

World War Two Shipwrecks; a toxic legacy?

Matthew Carter (Research Director, Major Projects Foundation)

Dr. William Jeffery (Assistant Professor, University of Guam, Division of Humanities)

Dr. Ian D MacLeod (AM, Principal, Heritage Conservation Solutions)

ABSTRACT

During the Second World War over 3,800 ships were sunk throughout the Pacific Region. The legacy of this conflict is still being felt today, with an unconfirmed number of potentially polluting wrecks (PPWs) still containing oil and unexploded ordinance. Many of these wrecks have deteriorated significantly and the threat of a spill is increasing as over 70 years of corrosion is causing collapse of the ships structures. The scale of this threat is largely unknown, however estimates indicate that thousands of tons of oil may remain in these wrecks with several identified as already leaking.

Aware of the increasing risk that these wrecks pose, the Major Projects Foundation was established in 2018 with the aim of mitigating this risk. The primary activity was the purchase of the former New Zealand Navy Diving Vessel HMNZ Manawanui as an expedition vessel. With the vessel newly renamed RV Ocean Recovery, and with a Memorandum of Understanding with the Secretariat of the Pacific Regional Environment Programme (SPREP) and the University of Newcastle, the Major Projects Foundation is dedicated to gathering robust scientific data on the condition of PPWs throughout the Pacific. Using cutting edge and incorporating industry standard technology, high-risk wrecks will be surveyed and assessed. Once wrecks with oil content are identified, commonly practiced subsea engineering solutions exist to mitigate the threat of an oil spill. Furthermore, the information from the survey of these wrecks will be used to educate and mobilise the public and policy makers to the risk such PPWs pose to marine ecosystems and the people who rely on them.

Key Words: UCH, WWII, Anthropocene, Pollutants, Peak-leak

List of Figures

Figure 1: Map showing the locations of vessels sunk in the Asia-Pacific region during WWII. (SPREP 2003b)

Figure 2: Number of Category 1 potentially polluting wrecks identified to country. (Carter 2021)

Figure 3: Impact of divers, dynamite fishing and typhoon damage on Chuuk wrecks.

Figure 4: Ian MacLeod and Arimichy Rudolph measuring active corrosion on the Tonoas dock boat. Note the "rust clouds" released during the assessments. Photo by Anerit Mailo 2008.

Figure 5: Fujikawa Maru shipwreck. (Greg Adams, 2002)

Figure 6: Sapuk Lighthouse, constructed on a Chuukese Traditional Indigenous site on Weno. (Bill Jeffery, 2019)

INTRODUCTION

Between 1941 and 1945 the Second World War brought more people into contact with the seas of the Asia-Pacific region than ever before. This influx of humanity and machinery left a correspondingly large archaeological signature with over 3,800 ships recorded as being sunk during the conflict (Fig. 1) (Michel et al. 2005; SPREP 2003b).

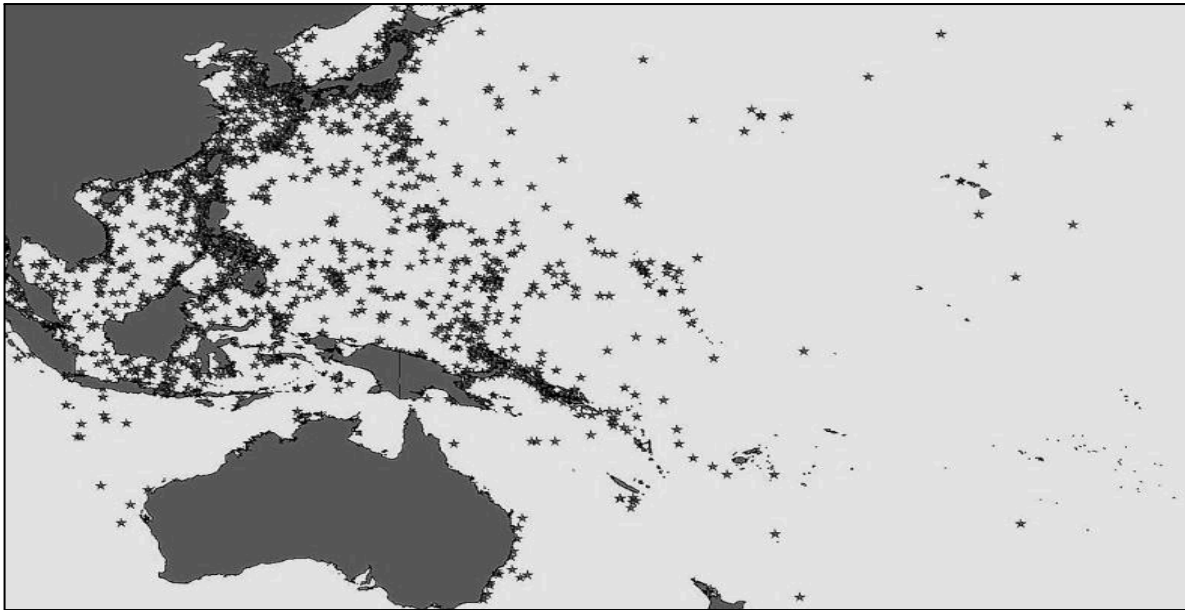


Figure 1: Map showing the locations of vessels sunk in the Asia-Pacific region during WWII. (SPREP 2003b)

Today, having been underwater for over 75 years these shipwrecks have been transformed into tropical reefs, becoming important components of local marine ecosystems (Emslie et al. 2007). Over this time these wrecks have also been inscribed with a range of sometimes conflicting values, becoming highly valued fishing spots for local communities, sites of remembrance and memorial for veterans and their descendants, and even tourism assets on which entire island economies may rely (Edney 2012; Jeffery 2004a). However, the presence of unexploded munitions and considerable volumes of pollutants on many of these wrecks means that they pose significant threats with the potential to disrupt or destroy the environmental and other values associated with these sites (e.g. Jeffery 2012; Monfils 2005; SPREP 2003a, Carter et al 2021). In 2019 ministers from the 21 governments in the Secretariat of the Pacific Regional Environment Programme (SPREP) reaffirmed the ‘significant environmental threat’ that the wrecks of World War II (WWII) ships pose to the marine ecosystems, cultures and livelihoods of the Pacific (SPREP 2019).

PREVIOUS RESEARCH

That WWII shipwrecks potentially pose a threat to the marine environments of the Pacific was first formally recognised by authorities during the 1990s with the Solomon Islands Government supporting a ‘contamination risk assessment study’ of WWII ship and plane wrecks within Iron Bottom Sound (Maharaj 1999). In 2001 fears over the pollution potential of WWII wrecks were realised when the wreck of the USS *Mississinewa* leaked approximately 24,000 gallons of oil into Ulithi Lagoon in Yap State of the Federated States of Micronesia (FSM) (Gilbert et al. 2003). A state of emergency was declared and all fishing in the lagoon area was banned. Unable to remove the threat, the President of FSM requested assistance from the United States Government who responded by funding the U.S. Navy Supervisor of Salvage and Diving (SUPSALV) to first plug the leak, and then in 2003 return and pump out the remaining 1.8 million gallons of oil (US Navy 2004).

With the USS *Mississinewa* emergency unfolding SPREP commissioned a *Regional strategy to address marine pollution from World War II shipwrecks* (SPREP 2003a). This document outlined a strategy through which potentially polluting wrecks in SPREP member countries and territories would be identified and an assessment process enacted. This strategy was progressed through the creation of the SPREP ‘WWII Shipwrecks of the Pacific database’ which contained 3855 vessels sunk in the Asia-Pacific region during World War II (SPREP 2003b). While the SPREP database was planned as the first phase of the regional strategy, Phase II, the environmental and risk assessment stages were not implemented. Instead in 2003 SPREP member countries decided that the secretariat would have ‘no further action on the strategy, and that any further developments be undertaken bilaterally between the flag state and the coastal state with SPREP offering technical assistance only’ (Talouli, Gilbert & Gilbert 2009).

(RE)ENGAGING WITH THE ISSUE OF PPW

Aware of the increasing risk of PPW in the Pacific the Major Projects Foundation (MPF) was established in 2018 with the mission of protecting marine ecosystems from PPW by building capacity within local communities to respond to this threat. Working in partnership with SPREP and the University of Newcastle, a program was developed to assess and mitigate the threat of potentially polluting wrecks within the borders of the 21 Pacific Island Countries and Territories that comprise the membership of SPREP.

The Foundation’s first project has been to update and refine the SPREP database created in 2003. Utilising in-depth historical research of both English-language and Japanese archival material, and interviews with various stakeholders including heritage managers, marine pollution advisors and scuba divers, this research narrowed the 3855 vessels from the 2003 database to a total of 1292 shipwrecks dating from WWII and the US Nuclear testing programme within the SPREP region (Carter et al., 2021). Using a ranking system based on Goodsir (et al. 2019) that includes variables such as a vessel’s age, its depth below the surface, and the potential volume of pollutants it may still hold, 53 of these 1292 wrecks were deemed to be of potentially ‘high environmental risk’. While these wrecks were deemed ‘Category 1’ based on the immediacy of the perceived risk they pose, wrecks placed in Category 2 and 3 also potentially represent environmental risks that will increase as these wrecks continue to age and collapse.

From this research MPF has been able to narrow down its main focus to the 53 potentially polluting wrecks that are located in eight main countries (Figure 2).



Figure 2: Number of Category 1 potentially polluting wrecks identified to country. (Carter 2021)

With the refined database of potentially polluting wrecks MPF is now moving on to the next phases of its mission. Following the 2003 SPREP strategy and current international best practice, MPF will gather the information required to not only understand the current condition of the 53 Category 1 wrecks and how much oil they may hold, but also from which suitable remediation options can be developed. Building on previous research MPF has begun this process in relation to the potentially polluting wrecks in Chuuk Lagoon.

CORROSION STUDIES OF PPW IN CHUUK LAGOON

The history of the United States carrier force of bombing raids on the Japanese harbour in Chuuk (Truk) lagoon in February 1944 is well described (e.g. Morison, 1975; Bailey, 2000) but for a corrosion-hunting conservator it was the best determined research program one could ever design. To have more than 65 iron wrecks, ranging from fishing boats, through auxiliary craft such as tugs, through merchant vessels, passenger liners to submarines and warships of the Imperial Japanese Navy (IJN) sent to the bottom within two weeks of each other was a dream work-scenario.

In-situ data on pH, depth of graphitisation of cast iron fittings, thickness of concretion and the corrosion potential (E_{corr}) all provide indicators of the rate of decay of historic iron shipwrecks in Chuuk (MacLeod 2006). The most sensitive indicator is the corrosion potential, as the log of the corrosion rate is linearly dependent on the voltage. Any change that exceeds the experimental error of ± 0.002 volts may be regarded as a net change in the microenvironment. The corrosion potential is a combination of the oxidation of iron and the reduction of oxygen. Decay is governed by the flux of dissolved oxygen to the concreted wrecks. For objects at the same water depth the corrosion rates increase with raised profile on the wrecks, which causes increased oxygen flux. On *Fujikawa Maru*

the protected bollards lost 6.5 ± 0.1 mm, less than the 8.4 mm (windlass) and the 11.6 mm for the gun mount (MacLeod 2005).

The 2002 initial survey of the iron wrecks included the iconic *Fujikawa Maru* which was visited an additional five times up to the 2015 post typhoon Maysak review. The Chuuk corrosion rate is logarithmically dependent on water depth, as seen in Equation 1,

$$\log d_g = -0.7314 - 0.0181 d \quad (1)$$

The orientation and aspect of a shipwreck can significantly alter the relative decay rate, since the wreck of the upside down *Yubae Maru* is corroding 45% higher than expected for the 28-metre depth of the vessel, due to the physical stresses on the hull. Because dynamite fishing and typhoon storm surges remove protective concretion, they dramatically increase the overall corrosion rate. The discovery of a new WWII wreck in 2006, the Tonoas dock boat (TDB), a bonito fishing boat, acts as a benchmark. It was assessed in 2007 and in 2008. The *Susuki Patrol Boat* (Susuki) is shallower than the *Fujikawa Maru* and it has also been subjected to dynamite fishing. A summary of the changes to the E_{corr} values is graphically presented in Figure 3.

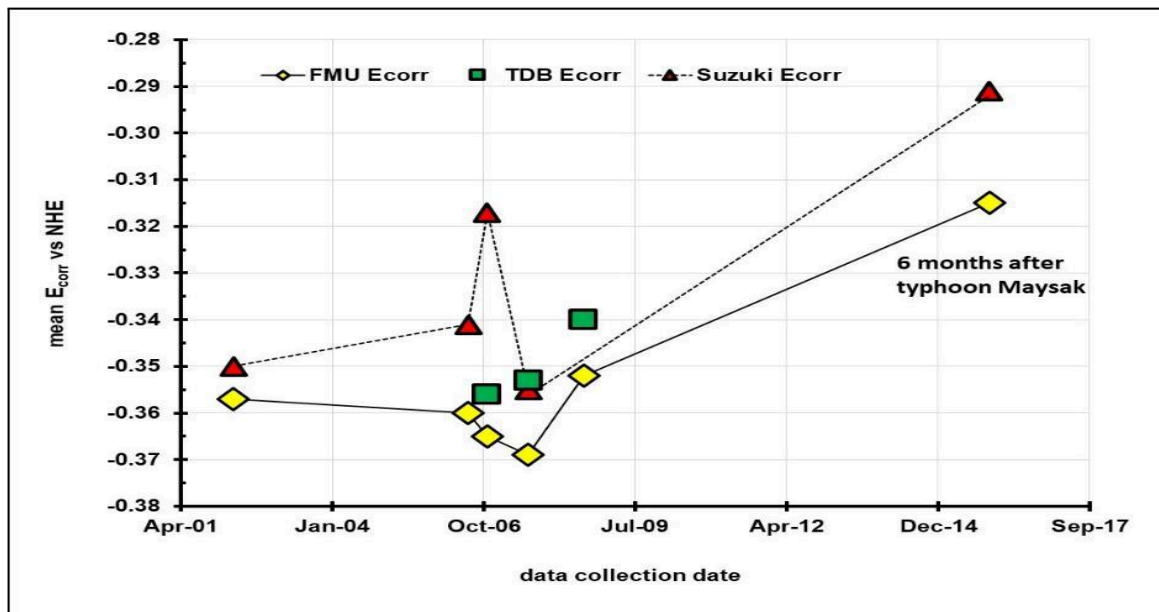


Figure 3: Impact of divers, dynamite fishing and typhoon damage on Chuuk wrecks.

For the Tonoas dock boat, the anodic shift of 3 mV one year after discovery is well within experimental scatter, but the +13- mV shift to less negative voltages reflects an increased rate of 5% per year, which can be associated with divers visiting the site and doing some weed clearing for better pictures. Repeat measurements are needed to see if there is any impact from the typhoon induced weather systems. The mean depth of the site measurements in the three data sets was a constant 14.4 ± 1.7 metres.



Figure 4: Ian MacLeod and Arimichy Rudolph measuring active corrosion on the Tonoas dock boat. Note the "rust clouds" released during the assessments. Photo by Anerit Mailo 2008.

For the *Susuki* the +9 mV increase in the mean E_{corr} between April 2002 and July 2006 can be ascribed to increased diver visitation after it was added to the list of “must-see” wrecks. This apparently small change in E_{corr} is equivalent to a 6.7% increase in corrosion rate. The significant elevation of the mean E_{corr} by 24 mV or 27% in four months was due to concretion damage from dynamite fishing between July and November 2006. Recolonisation of the wreck caused the E_{corr} to drop by 38 mV or nearly 30% in just over 9 months. The site was massively damaged by the typhoon in 2015 which saw the mean E_{corr} climb to - 0.291 volts vs. NHE or an increase of 53% on the 2002 original measurements. The 7.7 metres depth of the wreck site makes it prone to storm damage. Recolonisation would have been taking place in the nine months since the typhoon struck in March-April 2015, so this assessment reflects less than the full impact of the extreme weather event.

The initial inspection of the *Fujikawa Maru* showed evidence of concretion loss, so the fall in E_{corr} seen in Figure 1 is consistent with the marine concretion continuing to regrow in the next season. The corrosion rate continued to decline at 5.6% p.a. during recolonisation but one year later in August 2008, the +14 mV in the mean E_{corr} values was due to significant areas of concretion loss. Typhoon Maysak caused significant damage, so the additional +47 mV shift equated to a 140% increase on the pre-typhoon corrosion rate. The *Susuki* wreck had a great increase (159%) because *Fujikawa Maru* is twice as deep.

FUEL BUNKER CORROSION

Confirmation that the Lloyds rules can be used for calculating the original wall thickness of the fuel bunkers was provided through 2006 measurements on the metal thickness in two strategic hull locations which confirmed the hull plates of 16.3 mm, and the bridge structure thickness reflected a standard plate on top of a frame. For *Fujikawa Maru*, it is reasonable to assume that the fuel tanks were constructed of similar steel to the general plate thickness ranging from 13 mm ($1\frac{5}{32}$ "") to 16 mm ($\frac{5}{8}$ ""). The present corrosion rate can be calculated using Equation 1 at a depth of 30 metres then doubled to account for internal bacterial corrosion. Thus, the residual metal thickness for the thinner plating is about 4.8 ± 0.3 mm; a loss of nearly 65% of the original wall thickness. Increased stress from the weight of collapsed superstructures will accelerate the overall decay rate.

COLONIAL LEGACIES

In March 2018, the FSM became the first country in Oceania to ratify the *UNESCO Convention on the Protection of Underwater Cultural Heritage* (UCH) 2001. One of the reasons was because of the Japanese WWII shipwrecks located in Chuuk Lagoon. The Japanese value these sites as the graveyards of their comrades, while to the USA the sinking of the c.110 ships was a great tactical success in their advance across the Pacific. To the Chuukese, the sites represent when the war came to Chuuk, but are of little heritage value. Heritage to Chuukese, as it is to many Micronesians, is found in their traditional landscape, in their family relationships, and in their many cultural practices (Living Heritage). Yet the shipwrecks provide a much-needed economic benefit through cultural tourism.

The shipwrecks are a legacy of past colonialism when Chuuk Lagoon was used by the Japanese as a major military base, similar in importance as Pearl Harbor to the United States of America (U.S.). They are also a legacy of U.S. military action that commenced on 17 February 1944, and caused over 6,000 tons of bombs to be dropped on Chuuk in nearly 18 months. Fortunately the atomic bomb that was planned to be dropped on the fleet of ships anchored in Chuuk Lagoon did not eventuate (Stewart 1989: 97).

A neo-colonial legacy can be seen in how foreigners regard the shipwrecks as a source of artefacts for souveniring. In 1969, Jacques Cousteau visited Chuuk, made a film about his diving, titled 'Lagoon of Lost Ships', and 'eventually leaving with tonnes of "relics" salvaged from the previously undisturbed wrecks. Those relics, believed to still be in the Cousteau family somewhere, have never been seen since'¹ (Bailey 2000: 265). In 1971, a law, titled *Truk Lagoon District Monument*, made it illegal to 'remove, appropriate, damage or destroy, without the written permission of the Governor' any of the shipwreck material. This law also made it illegal to dive without a permit and a certified dive guide, which could be obtained from the licensed dive shops (Jeffery, 2004b: 9). Currently a \$50 annual fee is required to dive the submerged shipwrecks and aircraft. In 1973, Japanese groups, with permission from the US government, recovered some of the human remains found in the shipwrecks (Hezel and Graham 1997: 3).

¹ <https://www.expeditioncruising.com/2017/01/the-undersea-world-of-jacques-cousteau.html> Accessed 24 August 2021

VALUE OF THE WWII UCH IN CHUUK LAGOON

Today the WWII UCH are one of most significant maritime archaeological sites associated with WWII anywhere in the world (Fig. 4). The shipwrecks and aircraft located in the lagoon are relatively intact and exhibit the damage inflicted by the enemy. They are associated with the 4,000+ Japanese, and about 1,000 Chuukese killed during the war. A number of other Pacific nationals including Okinawans, Koreans and Nauruans, 30+ Americans and two British died in Chuuk during the war.

Other important values include:

- they provide a tangible symbol of WWII for the Chuukese, one which can be used to highlight the Japanese and American impact on Chuuk culture and society;
- they are associated with the development of the aircraft carrier, ‘the strike on Truk [Chuuk] demonstrated a virtual revolution in naval warfare; the aircraft carrier emerged as the capital ship of the future, with unlimited potentialities’ (Morison, 1975: 329-332);
- to the Japanese, the underwater sites are war graves.



Figure 5: Fujikawa Maru shipwreck. (Greg Adams, 2002)

In regard to how Chuukese value these sites and similar WWII material, a number of scholars have concluded: ‘Pacific cultures are societies founded and rooted in oral traditions and oral histories. Tangible reminders of the past are of lesser importance, if at all. Thus, for many Pacific Islanders the historical Second World War remains signified little and if they did, they were reminders of that painful period’ (Spennemann, 1992). Lin Poyer (et al., 2001: 336-337) found, ‘Physical mementos of war hold little historical interest for most Micronesians, who may use them for practical value.’

The oral history and site surveys in Chuuk in 2002-2008 by Jeffery, included 200 terrestrial WWII sites (Jeffery 2007). It was found there was considerably more empathy amongst the Chuukese men

with the terrestrial WWII sites compared to the submerged WWII sites. A Chuukese staff officer from the Chuuk Historic Preservation Office (HPO), Arimichy Rudolph, explained that while the submerged WWII sites were seen as important in tourism, he, and many other Chuukese saw them as significant ‘because they tell us about the bad time in the history of Chuuk’. With regard to the terrestrial WWII sites, they were significant ‘because they tell about the hardship our parents went through at that time’. This was an interesting distinction between the two types of WWII sites, the terrestrial sites having more personal, family connections—and family is a fundamental part of the cultural identity of being Chuukese (Fig. 6).



Figure 6: Sapuk Lighthouse, constructed on a Chuukese Traditional Indigenous site on Weno. (Bill Jeffery, 2019)

The war in Chuuk had a great impact on Chuukese, their traditional Indigenous sites, land ownership, food and traditional ways of life. This impact, loss and destruction is something that needs to be included in WWII material culture surveys, in ongoing research, management and interpretation, not just the American and Japanese material culture of WWII—it is an overlooked heritage. While there are memorials to the Japanese, on land and underwater, there are no memorials to the Chuukese, although there are ‘musings about construction of their own war memorials’ Poyer (et al., 2001: 337). It is a similar case in many places where WWII took place, traditional indigenous people are overlooked and are almost invisible in being recognised for how they were impacted by WWII.

CONCLUSION

With thousands of shipwrecks containing potentially millions of gallons of toxic oil the legacy of WWII is still very much evident in the Pacific region today. Through international collaboration a project is underway to mitigate the threat that these wrecks pose, starting with the area deemed to be

at highest risk from PPW, Chuuk Lagoon. This work has the benefit of building on previous research that has identified the key variables impacting the preservation of these PPW, and also the contested nature of their legacy.

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Biographies

Matt Carter, PhD., Major Projects Foundation,

Dr Matt Carter is a marine archaeologist and the Research Director for the Major Projects Foundation. He is a Vice-President of the Australasian Institute for Maritime Archaeology, the New Zealand representative on the ICOMOS International Committee on Underwater Cultural Heritage (ICUCH) and an International Fellow of the Explorers Club. Having combined archaeological, commercial, and technical diving for over a decade in 12 different countries around the world, today Matt's research sees him working to protect the marine ecosystems, cultures and livelihoods threatened by polluting shipwrecks in the Pacific.

Bill Jeffery, PhD., Anthropology, University of Guam

Bill Jeffery is an Associate Professor, Anthropology, University of Guam and holds a PhD from James Cook University, Townsville, Australia. His primary interest is maritime archaeology, which he commenced in Australia before going on to work with the Federated States of Micronesia National Historic Preservation Office, Sri Lanka, Hong Kong, and in east Africa. His interests are in researching traditional indigenous material culture and living heritage particularly in Oceania, revealing multi-vocality perspectives of underwater cultural heritage, developing community maritime archaeology, and highlighting how maritime cultural landscapes can reflect maritime cultural identities.

Ian D MacLeod, AM., BSc(Hons), PhD, DSc, FTSE, FRACI, FRSC, CChem, PMAICCM

Shipwreck sites are dynamic systems and analysis of the corrosion products shows up impacts of changing climates and burial environments. Monitoring the corrosion on historic shipwrecks provides heritage managers with independent data on which to make their decisions. Analysis of corrosion has enabled prediction of future decay mechanisms on oil rigs through corrosion of cast iron ballast on Norfolk Island's wreck of HMS Sirius (1790). An electrochemist with 40+ years of corrosion enables the author to provide good advice.