity of seabed scarring, the wooden wrecks pose a new problem. Some retain the ship shape, while others have had the timbers ripped apart by trawls, but a quantification of the extent of the damage to the wrecks is difficult. Additionally, further data needs to be collected in the region around Sinop to determine why some wrecks escaped damage and others did not.

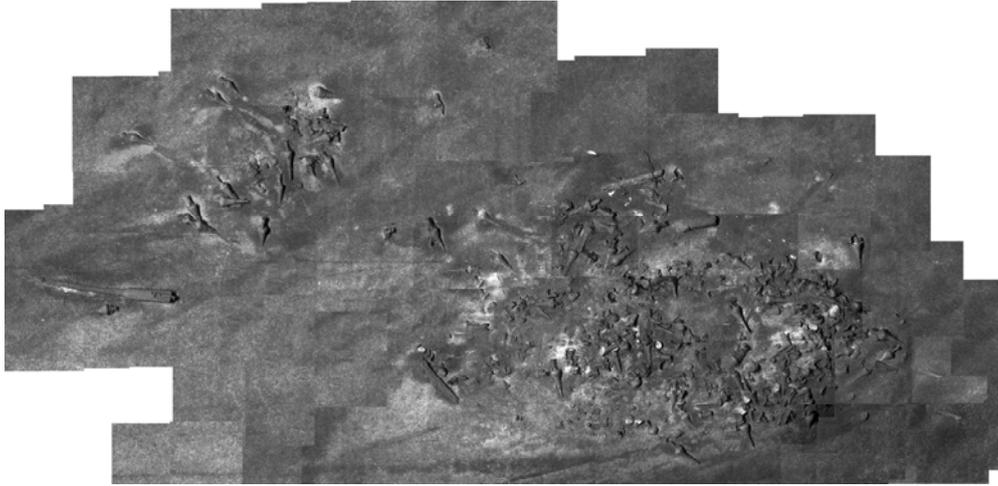


Figure 5. Preliminary photomosaic of Sinop A shipwreck site in the Black Sea. Figure by Chris Roman.

Marine Protected Areas

The 40 pre-modern shipwrecks we have located in Turkish waters comprise a large enough database that we can now begin to look at spatial relationships such as geographic location, depth, and proximity both to shore and to other wrecks in the region. Areas with a high concentration of wrecks, such as northwest of Sinop and southeast of Knidos, are prime locations for the consideration of potential marine protected areas. Especially the wrecks off Knidos show clear correlation to increased trawl damage with distance from the coastline. This general adherence to the coastal trawling restriction suggests that the combination of an MPA in this area and increased enforcement of this can provide the protection needed to preserve these sites *in situ*. Additional research into the preservation states of the Black Sea wrecks located in 2011 will also allow us to determine the most threatened areas along the northern Turkish coast, and suggest the establishment of a similar MPA. The enforcement of such protected areas can also help increase fish populations and allow benthic habitats to recover, in addition to preserving archaeological sites. The high number of pre-modern shipwrecks located in the deep waters off Turkey show that the salvage of threatened sites is not only an ethical issue, but also a logistical one. If the establishment and enforcement of regulations can protect these sites on the seafloor, then this should be the first action taken.

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