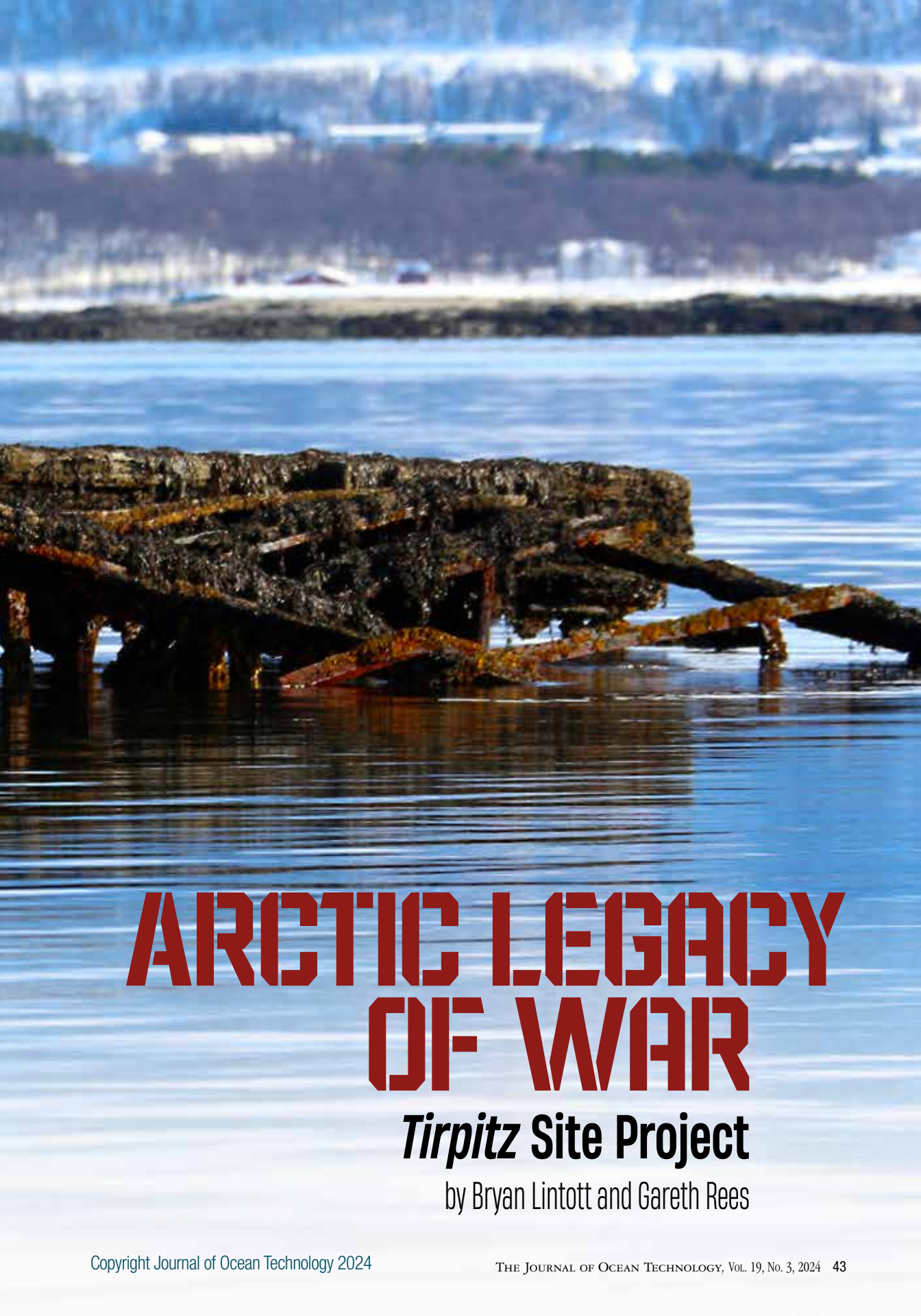




Tirpitz salvage wharf structure, 2023.

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ARCTIC LEGACY OF WAR

***Tirpitz* Site Project**

by Bryan Lintott and Gareth Rees

The *Tirpitz* salvage site is one of many areas in the Arctic where the legacy of war has resulted in contemporary concerns about effects on the biosphere and broader health and safety risks. Decades after the Royal Air Force sank the German battleship *Tirpitz* in 1944, and a subsequent salvage operation removed the ship's high-quality steel and operational equipment, hundreds of cubic metres of non-salvaged items remain on the site, along with widespread environmental contamination of the seabed. Current research on the *Tirpitz* salvage site, utilizing remote sensing and robotics, is developing innovative methods to map and monitor the site that can be utilized globally in near-shore environments.

The *Tirpitz* and its sister battleship *Bismarck* were the pride of the Third Reich's Kriegsmarine. Among the largest and most powerful battleships ever built, these ships posed a severe risk to Allied shipping convoys. *Bismarck*'s one sortie into the North Atlantic resulted in the sinking of HMS *Hood*, the flagship of the Royal Navy, before combined air and surface attacks sank the *Bismarck*. In response to this sinking, the *Tirpitz* was ordered to Norway, where it became a "fleet in being." The potential threat was so severe that even at anchor, the Royal Navy was forced to deploy numerous ships in case the *Tirpitz* attacked the Arctic convoys, which supplied vital military equipment to the USSR. While at anchor, *Tirpitz* was repeatedly attacked by the Fleet Air Arm, the Royal Air Force, the Red Army Air Force, and Royal Navy midget submarines. Due to extensive damage from these attacks, the *Tirpitz* was sailed to Tromsø, designated as a shore battery, and moored in shallow water. This would, it was thought, allow it to settle on the bottom if damaged in an attack. On November 12, 1944, the Royal Air Force's famous Dam Busters 617 Squadron and 9 Squadron attacked *Tirpitz* with Tallboy bombs. After direct hits and an internal explosion, the ship – badly damaged on one side – capsized (Figure 1) with the loss of over 900 German lives; the Royal Air Force squadrons returned

with no losses. Churchill, Roosevelt, and Stalin commended the mission.

The German military swiftly commenced salvage work, transporting the propellers and some of the hull's armourplate steel to Germany. Following the war, the Norwegian government awarded salvage rights to the private company Høvding Skipsopphoggeri, which cut apart the ship in conjunction with Eisen und Metall of Hamburg. High-quality steel and operational equipment were salvaged, but other materials were dumped on the seabed. No environmental protection controls were in place. Over subsequent decades, environmental surveys have shown that the site is still contaminated with hydrocarbons, PCBs, and heavy metals.

The [Tirpitz Site Project](#) is utilizing the site for ongoing scientific research, technological development, and environmental monitoring. The project is being undertaken by UiT The Arctic University of Norway's Institute for Technology and Safety and the Scott Polar Research Institute of the University of Cambridge. In 2025, an updated environmental contamination assessment is planned with the REMARCO EU research consortium ([Remediation, Management, Monitoring and Cooperation addressing North Sea UXO](#), a European project funded by [Interreg North Sea](#)).

The *Tirpitz* Site Project team has begun to survey the site using an innovative method of aerial-based through water remote sensing (Figure 2). This work has resulted in the first map of the salvage site, which shows the remains of the salvage wharf and debris piles. The map was produced with an airborne robot with RGB and multispectral cameras that took images through the water on a calm, sunny day. Hundreds of images were combined, using Pix4D and further processing, to produce an image map showing over 7 hectares of the site for the first time. From this data, measurements accurate to around 2 cm were made to a depth of 5 metres. The



Figure 1: The capsized *Tirpitz*, May 26, 1945. The adjacent boats are from the German salvage operation.

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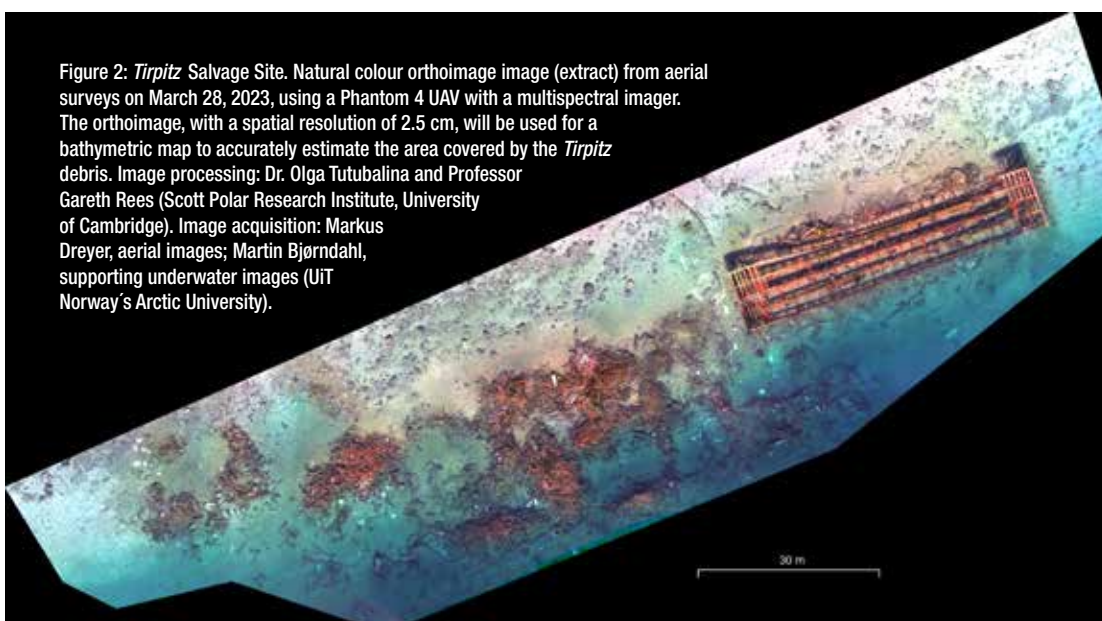


Figure 2: *Tirpitz* Salvage Site. Natural colour orthoimage image (extract) from aerial surveys on March 28, 2023, using a Phantom 4 UAV with a multispectral imager. The orthoimage, with a spatial resolution of 2.5 cm, will be used for a bathymetric map to accurately estimate the area covered by the *Tirpitz* debris. Image processing: Dr. Olga Tutubalina and Professor Gareth Rees (Scott Polar Research Institute, University of Cambridge). Image acquisition: Markus Dreyer, aerial images; Martin Bjørndahl, supporting underwater images (UiT Norway's Arctic University).

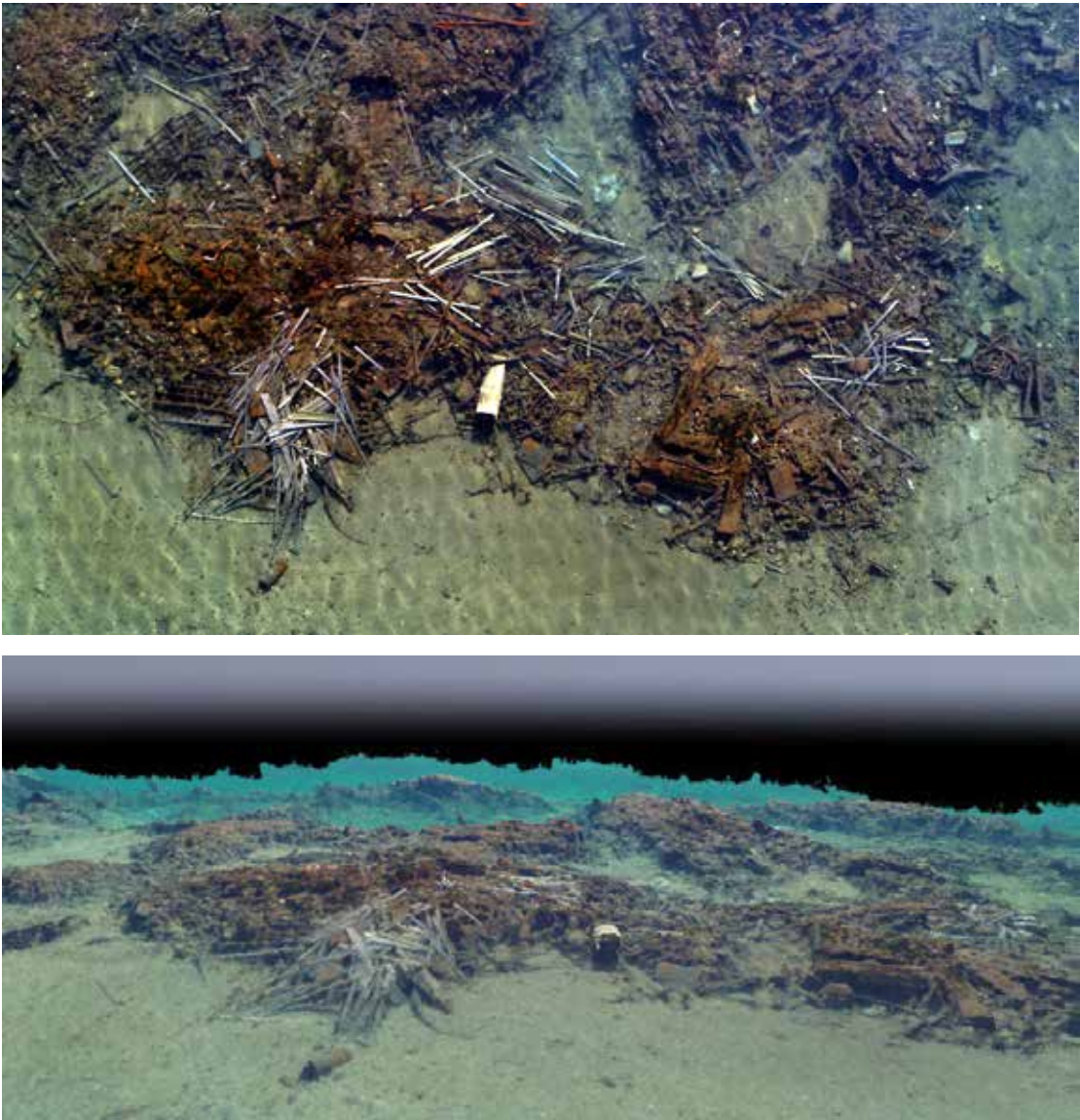


Figure 3: *Tirpitz* site debris piles, 2023. The top image was one of several utilized to produce the accompanying structure from motion 3D model. Image and model: UiT, Markus Dreyer

volume of debris piles has been estimated at around 750 m³, with a total mass of over 2,500 tonnes.

In addition, structure from motion has been utilized to produce 3D models of the debris piles (Figure 3). Blueye underwater robots have been deployed to identify images, such as the boiler tubes in Figure 4. This combination of robots proved to be swift, cost-effective, and environmentally benign.

This multidisciplinary project integrates science, technology, and archaeology with historical research. Recreational divers, who are a valuable source of information on how the site has evolved over the decades, are also important sources of information – as is the broader Tromsø community. This public engagement is a testament to the project's commitment to citizen science. It also acknowledges and respects the local community's central role in remembering the broader history of war in the Arctic.

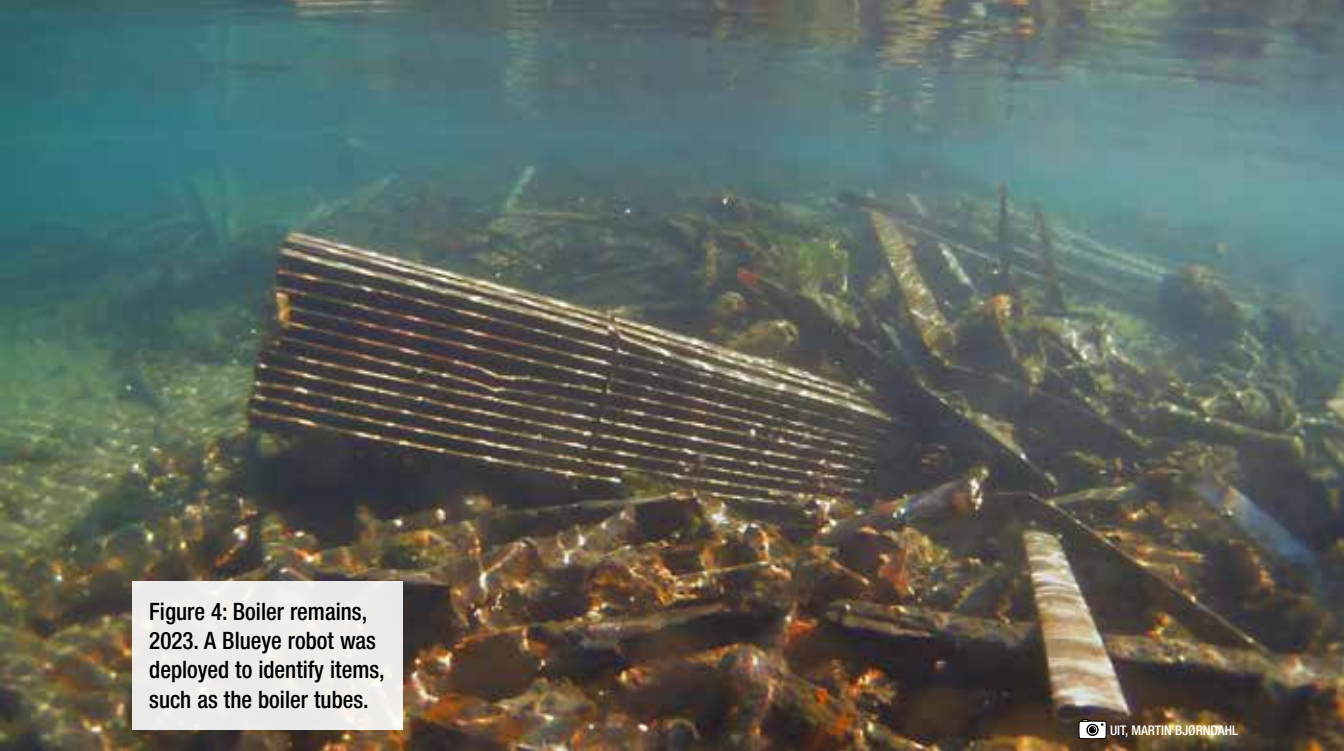


Figure 4: Boiler remains, 2023. A Blueeye robot was deployed to identify items, such as the boiler tubes.

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The legacy of war in the Arctic is similar to many other sites in the maritime realm. Areas where conflict has occurred may contain dangerous, even deadly, material that needs to be located, recorded, monitored, and, if necessary, the site remediated. There are also important issues of respect for the past; many sites are war graves and are profoundly important in national and related naval narratives and identities. Enhancing related technologies and methods has societal, environmental, and commercial value, particularly in ensuring fish stocks, lobsters, crayfish, mussels, and oysters are not contaminated. There is also a responsibility to current and future generations to deal with a worsening problem as fuel tanks leak and corroded shell cases allow explosives to enter the marine biosphere, posing a significant threat to the delicate balance of the marine ecosystem. Going forward, the *Tirpitz* Site Project's enhancement of remote sensing techniques and robotic technologies contributes to global endeavours to deal with the toxic legacy of war. The through water imagery techniques also apply to other research, planning, and engineering activities in the inter-tidal and near-shore environment. ~



Dr. Bryan Lintott is a polar historian at UiT Norway's Arctic University. He specializes in multidisciplinary projects ranging from Antarctic and Arctic heritage conservation, to dealing with the environmental aftermath of wars in the Arctic. He is a leading member of the International Council on Monuments and Sites (ICOMOS) polar and aerospace heritage endeavours. Dr. Lintott is an institute associate of the Scott Polar Research Institute, University of Cambridge.



Professor Gareth Rees is a pioneer in polar geoinformatics, utilizing his theoretical research and fieldwork in the Arctic. Based at the Scott Polar Research Institute, University of Cambridge, his research strongly focuses on interactions between climate, ecosystems, and energy policy in the Arctic. Increasingly, he is engaged with science diplomacy, guiding international research agendas for the Arctic, and with the democratization of science through citizen engagement. He is a fellow of Christ's College, Cambridge. Professor Rees has a strong association with UiT Norway's Arctic University.