

CONTAMINATION RISK ASSESSMENT FROM WW II ARMOURY IN IRON BOTTOM SOUND SOLOMON ISLANDS

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TABLE OF CONTENTS

EXECUTIVE SUMMARY	7
ACKNOWLEDGEMENTS	6
INTRODUCTION	9
BACKGROUND AND STUDY AREA	10
Background	10
The Study Area	11
DURATION OF THE PROJECT	11
RESOURCE MATERIAL	11
TASKS, METHODS AND TERMINOLOGY	11
Tasks	11
Methods	13
A Cautionary Note	13
Terminology	14
RESULTS	
Bathymetry and Hydrography of Iron Bottom Sound	14
Military Vessels and Ships Sunk	15
Aircraft Destroyed	18
Volume/Tonnage of Wreck	20
Lives Lost	21
Archival Photographs and Conditions of Submerged Wrecks	21
Cargo Contents	22
Possible Environmental Impacts	22
CONCLUSIONS	23
RECOMENDATIONS	24
BIBLIOGRAPHY	36
REFERENCES CITED	39

List of Figures

Figure

1	Location map of Solomon Islands	12
2	The regional hydrography of Iron Bottom Sound, Solomon Islands	16
3	Bathymetry and hydrography of Iron Bottom Sound, Solomon Islands	17
4	Location map of some of the <i>WW II</i> wrecks in Iron Bottom Sound,	19
	Solomon Islands	

List of Tables

Table

1	Naval battles fought over Iron Bottom Sound, Solomon Islands <i>WW II</i>	10
2	Catalog of Japanese Naval vessels sunk during operation <i>Cactus</i> , Iron Bottom Sound, Solomon Islands, <i>WW II</i>	26
3	Catalog of US Naval vessels sunk during operation <i>Cactus</i> , Iron Bottom Sound, Solomon Islands, <i>WW II</i>	30
4	Details of New Zealand Naval vessel sunk during operation <i>Cactus</i> , Iron Bottom Sound, Solomon Islands, <i>WW II</i>	32
5	Details of Australian Naval vessel sunk during operation <i>Cactus</i> , Iron Bottom Sound, Solomon Islands, <i>WW II</i>	32
6	Total number of US and Japanese naval vessels damaged and sunk and plane losses, <i>WW II</i> , Iron Bottom Sound, Solomon Islands	33
7	Aircraft types used in <i>WW II</i> , Iron Bottom Sound, Solomon Islands	34
8	Comparative table of the main types of fighter airplane, <i>WW II</i> , Iron Bottom Sound, Solomon Islands	35

List of Plates

Plate

1	Oblique aerial view, looking southwest of Cape Esperance, Guadalcanal's northwest coast, Iron Bottom Sound	40
2	Oblique aerial view, looking east-northeast, of Henderson Field, Guadalcanal, October 1942	41
3	The <i>USS Chicago</i> , a few hours before it was destroyed in the Solomons	41
4	The <i>HM-NZS Tui</i> , a New Zealand Navy minesweeper used primarily in anti-submarine operations during the Guadalcanal offensive 1942-1943	42
5	Douglas, <i>SBD-5 Dauntless-Dive Bombers</i> in action	42
6	A squadron of Lockheed, <i>PV-1 Ventura</i> US fighter planes at Henderson Field, November 1942	43
7	<i>WW II</i> photograph of Henderson Field, December 1942, with a Grumman, <i>F4F-4 Wildcat</i> fighter	43
8	Night action off Savo Island, <i>1st Battle of Savo</i> , August 1942	44
9	Japanese tanks destroyed by US artillery on October 1942, Matanikau River mouth, and north coast of Guadalcanal Island, Iron Bottom Sound	44
10	Air attack over Iron Bottom Sound, by Mitsubishi, <i>G4M-1 Betty Bombers</i> , 8 th August 1942	45

11	An underwater photograph of a section of a battleship in Iron Bottom Sound	45
12	An underwater photograph of a section of a battleship in Iron Bottom Sound	46
13	A diver inspects a sunken <i>WW II</i> naval wreck off Guadalcanal shores	46
14	Divers inspect the cockpit and control column of a US <i>B-17E, Flying Fortress Bomber</i> aircraft destroyed in Iron Bottom Sound, 24 th September 1942	47
15	Underwater photograph of a section of an aircraft in Iron Bottom Sound	47
16	Underwater photograph of an aircraft in Iron Bottom Sound	48
17	Underwater photograph of a Japanese submarine in Iron Bottom Sound	48
18	Underwater photograph of a Mitsubishi, <i>A6M Zero-Sen Zeke</i> aircraft in Iron Bottom Sound	49
19	Underwater photograph of the cockpit area of a Grumman, <i>F4F-4 Wildcat</i> aircraft in Iron Bottom Sound	49
20	Underwater photograph of the cockpit of a Grumman, <i>F4F-4 Wildcat</i> aircraft in Iron Bottom Sound	50
21	Remains of a US <i>F4F-4 Wildcat</i> fighter plane at the Vilu Village War Museum, west of Honiara, Guadalcanal	50
22	The <i>Kinugawa Maru</i> , a beached Japanese Navy transport vessel on the shores of Gaudalcanal, 14 th October 1942	51
23	The <i>Hirokawa Maru</i> , a beached Japanese Navy transport vessel on the shores of Gaudalcanal, 14 th October 1942	51
24	Rifle ammunition on one of the Japanese transport vessels in coastal areas of Iron Bottom Sound, north Guadalcanal	52
25	Preparing to destroy remaining <i>WW II</i> explosives on the north shores of Guadalcalal, Iron Bottom Sound	52

Appendix

Terms of reference for the project and SOPAC/UNDP contract	53
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This is **SOPAC's Project SB 99.03** - Solomons Islands.

EXECUTIVE SUMMARY

The Solomon Islands Government (SIG) requested the South Pacific Applied Geoscience Commission (SOPAC) to conduct a contamination risk assessment study of *World War II* (WW II) sunken vessels/ships and aircraft in Iron Bottom Sound, Solomon Islands.

The study area is defined as the sea area which lies between lines of longitude 159° 43' E and 160° 25'E and between latitude of 8° 58' S, to the north of Iron Bottom Sound, and Guadalcanal Island, which lies to the south of Iron Bottom Sound. The area is about 3500 km².

The purpose of this study is to collate the existing/documentated information on the military vessels and aircraft which were sunk and destroyed in Iron Bottom Sound, Solomon Islands, and assess the possible risk of contamination to the coastal and marine environment in the area. This information will then be used to evaluate the possible environmental impacts of WW II military hardware and armoury on the natural and human environment and assist in the developing of optimum management strategies for utilisation of the said areas.

The duration of the project was four (4) months. The project began on 4th January, 1999 and ended on 15th May, 1999.

Information was collected from published/public information, from maps, atlases, charts, aerial photographs, books and journals held in international libraries and national archives.

The main tasks identified for this phase of the project:

- Compile as complete an inventory as possible, on the number of vessels, their location, type/s and probable cargo content, using data from as wide a variety of sources as possible.
- Develop a database, in computerised GIS, using MapInfo software, with overlays of vessel location, water depth and oceanographic conditions (where available), such as currents and water quality.
- Identify, from preliminary assessment, areas of potential environmental impact.
- Define a follow-up work program, as deemed necessary, for further field investigations of selected areas to assist in developing sustainable planning and management strategies for the coastal and marine areas.

Results of a contamination risk assessment study in Iron Bottom Sound have shown that:

- 111 Japanese, American and New Zealand naval vessels were destroyed and sunk.
- This comprises 65 Japanese, 44 American, 1 Australian and 1 New Zealand vessel.

In addition,

- 1450 fighter planes (1120 Japanese and 330 American) were destroyed and
- 15 000-20 000 military personnel were killed in the Sound.

Of 52 wrecks with known bathymetric locations,

- 10 are in water depth of less than 100 m;
- 8 in 100-500 m;
- 31 in 500-1000 m; and
- 3 in water greater than 1000 m deep.

Calculation of the volume/tonnage (T) of debris, which littered the seabed of the Sound, indicates a cumulative mass of 446 517 t of metal from the 111 sunken vessels. Of this,

- 321 822 is from the Japanese,
- 115 795 t from the American, and
- the remaining wrecks from the Australian and New Zealand vessels.

Investigations show that the shallow water wrecks are extremely corroded and are heavily colonised by benthic species, including corals, green, red and brown algae and other macro-benthic dwellers. For the deeper wrecks, corrosion does not appear to be as aggressive as for those wrecks in shallow water. This is largely due to less available oxygen in these deeper waters, in some cases, down to 1000-1200 m. As a result, these deeper wrecks are more intact than their shallow-water counterparts.

The specific cargo contents of the various military vehicles, which were part of the Guadalcanal Offence, are unknown. For the various armed forces which participated in the Guadalcanal campaign, several types of cargo were common. These include rifle ammunition, bombs, torpedoes, explosives, land and sea mines, naval artillery ammunition, engine and lubricating oils, diesel oil and other fuel.

Much of these cargo contents of the sunken vessels and aircraft were destroyed before and during sinking. Since many aircraft were shot down and ships were bombed or torpedoed, many of these military arsenals were set on fire and partly burnt at sea, before coming to rest in their watery grave. Consequently, much fuel, oil and explosives was destroyed in this process. However, some of this material may still be present in many of the deeper wrecks.

Divers on many of the shallow wrecks report oil and rifle ammunition on several of the shallow wrecks, while land-sea mine explosives have also been recovered and destroyed, on the same north coast of Guadalcanal.

The military hardware, munitions and possible fuel and oil from the various vessels represents possible contamination risk to natural communities. Sources of risk and pollutants include the leakage of oils and fuel, leaching of trace elements and heavy metals from paints, corroded aircraft and ships and munitions.

These represent a real source of pollution to the natural environment. To determine if these petroleum hydrocarbons and metals are affecting the biophysical environment requires analysis of water and sediment and possibly, toxicological tests, depending on the level of petroleum hydrocarbons in the local environment. Since these types of data are not available, further comments cannot be made at this time.

Based on the physical characteristics and the location and possible distribution of *WW II* wrecks in Iron Bottom Sound, further and detailed assessment of environmental impacts and contamination risk, especially specific risk, should incorporate additional environmental variables. These variables will assist in further understanding of wreck distribution and their possible levels of contamination to the coastal and marine environment.

Based on the available bathymetric distribution of some of the wrecks, and the relatively deep ocean in Iron Bottom sound, it is recommended that further studies be concentrated in the shallow nearshore/coastal areas. These areas, are the zones of high biological productivity and concentration of marine biota, including reef species. They are also the areas most assessable to people on the surrounding islands and the area in which human contact is the most frequent.

Further studies should include,

- further information on the location of nearshore wrecks, especially within the 100 m bathymetric contour, for which positions are unknown;

- identification of the areal distribution of nearshore wrecks by swath or sonar mapping;
- assessment of the nature of ecosystems in the above-mentioned nearshore areas; and
- assessment of the levels of contamination of nearshore water and sediments, by various trace and heavy metals and petroleum hydrocarbons (both dissolved and dispersed petroleum hydrocarbons) which may be leaching from nearshore vessels into the surrounding water masses and sediment.

The assessment of water and sediment chemistry parameters should utilise control stations, from which background/normal concentration of the various chemical parameters can be assessed. If this is not done, assessment of water and sediment contamination will be meaningless.

For sound environmental management of the nearshore and marine areas, and to facilitate a rational use of the nearshore resources of the area, the assessment of the above parameters should be done. Only then can optimum environmental management strategies be drafted and formulated for the study area.

1.0 INTRODUCTION

The Solomon Islands Government (SIG) requested the South Pacific Applied Geoscience Commission (SOPAC) to conduct a contamination risk assessment study of *World War II (WW II)* sunken vessels/ships and aircraft in Iron Bottom Sound, Solomon Islands.

The project was submitted by SIG to the United Nations Development Programme (UNDP), and accepted for funding by UNDP under its United Nations Office for Project Services (UNOPS), SOPAC being the implementing and executing agency.

The terms of reference for this project are contained in attachments to **UNDP Reference: INT/96/705/YX** and **Contract Number C-98-2250** (Appendix 1) and in SOPAC's 1999 work program, as **SOPAC Project SB 99.03**.

This document is the final project report for this study, highlighting data collected during two field visits, one to Honolulu, Hawaii from 8 to 17 January, 1999, and the other to Honiara, Solomon Islands, from 23 to 30 January 1999.

This report presents inventories of Japanese, American, Australian and New Zealand military vessels and ships sunk in Iron Bottom Sound. Aircraft types and number destroyed, a location map of wrecks with known positions and estimates of the total tonnage of metal which may have accumulated due to sinking of these vessels are also presented.

The report also presents in digital format (in *MapInfo GIS* and *MS Assess* software) data on the bathymetry/hydrography of Iron Bottom Sound, possible water circulation pattern, condition of the sunken vessels, possible contamination risk and environmental problems.

In addition, a proposal for further work is discussed, to assist in developing sustainable planning and management strategies for the coastal and marine areas in Iron Bottom Sound.

2.0 BACKGROUND AND STUDY AREA

2.1 Background

Many areas within the South Pacific were subject to intense military activity and battles during *WW II*, resulting in the sinking of numerous military ships, vessels and aircraft.

The Pacific Theatre, as the area was later described by the military of the day, was the stage for some of the most disastrous naval battles fought, to date. This includes the *Battle of Savo Island, August 7-9, 1942*, which has been described by military specialists as the worst U. S. Navy (Naval) defeat to date.

The Solomon Islands was one country where fighting, over several years, between the Allied Forces (USA, Australia and New Zealand, led by the Americans - The US Army, Navy and Marines) and the Japanese, saw the loss of numerous military ships and aircraft in marine and coastal waters.

Several of the battles fought in the Solomon Islands during *WW II*, between August and December 1942, were centred on Guadalcanal Island, in particular, Iron Bottom Sound.

In south-east Solomon Islands, on Guadalcanal Island and surrounding coastal and marine areas, some of the most intense military campaigns (code-named operation *Cactus* by the U. S. military) were fought. These were the *Battles of Savo Island, Cape Esperance, Guadalcanal I and II and the Battle of Tassafaronga*, also referred to in military books as the *Battles of Savo I, II, II, IV and V* (Table 1).

These battles were fought over five months, between August 7th, 1942 and December 1st 1942 (Table 1). This culminated in the defeat, and retreat of the Japanese, by Allied Forces in Solomon Islands and the South Pacific in February 1943.

A total of 188 minutes of intense military assault was launched during these five battles, with numerous losses to military personnel, defence aircraft, battleships and other naval hardware. All five battles were fought at sea and involved largely naval military. Consequently, most losses were in the coastal and marine areas between Guadalcanal Island and the Florida Islands, now referred to as Iron Bottom Sound.

The name, Iron Bottom Sound, was coined after *World War II*, following the sinking of numerous battleships, aircraft and other military iron hardware of *WW II* in the said marine area. It describes the watery graveyard of the numerous ‘iron’ wrecks which have accumulated in the Sound.

Table 1. Naval battles fought over Iron Bottom Sound, Solomon Islands WW II.

BATTLES FOUGHT	DATES	DURATION, mins
1 st Battle of Savo/Savo Island	42.8.7 - 42.8.8	45
2 nd Battle of Savo/Cape Esperance	42.10.11 - 42.10.12	31
3 rd Battle of Savo/Guadalcanal I	42.11.11 - 42.11.14	32
3 rd Battle of Savo/Guadalcanal II	42.11.14 - 42.11.15	51
4 th Battle of Savo/Tassafaronga	42.11.30 - 42.12.1	29
TOTAL	42.8.7 - 42.12.1	188 mins

For those military ships and aircraft which were sunk, little is known of about the total numbers, their location and cargo content at the time of sinking. In addition, the potential environmental risks posed by these wreckage to marine bio-diversity, commercial fishery resources, tourism, and other coastal and marine-based economic activities in Iron Bottom Sound is unknown.

The purpose of this study is to collate the existing/documented information on the military vessels and aircraft which were sunk and destroyed in Iron Bottom Sound, and assess the possible risk of contamination to the coastal and marine environment in the area.

This information will then be used to evaluate the possible environmental impacts of *WW II* military hardware and armour on the natural and human environment and assist in the developing of optimum management strategies for utilisation of the said areas.

2.2 The Study Area

The study area is Iron Bottom Sound (Figure 1), located north of Guadalcanal Island and south and west of Florida Islands. Savo Island lies in the mid-west of the study area and is a sub-aerial volcano.

The study area is defined as the sea area (coastal and marine areas) which lies between lines of longitude 159° 43' E and 160° 25'E, and between latitude 8° 58' S, and Guadalcanal Island, which lies to the south of Iron Bottom Sound. The sea area is about 3500 km².

3.0 DURATION OF THE PROJECT

The project duration was about four months. The project began on 4th January, 1999, and ended on 15th May, 1999 (**UNDP reference: INT/96/705/YX and Contract Number C-98-2250**; Appendix 1).

4.0 RESOURCE MATERIAL

Information was collected from published/public information, from maps, atlases, nautical charts (1942 - *WW II*), black and white aerial photographs, military books and journals held in international libraries and national archives.

These include military archives in the USA; Bishop Museum Hololulu and the University of Hawaii, Manoa USA; military departments in Tokyo, Japan; and information from the SIG, Honiara.

5.0 TASKS, METHODS AND TERMINOLOGY

5.1 Tasks

The following are the main tasks identified for this phase of the project:

- Compile as complete an inventory as possible, on the number of vessels, their location, type/s and probable cargo content, using data from as wide a variety of sources as possible.
- Develop a database, in computerised GIS, using MapInfo software, with overlays of vessel location, water depth and oceanographic conditions (where available), such as currents and water quality.



Figure 1. Location map of Solomon Islands and Iron Bottom Sound.

- Identify, from preliminary assessment, areas of potential environmental impact.
- Define a follow-up work program, as deemed necessary, for further field investigations of selected areas to assist in developing sustainable planning and management strategies for the coastal and marine areas.

5.2 Methods

Information was collected from several sources, during two field trips. One trip was made to Honolulu, Hawaii, from 8 to 17 January, 1999, and the other to Solomon Islands, from 23 to 30 January 1999.

Over eighty publications were reviewed. These are listed in the bibliography, Section 9.0 of this report. All references contained in this list were seen by the author and form the basis of this report.

In Fiji, publications were reviewed from the Pacific and Reference Collection, University of the South Pacific (USP) Main Library.

In Honolulu, information was collected from the Pacific Collection, Maps and Aerial Photograph Sections and General Map Collection of the Hamilton Library, University of Hawaii, Manoa. In addition, publications and aerial photos were reviewed at the Bishop Museum, Honolulu, and the Main Library, East-West Center, Honolulu.

In Honiara, Solomon Islands, information was obtained from the USP Centre; Chief Hydrographic Surveyor, Ministry of Land and Housing; the Visitors Bureau, Ministry of Tourism, SIG; the National Archives; and National Museum, SIG.

Publications were procured from several agencies in Japan. These represent the best sources of information for the Japanese military operations in Solomon Islands. All documents and records obtained were in Japanese and were translated by the author.

Agencies in Japan which were consulted are the Japan Mining Engineering Center for International Co-operation, Tokyo; The National Diet Library, Tokyo; the Military History Department, National Institute for Defence Studies, Tokyo; the Main Library, University of Tokyo, Tokyo; and The Main Library, Kyoto University, Kyoto.

Several publications and information were obtained from the United States Naval Institute (USNI), Maryland, U.S.A. (<http://www.usni.org>). E-mail address: ADBDPT@AOL.com. The USNI has published numerous accounts of military operations in the Pacific Theatre, WWII, in particular a number of well-referenced volumes on Guadalcanal (see Section 9.0 for reference to several of these volumes).

5.3 A Cautionary Note

It is noteworthy to mention that in collecting of the data for this project, it was found that there were several variations in the annals of war written by the Japanese, Americans and other military historians. This include information on the total number of vessels sunk, their location and possible final resting places and in some instances, the date some were sunk. In many cases, the search for documented information was almost analogous to looking for the proverbial needle in a haystack.

For this report, the records procured from the Japanese and American military are thought to be the most accurate of their respective operations during the military events which transpired in the Solomon Islands and the *Pacific Theatre* during *WW II*. Further, these records are thought to be superior to any others written on the subject.

In light of the above, the arduous reader is urged to use with caution, the tabulated results contained in this report.

This report is not intended as a field guide to sunken ships and military arsenal of Iron Bottom Sound, Guadalcanal, Solomon Islands.

5.4 Terminology

For the purpose of this study, the definition of risk is important, so as to sensitise the reader and the users of this report to the context in which it has been interpreted and used.

The perception of risk, by individuals, is influenced by a number of factors.

People perceive risks differently, depending on the likelihood of a hazard having adverse effects; how widespread, familiar, and dreaded the effects are; how a hazard affects individuals personally and whether they have agreed to bear the risks (Slovic, 1986).

For the purposes of this study and for clarity, the term risk is defined as follows:

- *Risk is defined as the possibility of suffering harm from a hazard.*
- *A hazard is a source of risk and refers to a substance or actions that can cause harm (Nathan and Bronstein, 1998).*

Risk assessment refers to the technical assessment of the nature and magnitude of risk (NRC, 1989). In the case of this study, it is the technical assessment of possible contamination of the natural environment by various materials degrading, leaching and being discharged from military hardware/armour in Iron Bottom Sound. The possible hazard in this case is the presence of *WW II* military hardware in Iron Bottom Sound.

Although risk analysis is sometimes used synonymously with risk assessment, it is used here to include methods of risk assessment, as well as methods to best use the resulting information and data.

6.0 RESULTS

6.1 Bathymetry and Hydrography of Iron Bottom Sound

The hydrography of the study area is taken from Hydrographer of the Navy (1989). Iron Bottom Sound represents an eastern extension of the New Georgia Sound and Central Solomon Trough (Figure 2). The Central Solomon Trough is a southeast-trending ocean trough, that can be traced further west to Bougainville and to the eastern part of the Solomon Islands. This area is a tectonically controlled fracture zone, and represents part of the plate boundary where the Indo-Australian and Pacific Plates meet.

Compressional and oblique forces affect this plate boundary in this part of the Pacific. The plate boundary here is a largely convergent margin of oceanic-oceanic lithosphere material. Consequently, the sea floor in this area and in Iron Bottom Sound is very narrow in comparison to its length, forming a classic ocean trough, with steep side slopes under deep ocean water (Figure 3).

The sea area of Iron Bottom Sound delineated for this study corresponds to an area 24 km wide in the east and 42 km wide in the west, giving it a funnel shape (Figure 3).

The Sound is about 80 km long along its main axis, which trends northwest.

The bathymetry of Iron Bottom Sound shows a generally cone-shaped morphology, with shallower areas in the east and deeper areas to the west. Consequently, there is a natural gradient and corresponding gravity flow of deep water to the west and northwest.

To the east, water depth varies between 50 and 90m in the shallow nearshore areas. These areas consist of numerous shoals and reef areas, both in Lengo Channel, north of Guadalcanal Island, and in Nggela Channel, to the immediate south of Nggela Pile in the Florida Islands Group (Figure 3). In addition, the southern side of the Sound is also shallow and is colonised by coral reef species, e.g. Plate 1*.

The shoals on the southern side of the Sound support several coral reefs and other benthic reef biota in the more photic zones (less than 30 m of water). Between these shallow areas, water depth increases sharply, down to 320-360 m, in the Sealark Channel, an eastnortheast-trending (075°) trench. Slope gradients across these deep areas are estimated to be greater than 10°. Slope is to the southwest/255°, in the Sealark Channel, with estimated gradient of 1°.

The western and central part of Iron Bottom Sound is significantly deeper, with only narrow sections of shallow coastal waters, averaging 0.5-1 km wide. Beyond 1 km from the Guadalcanal and Savo Island shores, slopes become progressively steeper, with water depths of up to 800 m in the central part of the Sound, and up to 1225 m to the northwest part of the Sound. In these areas, slope is also to the northwest (Figure 3). Estimated slope in the central and western part of the Sound varies between 0.8 and 1°.

Due to the natural gradient to the west and northwest, deep-water circulation will be significantly influenced by gravity, causing a predominant westerly flow. In shallower areas, like on the shoals north of Guadalcanal Island and Nggela Pile, in addition to tidal streams, predominant winds and waves, will influence flow. As a result of tidal variations, currents change directions with falling and rising tides, as shown by opposite arrows on the shoal areas in Figure 3. Bottom current flow of 2-3 knots (3.88-5.82 m s⁻¹) has been noted in these areas by hydrographic survey vessels (Hydrographer of the Navy, 1989 and Figure 3).

6.2 Military Vessels and Ships Sunk

Tables 2-5* present the results of the literature review and inventories of Japanese, American, Australian and New Zealand naval vessels which were destroyed and sunk in Iron bottom Sound.

Based on records reviewed,

- 65 Japanese;
- 44 America;
- one Australian and
- one (1) New Zealand vessel were sunk in the study area.

This gives a total of 111 naval vessels destroyed. In addition, 154 Japanese and 37 American vessels were damaged, contributing further wreckage to the already littered seabed (Table 6).

However, records obtained from the U. S. military, in particular data presented in Harms (1987), and written by the Commander in Chief of the Pacific Fleet, Admiral Chester W. Nimitz, dated 17th April 1943, indicates that 121-145 vessels were destroyed (Table 6) during the five battles fought in August-December 1942. The additional 10-34 naval vessels destroyed, as suggested by these records, are not known. In addition, the poor data quality and variations in available records by both the Japanese and Americans, as documented in various publications, do not facilitate any clarifications of this information.

*For Plates see from page 40 to page 52, and for Table 2 onwards see from page 25 to page 35

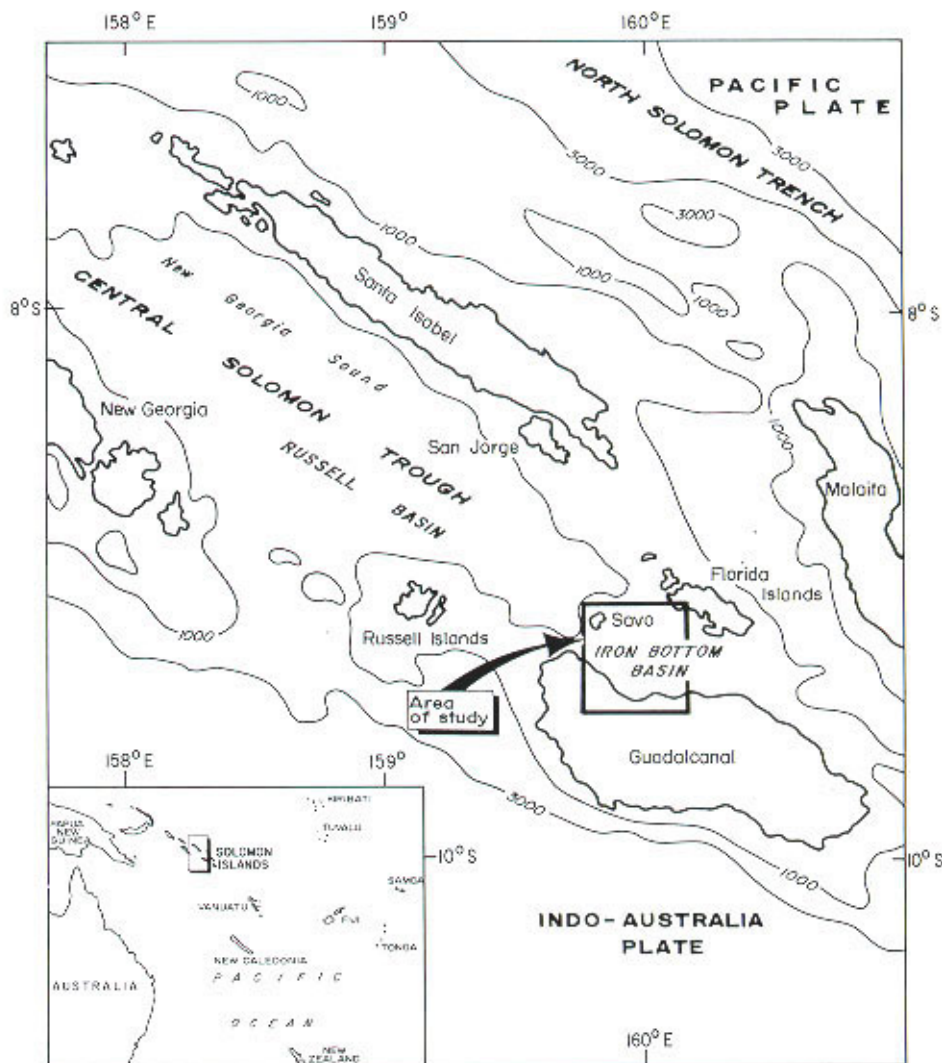


Figure 2. The regional hydrography of Iron Bottom Sound, Solomon Islands.

Japanese military records show that many additional naval vessels were destroyed during the “Solomon War” of 1942-1943. However, these records also indicate that the exact locations of these vessels are not known, while some give estimated locations out of the study area, at several degrees west and north from Iron Bottom Sound. It is the author’s opinion that any inclusion of these uncertain data be discouraged.

From the Japanese Navy (J), 65 vessels were sunk. These were:

- 21 destroyers (DD) (for abbreviations see next page);
- 3 heavy cruisers (CA);
- 2 battleships (BB);
- 6 submarines (JS);
- 5 transport vessels (AP/APD);
- 20 supply/transport vessels (JT);
- 1 landing tank (LST);
- 2 cargo ships (AK);
- 1 light cruiser (CL);
- 1 carrier (CV) and
- 2 craft of unknown designation (Table 2).

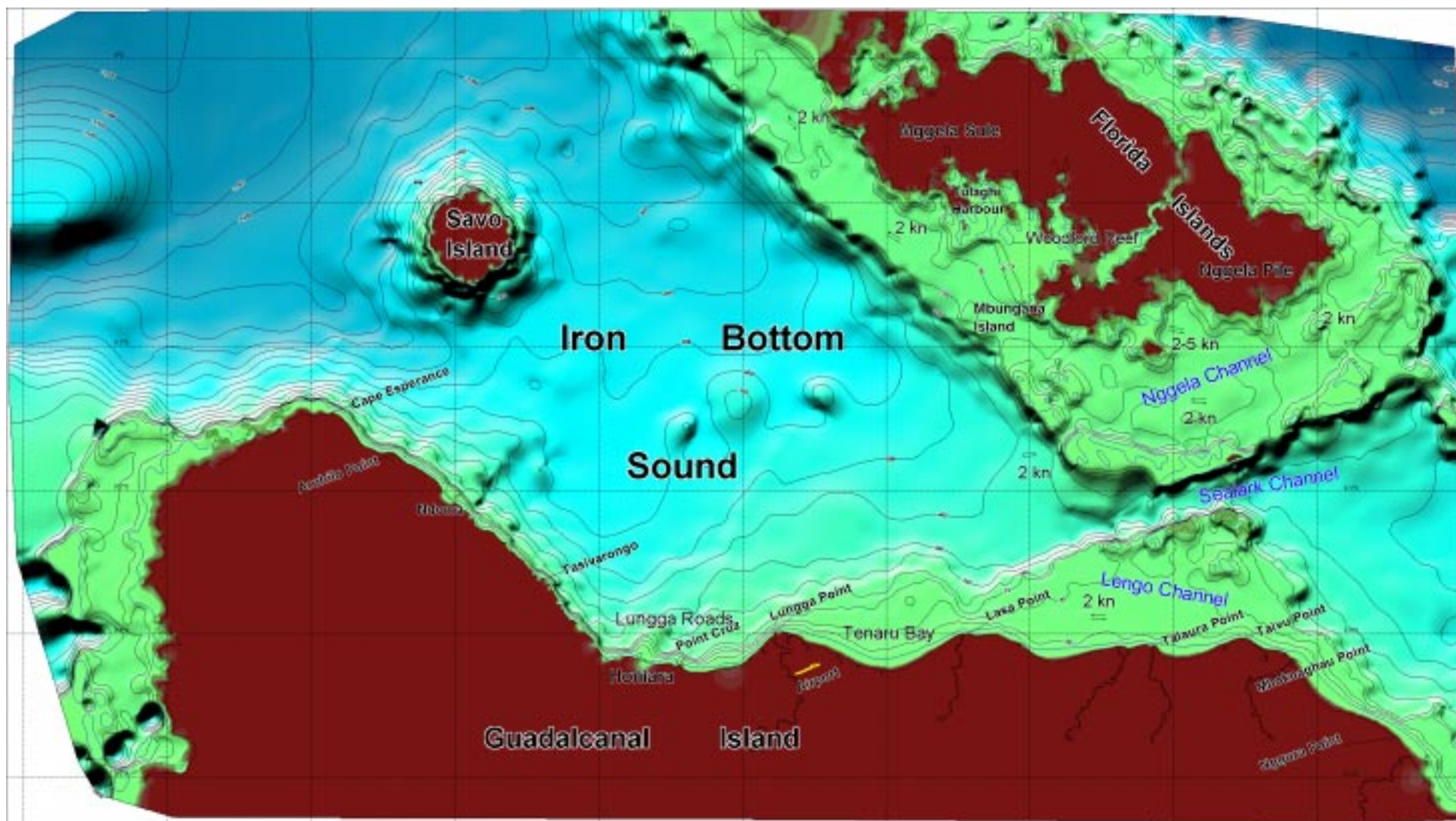


Figure 3. Bathymetry and hydrography of Iron Bottom Sound, Solomon Islands (extracted from Hydrographer of the Navy, 1989, Chart 1713, Scale 1:100,000 at latitude $9^{\circ} 15'$). All data shown were reduced to Chart datum, approximately the level of Lowest Astronomical Tide (LAT). The positions of this sheet were based on Directorate of Overseas Survey Datum (1960). Positions obtained using differential Global Positioning System (GPS), normally referred to as WGS (World Geodetic System) 84, should be adjusted as follows, to agree with the data on this chart: move 0.414' Northwards and 0.061' Westwards (Kevin Dixon, Chief Geodetic Surveyor, U.K. Hydrographic Office, personal communication).

From the US Navy (US), 44 vessels were sunk. These were,

- 20 destroyers (DD);
- 8 heavy cruisers (CA);
- 8 transport vessels (AP/APD);
- 1 tug;
- 1 light cruiser (CL) and
- 6 patrol vessels (PT) (Table 3).

One heavy cruiser (CA) from the Royal Australian Navy (RAN) the *HMS Canberra*, and one mine-sweeper, from New Zealand (NZ) *Moa*, were also sunk (Tables 4 and 5).

From the records presented in Tables 2-5, vessels sunk comprise

- 44 destroyers (DD);
- 12 heavy cruisers (CA);
- 2 battleships (BB);
- 6 Japanese submarines (JS);
- 13 transport vessels (AP/APD);
- 20 Japanese transport (JT);
- 1 landing tank (LST);
- 2 cargo ships (AK);
- 1 light cruiser (CL);
- 1 carrier (CV);
- 1 tug;
- 1 mine sweeper and
- 2 unknown naval vessels.

The summary presented in Table 6 and extracted from Harms (1987) shows some variations from the above figures. This table shows a larger number of Japanese vessels and a smaller number of American vessels sunk in Iron Bottom Sound. At this point, data are not available for clarification of this aspect.

Figure 4 shows the location of some of the Japanese and American vessels sunk in the study area. Only those vessels for which good-quality location data exist are shown here. Since the latitude and longitude of most of the vessels destroyed are not known, their positions cannot be plotted on a map.

Analysis of the data presented in Tables 2-5 and Figure 4 shows that of vessels for which bathymetric records are available (52), most are found in water depth greater than 100 m (42 or about 80% of the total for which depth are known). These are as follows:

- 10 vessels in 0-100 m depth of water, of which 5 were beached,
- 8 vessels at 100-500 m,
- 31 vessels 500-1000 m and
- 3 vessels in water depths greater than 1000 m.

6.3 Aircraft Destroyed

Tables 7 and 8 present lists of the various aircraft used by the military in the five Guadalcanal battles fought from August 7th to December 1st 1942.



Figure 4. Location map of some of the WW II wrecks in Iron Bottom Sound, Solomon Islands.

Records obtained from the U. S. military, in particular data presented in Harms (1987), and written by the Commander in Chief of the Pacific Fleet, Admiral Chester W. Nimitz, dated 17th April 1943, indicate that 330 American and 1120 Japanese planes were shot down in the study area (Table 7). This gives a total of 1450.

Most of these were shot down over Iron Bottom Sound. However, the locations of these military aircraft are not known.

6.4 Volume/Tonnage of Wreck

Of the 111 vessels which are tabulated in Tables 2-5, 66 have tonnage information (T = short tons). These records are more complete for the Japanese Navy vessels than the American Navy.

Fifty-six of the 65 Japanese vessels have tonnage records. For the tonnage indicated in Table 2, their cumulative weight is 292 463 T. For the American vessels, 10 of which have tonnage records, their cumulative weight is 60 615 T. This gives a sub-total of 353 078 T of metal wreck.

For the remainder of the Japanese and American vessels which have no tonnage data, estimates were made, using averages from vessels of similar class/category.

For the Japanese Navy the following was obtained:

➤ 1 class/category CA vessel @ 7100 T	7100 T
➤ 1 class/category CL vessel @ 1800 T	1800 T
➤ 3 class/category JS vessel @ 1953 T	1953 T
➤ 1 class/category DD vessel @ 1800 T	1800 T
➤ 1 class/category CV vessel @ 1800 T	1800 T
➤ 2 class/category CT vessel @ 5500 T	11 000 T

This gives a total of nine Japanese vessels, with a sub-total of 29 359 T.

For the American Navy (USN) the following was obtained:

➤ 4 class/category PT vessel @ 45 T	180 T
➤ 1 class/category CL vessel @ 1800 T	1800 T
➤ 2 class/category CA vessel @ 7100 T	14 200 T
➤ 6 class/category AP vessel @ 200 T	1200 T
➤ 21 class/category DD vessel @ 1800 T	37 800 T

This gives a total of 34 USN vessels, with a sub-total of 55 180 T.

In addition, the one RAN and one NZ vessel are estimated to have weights of 7100 T and 1800 T respectively.

The total estimated tonnage for the additional 45 vessels is 93 439 T. This gives a total tonnage of metal wreck, for the 111 naval vessels, of 446 517 T.

6.4 Lives Lost

In addition to the metal/iron wrecks sunk in Iron Bottom Sound, thousands of soldiers were killed while fighting. These represent an additional contribution to the seabed carnage of the area.

Data presented in Harms (1987), and written by the Commander in Chief of the Pacific Fleet, Admiral Chester W. Nimitz, dated 17th April 1943, indicated that over 35,000 lives were lost during the battles which were fought between August-December 1942. These records also indicate that 15,000-20,000 lives were lost at sea, in Iron Bottom Sound.

6.5 Archival Photographs and Condition of Submerged Wrecks

Plates 2-25 show typical examples of *WW II* and recent photographs of military operations, vessels and aircraft from Iron Bottom Sound, Solomon Islands.

Plates 3 and 4 show examples of typical destroyers and navy mine-sweepers which fought in the naval battles of Guadalcanal. Plates 5-7 show examples of airforce fighter planes, from the Pacific Ocean command of the US airforce, 1942. Plate 21 show an example of a US *F4F-4* Wildcat fighter on Guadalcanal. Typical scenes of naval and air attack are shown in Plates 8-10.

The condition of most wrecks in Iron Bottom Sound is yet unknown. Professional and amateur divers alike have inspected the shallow wrecks. In addition, at least a dozen of the deep water wrecks were surveyed by Robert Ballard, in 1992, using underwater video photography and two ROV (remotely operated vehicle), the *Sea Cliff* and the *Scorpio*, both developed for deep sea exploration.

These investigations show that the shallow water wrecks are extremely corroded and are heavily colonised by benthic species, including corals, green, red and brown algae and other macro-benthic dwellers. Typical examples of these encrustation and colonisation of wreck debris are shown in Plates 11-20 and Plate 24. In addition, sections of many wrecks are fragile and falling apart due to aggressive corrosion in sea water. Many of these wrecks serve as FADS (fish aggregating devices), also serving to increase the biological productivity of the local area. In addition, they attract a considerable number of sport and professional divers each year.

Divers on many of the shallow wrecks also report seeing oil escaping from several of these wrecks, in particular the *Hirokawa Maru* and *Kinugawa Maru* (Plates 22 and 23 respectively). For these particular wrecks, which are both lying right way up, there may still be oil and fuel inside the vessel. In addition, other similar vessels, which were not completely destroyed and were sunk, may also contain fuel and oil.

For the deeper wrecks for which some limited data exists, corrosion does not appear to be as aggressive, as for those wrecks closer to shore and in shallow water. This is largely due to less available oxygen in these deeper water, and less corrosion of these deep wrecks, in some cases, down to 1000-1200m. As a result, these deeper wrecks are more intact than their shallow water counterpart. This suggests that some of the contents of these vessels may also still be aboard, less those which may have burnt before sinking and which may have gone afloat or transported out of the vessels by strong, deep water currents.

The relatively sediment free nature of the surface of these deep water wrecks suggests that these sites are well flushed by bottom currents. In addition, the growth of several macro-benthic biota also suggest good circulation and available oxygen.

6.6 Cargo Contents

The specific cargo contents of the various military, which were part of the Guadalcanal Offence, are unknown. For the various navies and armed forces which participated in the Guadalcanal campaign, several types of cargo were common. These include, but are not limited to:

- Rifle ammunition,
- Aircraft bombs,
- Torpedoes,
- Explosives,
- Land and sea mine explosives,
- Naval artillery ammunition,
- Engine and lubricating oils,
- Diesel,
- Fuel,

Much of these cargo contents of the sunken vessels and aircraft were destroyed before and during sinking. Since many aircraft were shot down and ships were bombed or torpedoed, many of these military arsenal were set on fire and partly burnt at sea, before coming to rest in their watery grave. Consequently, much fuel, oil and explosives were destroyed in this process. However, some of this material may still be present in many of the deeper wrecks.

Divers on many of the shallow wrecks report oil escaping from several of these wrecks, in particular the *Hirokawa Maru* and *Kinugawa Maru* (Plates 22 and 23 respectively). Other vessels, which were not completely destroyed may also contain fuel and oil.

Divers have also noted rifle ammunition on several of the shallow wrecks, off the north coast of Guadalcanal, e.g. Plate 24. In addition, land-sea mine explosives have also be recovered and destroyed, by Solomon Island Police, on the same north coast of Guadalcanal, bordering Iron Bottom Sound (Plate 25). The volume of these munitions nor are their real distribution are known. Consequently, further comments are not possible at this time.

6.6 Possible Environmental Impacts

The presence of any foreign substance in the marine and coastal environment can pose a threat to natural ecosystems. In the case of Iron Bottom Sound, the presence of military hardware, munitions and possible fuel and oil from the various vessels represent possible contamination risk to natural communities.

To identify the real risk however, requires further information on the real distribution of the various hazards (the source of risk), in this case, the military arsenal and their contents. Without information on these parameters, it is not possible to clarify the perceived risk and quantify the real risk to the natural systems and human communities. Without such data, only general comments can be made.

Sources of risk and pollutants include:

- The leakage of oils and fuel,
- The leaching of trace elements and heavy metals from corroded aircrafts and ship's,
- The leaching of paints from aircrafts and ship's and
- The leaching of metals from munition.

These represent a real source of pollution to the natural environment. To determine if these petroleum hydrocarbons and metals are affecting the biophysical environment, requires analysis of water and sediment chemistry and possibly, toxicological tests, depending on the level of petroleum hydrocarbons in the local environment. Of course, these analytical data must be compared with background levels of hydrocarbon and metals, from control stations, in the coastal and marine environments, to determine if the present levels are higher or lower than normal background levels. Only then can this type of analysis be meaningful.

Since these types of data are not available, further comments cannot be made at this time. Speculation on possible environmental impacts and problems should not be encouraged, as impacts (both positive and negative) are site specific and are dependent on the local environmental conditions.

7.0 CONCLUSIONS

Results of a contamination risk assessment study in Iron Bottom Sound have shown that 111 Japanese, American and New Zealand naval vessels were destroyed and sunk in Iron Bottom Sound. These include 65 Japanese, 44 American, 1 Australian and 1 New Zealand vessel. In addition, 1450 fighter planes and bombers (1120 Japanese and 330 American) were also shot down, while 15,000-20,000 military personnel were killed and were sunk in the Sound.

Of the 52 wrecks with known locations,

- 10 are in water depth of less than 100 m,
- 8 in 100-500 m;
- 31 in 500-1000 m; and
- 3 in water greater than 1000 m deep.

Calculation of the volume/tonnage (T = short tons) of debris, which littered the seabed of the Sound, indicates a cumulative volume of 446,517 T of metal from the 111 sunken vessels. Of this,

- 321,822 T are from the Japanese,
- 115,795 T from the American,
- the remaining wrecks from the Australian and New Zealand vessels.

Investigations show that the shallow water wrecks are extremely corroded and are heavily colonised by benthic species, including corals, green, red and brown algae and other macro-benthic dwellers. For the deeper wrecks, corrosion does not appear to be as aggressive, as for those wrecks in shallow water. This is largely due to less available oxygen in these deeper water, in some cases, down to 1000-1200 m. As a result, these deeper wrecks are more intact than their shallow water counterpart.

The specific cargo contents of the various military, which were part of the Guadalcanal Offence, are unknown. For the various armed forces which participated in the Guadalcanal campaign, several types of cargo were common. These include rifle ammunition, bombs, torpedoes, explosives, land and sea mines, naval artillery ammunition, engine and lubricating oils, diesel and fuel.

Much of these cargo contents of the sunken vessels and aircraft was destroyed before and during sinking. Since many aircraft were shot down and ships were bombed or torpedoed, much of the military arsenal was set on fire and partly burnt at sea, before coming to rest in their watery grave. Consequently, much fuel, oil and explosives was destroyed in this process. However, some of this material may still be present in many of the deeper wrecks.

Divers on many of the shallow wrecks report oil and rifle ammunition on several of the shallow wrecks while, land-sea mine explosives have also been recovered and destroyed, on the same north coast of Guadalcanal.

The presence of military hardware, munitions and possible fuel and oil from the various vessels represent possible contamination risk to natural communities. Sources of risk and pollutants include, the leakage of oils and fuel, leaching of trace elements and heavy metals from paints, corroded aircraft's and ship's and munition.

These represent a real source of pollution to the natural environment. To determine if these petroleum hydrocarbons and metals are affecting the biophysical environment, requires analysis of water and sediment chemistry and possibly, toxicological tests, depending on the level of petroleum hydrocarbons in the local environment. Since these types of data are not available, further comments cannot be made at this time.

8.0 RECOMMENDATIONS

Based on the physical characteristics and the location and possible distribution of *WW II* wrecks in Iron Bottom Sound, further and detailed assessment of environmental impacts and contamination risk, especially specific risk, should incorporate additional environmental variables. These variables will assist in further understanding of wreck distribution and their possible levels of contamination to the coastal and marine environment.

Based on the available bathymetric distribution of some of the wrecks, and the relatively deep ocean in Iron Bottom sound, it is recommended that further studies be concentrated in the shallow nearshore/coastal areas. These areas are the zones of high biological productivity, and concentration of marine biota, including reef species. It is also the area the most assessable to people on the surrounding islands and the areas in which human contact is the most frequent.

Further studies should include,

- further information on the location of nearshore wrecks, especially within the 100m bathymetric contour, for which positions are unknown;
- identification of the aerial distribution of nearshore wrecks by swath or sonar mapping;
- assessment of the nature of ecosystems in the above mentioned nearshore areas;
- assessment of the levels of contamination of nearshore water and sediments, by various trace and heavy metals and petroleum hydrocarbons (both dissolved and dispersed petroleum hydrocarbons) which may be leaching from nearshore vessels into the surrounding water masses and sediment;
- the assessment of water and sediment chemistry parameters should utilise control stations, from which background/normal concentration of the various chemical parameters can be assessed. If this is not done, assessment of water and sediment contamination will be meaningless.

For sound environmental management of the nearshore and marine areas and to facilitate a rational use of the nearshore resources of the area, the assessment of the above parameters should be done. Only then can optimum environmental management strategies be drafted and formulated for the study area.

Abbreviations used for the various classes of vessels listed in Tables 2 – 6

➤ <i>AK</i>	CARGO SHIP
➤ <i>AP</i>	TRANSPORT VESSEL
➤ <i>APA</i>	TRANSPORT ATTACK VESSEL
➤ <i>APD</i>	HIGH SPEED TRANSPORT VESSEL
➤ <i>BB</i>	BATTLESHIP
➤ <i>CA</i>	HEAVY CRUISER
➤ <i>CL</i>	LIGHT CRUISER
➤ <i>CV</i>	CARRIER
➤ <i>DD</i>	DESTROYER
➤ <i>JN</i>	JAPANESE NAVY
➤ <i>JS</i>	JAPANESE SUBMARINE
➤ <i>JT</i>	JAPANESE TRANSPORT VESSEL
➤ <i>MN</i>	MINESWEEPER
➤ <i>PT</i>	PATROL VESSEL
➤ <i>RAN</i>	ROYAL AUSTRALIAN NAVY
➤ <i>SS</i>	AMERICAN SUBMARINE
➤ <i>USN</i>	UNITED STATES
➤ <i>LST</i>	LANDING SUBMERSIBLE TANK
➤ <i>NZ</i>	NEW ZEALAND

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Table 2. Catalog of Japanese Naval vessels sunk during operation Cactus, Iron Bottom Sound, Solomon Islands, WW II.

ENTRY CODE	NAME	CLASS OF VESSEL	OWNER	TONNAGE	DATE DESTROYED	CAUSE OF SINKING	AREA	LATITUDE	LONGITUDE	WATER DEPTH, m	REMARKS
J1	Hubuki	DD	JN	1700-2090T	42.10.11	Air Attack	NW Savo Is.	9° 0'S	159°50'E	1300	SE of Savo Island
J2	Hurutaka	CA	JN	7100T	42.10.12	Air Attack	NW Savo Is.	9° 0'S	159°40'E	1300	
J3	Murakumo	DD	JN	1700-2090T	42.10.12	Air attack		?	?		
J4	Natsukumo	DD	JN	1500-2370T	42.10.12	Air attack	W Savo Is.	?	?	800	
J5	Hiei	BB	JN	32 510T	42.11.13	Torpedo Air Attack	NW Savo Is.	?	?	800	
J6	Akatsuki	DD	JN	1700-1980T	42.11.13	Air attack	Iron Bottom Sound	9° 10"S	159° 0'E	800	
J7	Yudachi	DD	JN	1368-1980T	42.11.13	Air and sea attack	NE Cape Esperance	?	?	800	
J8	Kirishima	BB	JN	32 156T	42.11.14 or 15?	Air and sea attack	NW Savo Is.	?	?	680+	
J9	Kinugasa	CA	JN	7100T	42.11.14		?	?	?	800	
J10	Ayanami	DD	JN	1950-2090T	42.11.14	Air and sea attack	Iron Bottom Sound	?	?	800.	
J11	Takanami	DD	JN	2040-2520T	42.11.30	Air attack	Tasivarongo Pt	?	?	800	
J12	I 3	JS	JN	1955T	42.12.9 or 10?	Torpedo	Cape Esperance	?	?	500	
J13	Terutsuki	DD	JN	2700-3700T	42.12.11	PT Boat	NE Cape Esperance	?	?	500+	
J14	I 15	JS	JN	1950T	42.11.10 or 16?	Sea attack	W of Savo	9° 10'S	159° 30'E	360	
J15	I 1	JS	JN	1850-1955T	43.1.20	Sea attack	Cape Esperance	?	?		
J16	Makikumo	DD	JN	2040T	43.2.1	Sea attack	Doma Cove	?	?	20	
J17	Kikuzuki	DD	JN	1772T	42.5.5	Air attack	Tulagi	?	?		

Continuation Risk Assessment, Iron Bottom Sound, Solomon Islands

ENTRY CODE	NAME	CLASS OF VESSEL	OWNER	TONNAGE	DATE DESTROYED	CAUSE OF SINKING	AREA	LATITUDE	LONGITUDE	WATER DEPTH, m	REMARKS
J18	Sotoku 1	?	JN	215T	?	Air and sea attack	Iron Bottom Sound	?	?	Less than 100	
J19	Sotoku 2	?	JN	215T	42.5.4	Air and sea attack	Iron Bottom Sound	?	?		
J20	Kikutsuki	DD	JN	1350T	?	Air and sea attack	Woodford Reef	?	?		
J21	Tamamaru	AP	JN	265T	42.5.4	Air attack ran aground	Woodford Reef	90°, 0" S ??	160° 0" E?		
J22	AP 13	AP	JN	11 773T	?	Air and sea attack	SE of Tulagi	W. of Mbungana Is.	?		
J23	APA 23	APA	JN	15 420T	?	Air and sea attack	NE Guadalcanal	?	?		
J24	DD 483	DD	JN	1850T	?	Air and sea attack	SW of Tulagi	?	?		
J25	AO 1	?	JN	4990T	?	Air and sea attack	SW of Tulagi	?	?		
J26	Keijomaru	AP	JT	200T	?	Air and sea attack	SW of Tulagi	?	?		
J27	DD 387	DD	JN	1500T	?	Air and sea attack	Iron Bottom Sound	?	?		
J28	DD 393	DD	JN	1500T	?	Sea attack	Iron Bottom Sound	?	?	1000 m	
J29	DD 469	DD	JN	1570T	43.2.1	Sea attack	ESE Savo Is.	9° 09'S	159° 32'E		
J30	Kinugawamaru	JT	JN	6936T	42.10.14	Air attack ran aground	Cape Esperance	9° 20'S	159° 50'E		
J31	Shimanami	DD	JN	2040T	?	Sea attack	Iron Bottom Sound	?	?		
J32	Makigumo	DD	JN	2550-2040T	42.1.1	Mine	SE Aruhilo Pt	?	?		

ENTRY CODE	NAME	CLASS OF VESSEL	OWNER	TONNAGE	DATE DESTROYED	CAUSE OF SINKING	AREA	LATITUDE	LONGITUDE	WATER DEPTH, m	REMARKS
J33	Yamauramaru	JT	JN	6797T	42.10.14	Air attack ran aground	NN Tasivarongo. Pt	9° 20'S	159° 50'E	Beached	
J34	Hirokawamaru	JT	JN	6872T	42.10.14	Air attack ran aground	SE Tasivarongo Pt	9° 20'S	159° 50'E	Beached	
J35	Kyushumaru	JT	JN	8666T	42.10.14	Air attack ran aground	SE Tasivarongo Pt	?	?	Beached	
J36	APD 2	APD	JN	1400T			NW Lungga Pt	?	?		
J37	LST 340	LST	JN	1490T			Tenaru Bay	?	?		
J38	AK 23	AK	JN	4023T			N. Lungga Pt.	?	?		
J39	AK 76	AK	JN	4023T			N. Lungga Pt.		?		
J40	Nankaimaru	JT	JN	9300T	42.10.14	Air attack ran aground	Tasivarongo Pt	?	?		Exact location unknown
J41	Sassgomaru	JT	JN	9258T	42.10.14	Air attack ran aground	Tasivarongo Pt	9°, 30"S	160°, 0"E		Exact location unknown
J42	Nakomaru	JT	JN	7145T	42.10.14	Air attack ran aground	Tasivarongo Pt	8°, 58"S	159°, 6"E		Exact location unknown
J43	Yamakukimaru	JT	JN	6438T	42.10.14	Air attack, ran aground	Tasivarongo Pt	9° 20"S	159° 50"E		Exact location unknown
J44	Terutsuki	DD	JN	2040T				?	?		Exact location unknown
J45	Azumayamamaru	JT	JN	6645T	42.10.14	Air attack ran aground	Tasivarongo Pt	?	?		Exact location unknown
J46	Keijomal	JT	JN	2626T	42.6.21	Air attack S-44 & 55 – 155		9° 0"S	160° 0"E		Exact location unknown
J47	Tenzanmaru	JT	JN	2775T	42.7.8	Air attack S-37 & 55 – 132		?	?		
J48	Senkaimaru	JT	JN	2103T	42.10.7	Amberjack (air) 55 – 219		?	?		Exact location unknown

ENTRY CODE	NAME	CLASS OF VESSEL	OWNER	TONNAGE	DATE DESTROYED	CAUSE OF SINKING	AREA	LATITUDE	LONGITUDE	WATER DEPTH, m	REMARKS
J49	Shiroganemaru	JT	JN	3630T	42.9.19	Amberjack (air) 55 – 219		6°, 25'–30"S	156°, 5' – 20"E		Exact location unknown
J50	Arizonamaru	JT	JN	9683T	42.11.14	Air attack ran aground	Tasivarongo Pt	?	?	800	Exact location unknown
J51	Shinanogawamaru	JT	JN	7504T	42.11.14	Air attack ran aground	Tasivarongo Pt	?	?		Exact location unknown
J52	Nagaramaru	JT	JN	7145T	42.11.14	Air attack ran aground	Tasivarongo Pt	?	?		Exact location unknown
J53	Furutaka	CA	JN		42.9.11	Air attack	Savo Is	?	?		
J54	Yura	CL	JN		42.9.25	Air attack	Guadalcanal	?	?		Exact location unknown
J55	I 23	JS	JN				Cape Esperane	?	?	500+	Exact location unknown
J56	Shirakuno	DD	JN		42.10.11	Sea attack	Savo Is.	?	?		Exact location unknown
J57	Ryujo	CV	JN		42.8.24	Air attack		?	?		Exact location unknown
J58	Shirayuki	DD	JN	2090T	42.10.11	Sea attack	Savo Is.	?	?		
J59	I 123	JS	JN		42.08.28	Sea attack	E. Savo Is	?	?	800	Exact location unknown
J60	Kumagawamaru	JT	JN		42.11.14	Sea attack	Iron Bottom Sound	?	?	800	
J61	Sadomaru	JT	JN	9246T	42.11.14	Sea attack	Iron Bottom Sound	?	?	800	
J62	Canberramaru	JT	JN	6477T	42.11.14	Sea attack	Iron Bottom Sound	?	?	800	
J63	I 29	JS	JN		43.1.29	Sea attack	Cape Esperance	?	?	800	
J64	Brisbaremaru	JT	JN	5425T	42.11.14	Sea attack	Iron Bottom Sound	?	?	800	
J65	Azumasanmaru	JT	JN		42.11.14	Sea attack	Iron Bottom Sound	9° 25'S	159° 59'E	Beached	Beached

Table 3. Catalog of US Naval vessels sunk during operation Cactus, Iron Bottom Sound, Solomon Islands, WW II.

ENTRY CODE	NAME	CLASS OF VESSEL	OWNER	TONNAGE	DATE DESTROYED	CAUSE OF SINKING	AREA	LATITUDE	LONGITUDE	WATER DEPTH (m)	REMARKS
US1	PT 37	PT	USN		43.2.1		NW Savo Is.	?	?		
US2	PT 111	PT	USN		43.2.1		NW Savo Is.	?	?		
US3	PT 44	PT	USN				SW Savo Is.	?	?	800+	Exact position unknown
US4	PT 112	PT	USN	45T			Cape Esperance	?	?	300+	Exact position unknown
US5	PT 43	PT	USN	45T			Cape Esperance	?	?	250+	Exact position unknown
US6	APD 3	APD	USN	1400T			Iron Bottom Sound	?	?		
US7	APD 4	APD	USN	400T			Iron Bottom Sound	9°20'S	160°01'E	400	Lungga
US8	Vincennes	CA	USN	9400T	42.8.9		Iron Bottom Sound	?	?	800+	
US9	Quincy	CA	USN	9375T	42.8.9		Iron Bottom Sound	?	?	500+	
US10	Astoria	CA	USN	9950T	42.8.9		Iron Bottom Sound	?	?	400 to 800	
US11	Northhaupton	CA	USN	11 000T	42.11.30	Torpedo	Iron Bottom Sound	?	?	800+	
US12	Atlanta	CA	USN	10 000T	42.11.13		N. of pt. Cruz	?	?	100-125	
US13	Juneau	CA	USN	10 000T	42.11.13	Submarine attack	N. of pt. Cruz	?	?	680+800	
US14	Helena	CL	USN		42.11.13	Torpedo	Kula	9° 12'S	159° 52'E	800+	
US15	G.F.I.Riot	CA	USN					?	?		
US16	Arukiba	AP	USN					?	?		
US17	Seren	AP	USN					?	?		
US18	Jarvis	DD	USN		42.8.9	Air attack	Tulagi	?	?		
US19	Helm	DD	USN		42.8.9	Air attack	Savo Is.	?	?		Location Unknown
US20	Wilson	DD	USN		42.8.9	Air attack	Savo Is.	?	?		Location Unknown
US21	Duncan	CA	USN		42.10.12	Torpedo/Air	Esperance	?	?		Location Unknown
US22	Barton	DD	USN		42.11.13	Torpedo	Guadalcanal	?	?	800	Location Unknown

ENTRY CODE	NAME	CLASS OF VESSEL	OWNER	TONNAGE	DATE DESTROYED	CAUSE OF SINKING	AREA	LATITUDE	LONGITUDE	WATER DEPTH (m)	REMARKS
US23	Cushing (1)	DD	USN	USN	42.11.13	Air attack	Guadalcanal	?	?		Location Unknown
US24	Laffey (1)	DD	USN		42.11.13	Torpedo	Guadalcanal	?	?	800	Location Unknown
US25	Monsen (1)	DD	USN		42.11.13	Sea attack	Guadalcanal	?	?	800	Location Unknown
US26	Preston (1)	DD	USN		42.11.1	Air attack	Guadalcanal	NE Cape Esperance		600 - 800	Location Unknown
US27	Benham	DD	USN		42.11.15	Air & Sea attack	Guadalcanal	?	?	800	Location Unknown
US28	Meredith	DD	USN		42.10.15	Air attack	Guadalcanal	?	?		Location Unknown
US29	Walke (1)	DD	USN		42.11.15	Air attack	Guadalcanal	?	?	800	Location Unknown
US30	Dehaven (1)	DD	USN		43.2.1	Air attack	S. Savo Is.	?	?		
US31	Bruno	DD						?	?		
US32	Colhoun (1) APD	DD			42.8.30	Air attack	Guadalcanal	?	?		
US33	Gregory (1)APD	DD	USN		42.9.5	Air attack	Off Lungga	9°20'S	160°01'E	400	
US34	Little (1) APD		DD			42.9.5	Air attack	Guadalcanal	?	?	
US35	John Penn	APA	USN		43.8.13	Air attack	Tenaru Bay	9° 23'S	160° 30'E	450	
US36	Canea	AP	USN					?	?		
US37	Seminole	Tug	USN					?	?		
US38	Blue (1)	DD	USN		42.8.22	Air attack	Tulagi	9° 17'S	160° 02'E	500	Iron Bottom Sound
US39	Aaron Ward (1)	DD	USN		43.4.7	Air attack	Lungga	?	?		
US40	AP 13	AP	USN					?	?		
US41	Sesinor	DD	USN					?	?		Location Unknown
US42	Chicago	CA/DD	USN		43.1.30	Air attack		11°25'S	160°56'E		Rennell Is.
US43	Gulboun	APD	USN		42.08.30		Lunga	9°24'S	160°01'E	50	
US44	PT123	PT	USN		43.2.1	Sea attack	Iron Bottom Sound	?	?		

Table 4. Details of New Zealand Naval vessel sunk during operation Cactus, Iron Bottom Sound, Solomon Islands, WW II.

ENTRY CODE	NAME	CLASS OF VESSEL	OWNER	TONNAGE	DATE DESTROYED	CAUSE OF SINKING	AREA	LATITUDE	LONGITUDE	WATER DEPTH (m)	REMARKS
NZ1	Moa	MN	NZ	?	?	Sea attack	Tulagi?	?	?	50-60	Exact location unknown

Table 5. Details of Australian Naval vessel sunk during operation Cactus, Iron Bottom Sound, Solomon Islands, WW II.

ENTRY CODE	NAME	CLASS OF VESSEL	OWNER	TONNAGE	DATE DESTROYED	CAUSE OF SINKING	AREA	LATITUDE	LONGITUDE	WATER DEPTH (m)	REMARKS
RAN 1	Canberra	CA	RAN	?	42.8.9	Sea attack	SE of Savo Is.	?	?	650-750 m	Exact location unknown

Table 6. Total number of US and Japanese naval vessels damaged and sunk and plane losses, WW II, Iron Bottom Sound, Solomon Islands.

US VESSELS DAMAGED		US VESSELS SUNK		US PLANE
Vessel	Numbers	Vessel	Numbers	
BB	2	CA	6	330
CA	11	CV	2	
CV	2	CL	2	
CL	1	DD/APD	17	
DD/AVD	11	SS	1	
SS	1	AP/AK	4	
AP/AK/AO	6	PT	6	
PT	3	YP	1	
AT		1		
SUB TOTAL	37		40	330
JAPANESE VESSELS DAMAGED		JAPANESE VESSELS SUNK		JAPANESE PLANES LOSSES
Vessel Class	Numbers	Vessel Class	Numbers	
BB	4	BB	2	1120
CA	15	CA	3-4	
CV	3	CV	1	
CL	13	CL	2-3	
DD/DE/PG	43	DD	21-27	
SS	3	PE PC/PG	5-11	
AP/AK/AO	70	SS	9-12	
AV	2	AP/AK/AO	33-38	
PG	1	AK	4-6	
DM		1		
SUB TOTAL	154		81-105	1120
TOTAL	191		121-145	1450

Table 7. Aircraft types used in WW II, Iron Bottom Sound, Solomon Islands.

AIRCRAFT	MODEL	TYPE	LOCATION
Grumman	F4F-4	Wildcat	Guadalcanal
Grumman	TBF-1	Avenger	Honiara/Guadalcanal
Lockheed	PV-1	Ventura	Honiara/Guadalcanal
Douglas	SBD-5	Dauntless-Dive Bombers	Guadalcanal
Mitsubishi	A6M Zero - Sen	Zeke	Guadalcanal
Mitsubishi	G4M - 1	Betty-Bombers	Guadalcanal
Mitsubishi	A6M - 2	Zeke-Bombers	Guadalcanal
Mitsubishi	A6M - 3	Zeke-Bombers	Guadalcanal
USA (make unknown)	B17	Flying Fortress Bomber	Guadalcanal

Table 8. Comparative table of the main types of fighter airplane, WW II, Iron Bottom Sound, Solomon Islands.

Aircraft	Length	Span	Engine (hp)	Max Speed (mph)/altitude (feet)	Range normal/max (miles)	Armament	Number Built
U.S. Navy							
F4F-4 Wildcat	28'9"	38'0"	Pratt & Whitney R-1 830-86 (1,200)	320/19 400	910/1250	4 x (later 6) .50-cal. Machine guns	1168
4U-1 Corsair	33'4"	41'0"	Pratt & Whitney R-2830-8 (2,000)	417/19 900	1,015/1562	6x .50-cal. machine guns	9444 ¹
USAAF							
P-400 (P-39D) Airacobra	30'2"	34'0"	Allison V-1710 (1,150)	335/5000	600/1100	1x20mm can. 4x.30-cal. 2x.50-cal. Machine guns	179 ²
P-40E Warhawk	31'2"	37'4"	Allison V-1710 (1,150)	335/5000	650/850	6x.50-cal machine guns	2320
Japanese Navy							
A6M2 Model 21 Zero-sen (Zeke)	29'8"	39'4"	Nakajima Sakai 12 (925)	331/15 000	1,160/1930	2x20mm can. 2x7.7mm machine guns	1100 ³
A6M2-N (Rufe)	33'1"	39'4"	Nakajima Sakai 12 (925)	270/16 400	714/1107	2x20mm can. 2x7.7mm machine guns	327
Japanese Army							
Ki, +3-1A Yayabusa (Oscar)	28'11"	37'6"	Nakajima Ha-25 (950)	308/13 100	745 max	2x7.7mm or 12.7mm machine guns	716
Ki,61-1a Hien (Tony)	28'8"	39'4"	Kawasaki Ha-40 (1,175)	368/16 000	373/684	2x12.7mm 2x7.7mm machine guns	1380

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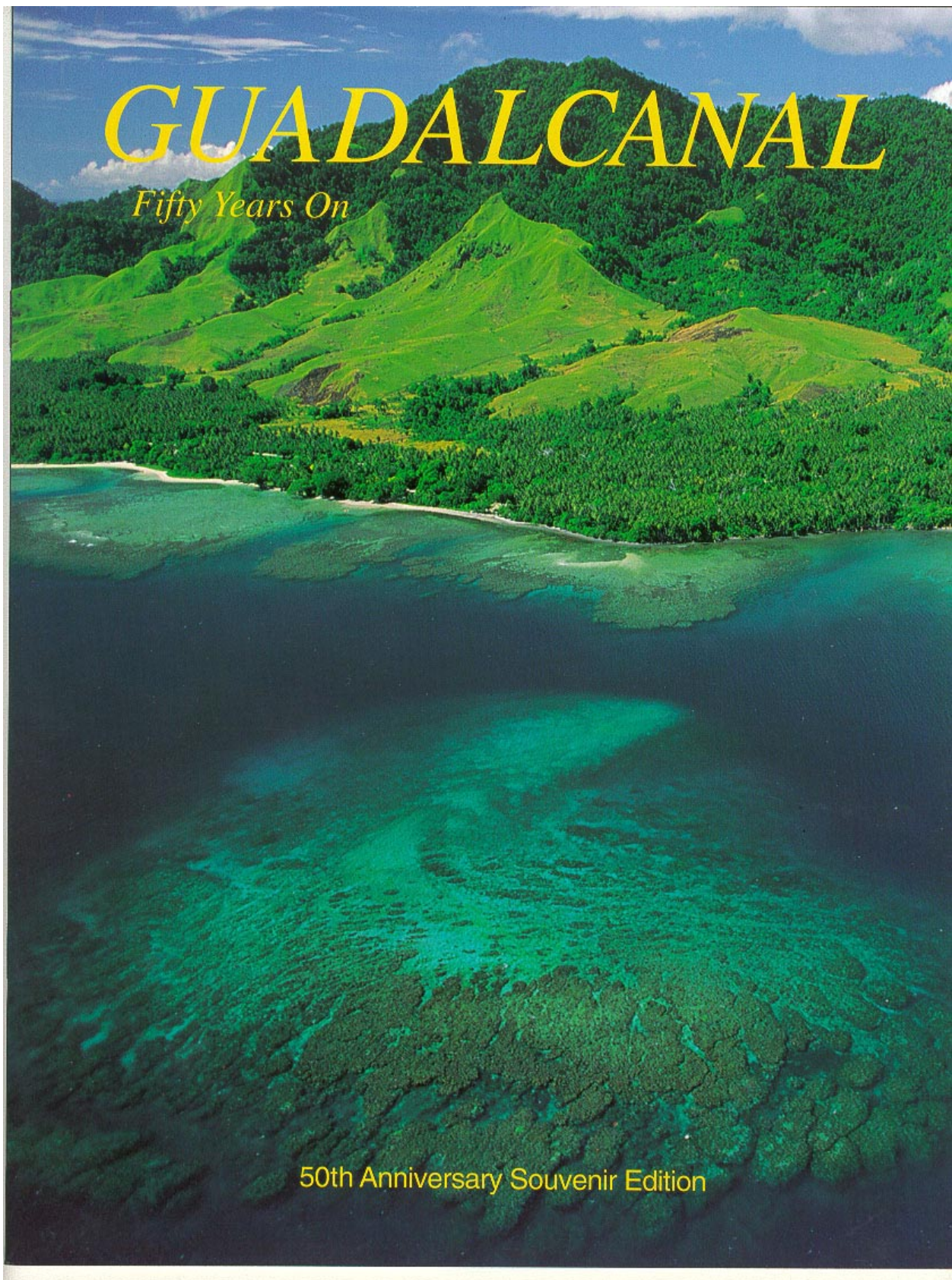


Plate 1. Oblique aerial view, looking southwest, of Cape Esperance, Guadalcanal's northwest coast, Iron Bottom Sound. Note the extensive coral reef growth in the foreground and close to the shore and the shallower lagoon (light blue) in the background. A well-developed deeper (darker blue) channel separates the lagoon from the shore, suggesting effective circulation and proper tidal flushing of these nearshore areas. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.



Plate 2. Oblique aerial view, looking east-northeast, of Henderson Airfield Guadalcanal, October 1942. Note the numerous US airforce fighter planes at base and the naval vessel in the nearshore areas of Iron Bottom Sound (in the background). Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.



Plate 3. The USS Chicago, a few hours before sinking in the Solomon's. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

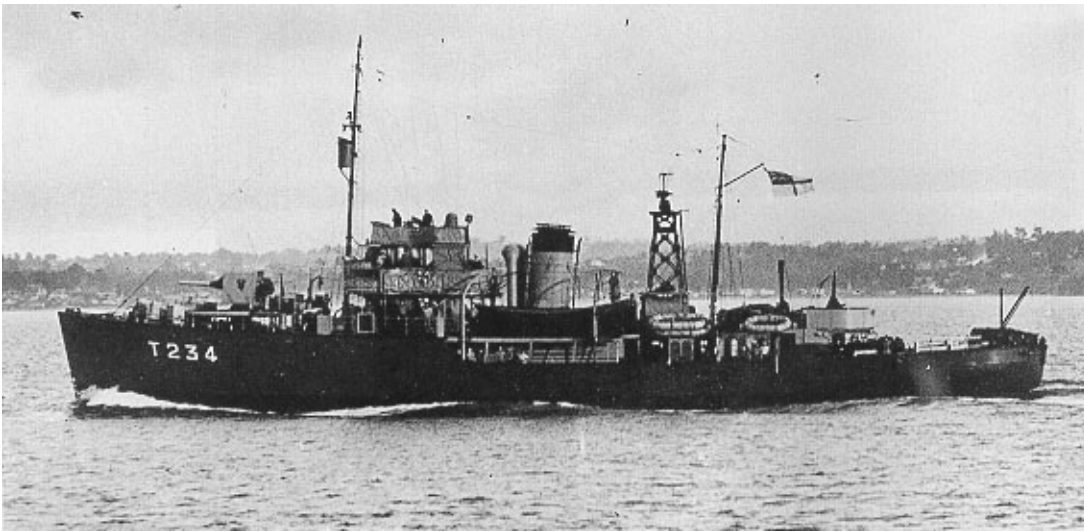


Plate 4. The HM-NZS Tui, a New Zealand Navy minesweeper used primarily in anti-submarine operations during the Guadalcanal offensive 1942-1943. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

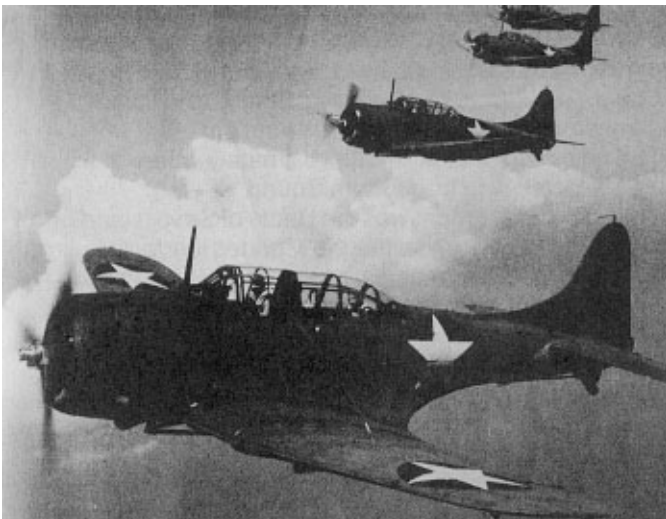


Plate 5. Douglas, SBD-5 Dauntless-Dive Bombers in action, a typical aircraft destroyed over Iron Bottom Sound. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.



Plate 6. A squadron of Lockheed, PV-1 Ventura US fighter planes at Henderson Airfield, November 1942. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.



Plate 7. WW II photograph of Henderson Airfield, December 1942, with a Grumman, F4F-4 Wildcat fighter. Photo reproduced with the kind courtesy Solomon Islands Philatelic Bureau, Honiara.

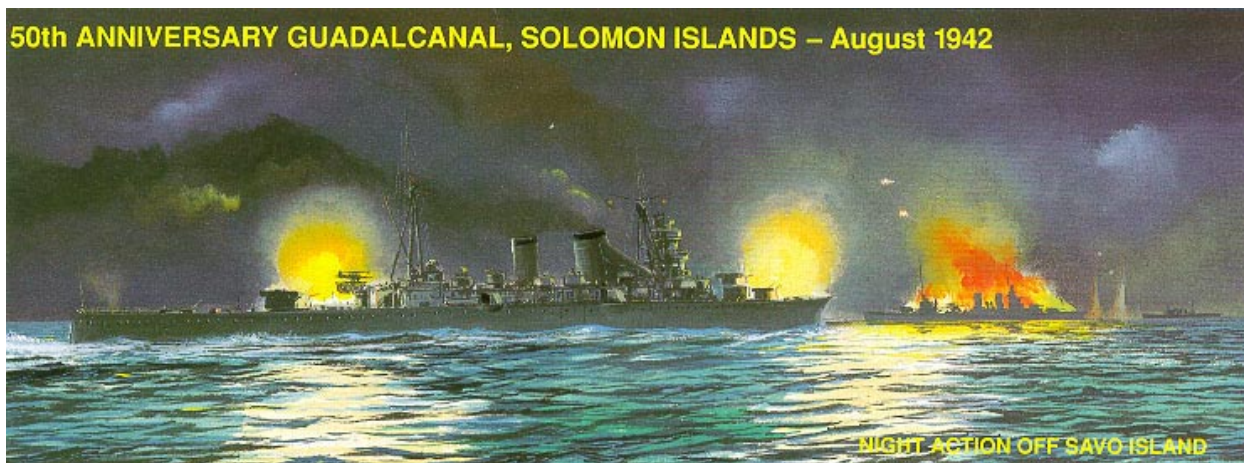


Plate 8. Night action off Savo Island, 1st Battle of Savo, August 1942. Photo reproduced with the kind courtesy Solomon Islands Philatelic Bureau, Honiara.



Plate 9. Japanese tanks destroyed by US artillery on October 1942, Matanikau River mouth, and north coast of Guadalcanal Island, Iron Bottom Sound. Photo reproduced with the kind courtesy Solomon Islands Philatelic Bureau, Honiara.



Plate 10. Air attack over Iron Bottom Sound, by Mitsubishi, G4M-1 Betty Bombers, 8th August 1942. Photo reproduced with the kind courtesy Solomon Islands Philatelic Bureau, Honiara.



Plate 11. An underwater photograph of a battleship in Iron Bottom Sound. Note the heavily encrusted and highly corroded metal surface. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.



Plate 12. Underwater photograph of a battleship in Iron Bottom Sound. Note the heavily encrusted and highly corroded metal surface. Encrustation of various types of marine algae and small corals are common. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

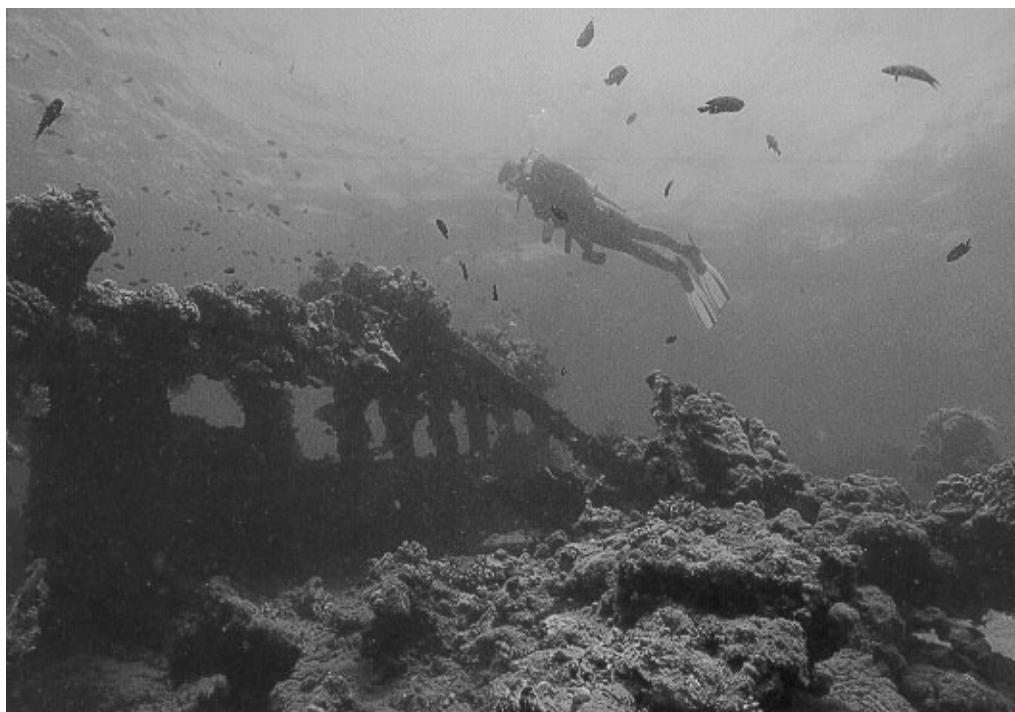


Plate 13. A diver inspects a sunken WW II naval wreck off Guadalcanal shores. This wreck, like many others, which litter the sea floor of Iron Bottom Sound, offer a haven of interesting sights and scene for the keen diver. The large surface area of these wrecks provides additional encrusting surfaces for benthic marine dwellers, in particular, isolated corals and algae. These attract fish population, also increasing local marine biodiversity. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.



Plate 14. Divers inspect the cockpit and control column of a US B-17E, Flying Fortress Bomber aircraft destroyed in Iron Bottom Sound, 24th September 1942. Note the heavily encrusted metal surface, finger corals on the left; red and green algae and other benthic biota. Note the prolific growth of algae on the gun turret in the background. Encrustation by various marine algae is common. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

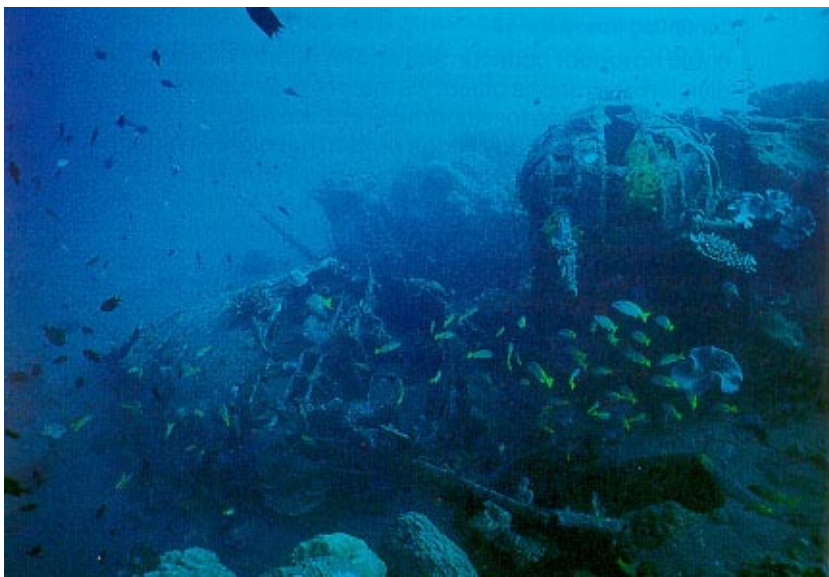


Plate 15. Underwater photograph of a section of an aircraft in Iron Bottom Sound. Note the heavily encrusted and highly corroded metal surface. Encrustation of various types of marine algae and small corals are common. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.



Plate 16. Underwater photograph of an aircraft in Iron Bottom Sound. Note the heavily encrusted and highly corroded metal surface. Encrustation of various types of marine algae and small corals are common. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.



Plate 17. Underwater photograph of a submarine in Iron Bottom Sound. Note the heavily encrusted and highly corroded metal surface. Encrustation of various types of marine algae and small corals are common. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

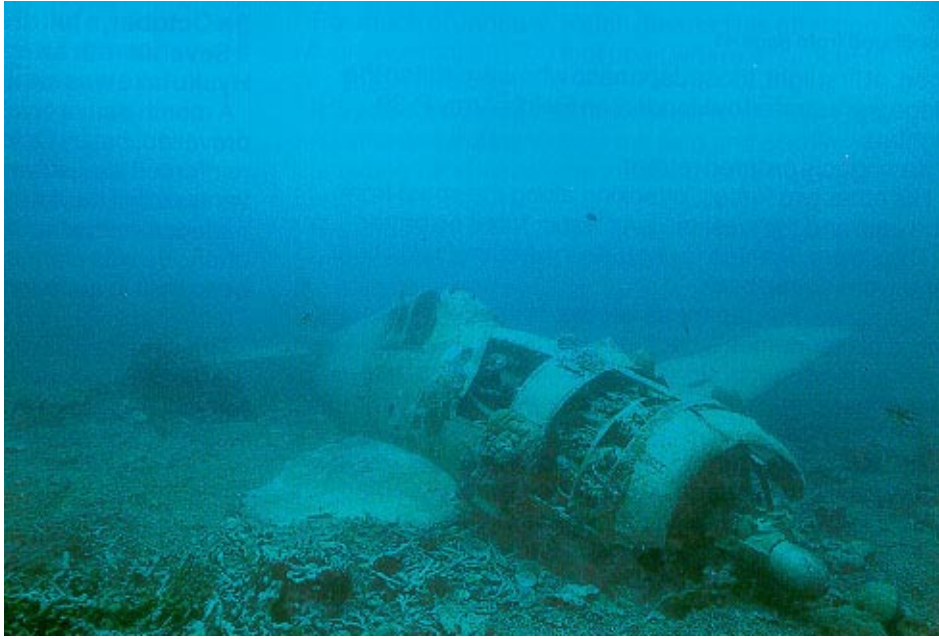


Plate 18. Underwater photograph of a Mitsubishi, A6M Zero-Sen Zeke aircraft in Iron Bottom Sound. It has been described as the fastest fighter aircraft of the Guadalcanal campaign in the Pacific Theatre and of World War II at that time. Note the heavily encrusted metal surface. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.



Plate 19. Underwater photograph of the cockpit area of a Grumman, F4F-4 Wildcat aircraft in Iron Bottom Sound. Note the heavily encrusted metal surface. Encrustation of various marine algae is common. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.



Plate 20. Underwater photograph of the cockpit of a Grumman, F4F-4 Wildcat aircraft in Iron Bottom Sound. The Wildcat was the principal US Navy fighter plane and described by military historians as the first successful western shipboard fighter monoplane. Note the heavy encrustation of various types of marine algae. These wrecks support considerable benthic marine biota, adding to the productivity of the nearshore coastal region. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.



Plate 21. Remains of a US F4F-4 Wildcat fighter plane at the Vilu Village War Museum, west of Honiara, Guadalcanal. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

A black and white photograph showing the bow of the USS Arizona, a rusted metal shipwreck, partially submerged in the water. A group of about seven people, mostly men in light-colored shirts and dark trousers, are standing on a grassy bank in the foreground, looking at the ship. A palm tree is visible on the left side of the frame. The ship's hull is heavily corroded, and the water level is visible around the base of the bow.

R.J. Maharaj, 1999: SOPAC Final Report to UNDP/UNOPS, Suva, Fiji : SOPAC Technical Report 280



Plate 24. Rifle ammunition on one of the Japanese transport vessels in coastal areas of Iron Bottom Sound, north Guadalcanal. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

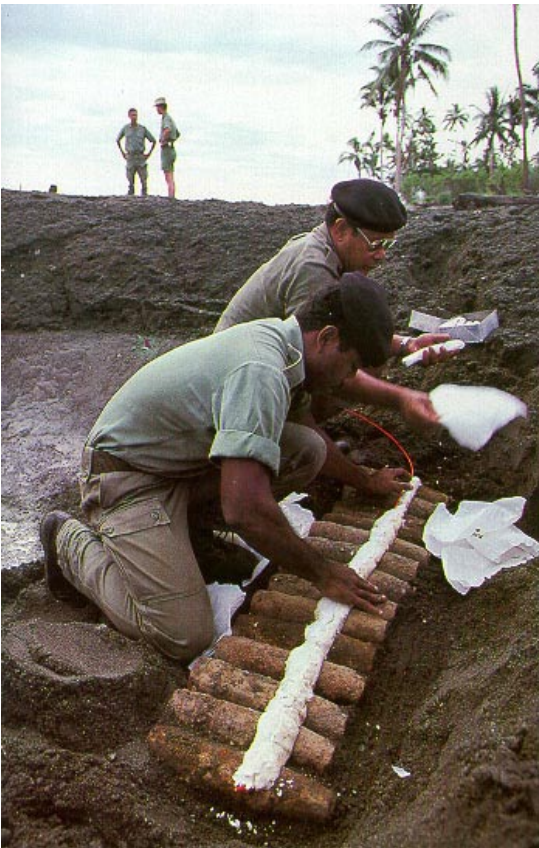


Plate 25. Preparing to destroy remaining WW II explosives on the north shores of Guadalcanal, Iron Bottom Sound. Photo reproduced with the kind courtesy Solomon Islands Visitors Bureau, Ministry of Tourism, Honiara.

APPENDIX I

TERMS OF REFERENCE FOR THE PROJECT AND SOPAC/UNDP CONTRACT

CONTAMINATION RISK ASSESSMENT FROM WWII SUNKEN VESSELS IRON BOTTOM SOUND, SOLOMON ISLANDS: SOPAC PROJECT - SB 99.03

Objectives

To compile an inventory in GIS-based format of sunken ships and aeroplanes (if possible) in Iron Bottom Sound, Solomon Islands.

Background

Many areas within the Pacific were subject to intense military activity during WW II, resulting in the sinking of numerous military ships and aircraft. Solomon Islands was one particular area where fighting over a span of 5 years, saw the loss of some 100 plus ships in coastal waters. For these ships and aircraft little is known of about the cargo content at the time of sinking, their location, water depth and therefore the potential hazards risks posed to marine biodiversity, the impacts on sustainability of commercial fisheries, tourism, and other marine-based economic activities.

Equipment and Resources

Access to pre-existing sources of information.

Work Program

- Compile as complete an inventory as possible, on number of vessels, probable cargo content using data from as wide a variety of sources as possible in the time available, such as war archives in Washington, Bishop Museum, Tokyo and Honiara.
- Develop a database in GIS with overlays of vessel location, water depth, oceanographic conditions where available, such as currents and water quality.
- Preliminary definition of areas of potential environmental impact.
- Define a follow-up work plan as may be necessary.

Output

Inventory of ships, locations, water depths cargo content in GIS MapInfo format, together with recommendations, as may be necessary, for further field investigations of selected areas to assist in developing sustainable planning and management measures.

Client

Solomon Islands Government (SIG).

Technical Personnel/Professional Staff

SOPAC Coastal and Information Technology Units