

PB2Y CORONADO FLYING BOAT ARCHAEOLOGY AND SITE FORMATION STUDIES
TANAPAG LAGOON, SAIPAN

by

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April, 2015

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The focus of this thesis is the further study of both pre- and post-depositional site formation processes that affect submerged WWII aircraft, specifically an unidentified US Navy Consolidated PB2Y Coronado flying boat in Tanapag Lagoon, Saipan, Commonwealth of the Northern Mariana Islands. The study of submerged aircraft is a relatively recent field of study in maritime archaeology. With the inclusion of aircraft in the Sunken Military Craft Act of 2004, these studies have become increasingly more important to stakeholders such as the US Navy.

Site formation process studies stipulate that a crucial aspect of the accurate interpretation of a site first requires a thorough understanding of the processes that create and subsequently alter the site. For terrestrial archaeologists, as well as those maritime archaeologists studying shipwreck sites, a database of this knowledge exists. For submerged aircraft, however, this database is incomplete. This thesis will contribute to the overall understanding and interpretation of submerged aircraft sites through the studies of the processes that created and subsequently affected the Tanapag Lagoon PB2Y Coronado site. Archaeological and historical evidence will be examined to identify the specific aircraft, determine its cause of crash, and understand any cultural or natural factors that may have affected the site. This will contribute further information

about site formation processes on three different levels: specific (Consolidated PB2Y Coronado), general (flying boats), and broad (wreck type and artifact distribution).

Further, this information will be used to identify management challenges specific to this site, and offer solutions to those challenges. The management issues and solutions, as well as a completed application for the National Register of Historic Places, will be turned over to the relevant stakeholders. This will assist in the proper protection and management of not only this specific site, but will also be applicable to other submerged aircraft sites throughout the Pacific in particular and the world in general.

Key Words: WWII, US Navy, aircraft, flying boat, site formation process studies, PB2Y Coronado, management, Saipan

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TANAPAG LAGOON, SAIPAN

A Thesis

Presented To the Faculty of the Program in Maritime Studies of Department of History
East Carolina University

In Partial Fulfillment of the Requirements for the Degree
Master of Arts in Maritime Studies

by

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April, 2015

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Acknowledgements

There are many people I must acknowledge who made this thesis possible. First and foremost, I would like to thank my advisor, Dr. Jennifer McKinnon. Our journey began when I walked into her office and said, “I need a thesis topic.” Since then, she expertly pushed, pulled, prodded, and guided me through to completion. Without her guidance, and patience, this project would not have finished on time, if at all.

Gratitude must also be extended to the Naval History and Heritage Command Underwater Archaeology Branch. The time I spent there allowed me to fully grasp the importance of research on submerged aircraft sites. They also graciously sent me to the archives, both National and Naval, and let me conduct my own research once I completed my tasks. Without those days in the archive, the timbre of this thesis would be much different.

During my month of fieldwork in Saipan, many people helped me in every way possible. I would specifically like to thank two who helped me stay safe, efficiently conduct research, find the things I needed, and have fun. Julie Mushynsky took time out of her busy research schedule to act as chauffeur, concierge, tour guide, and most importantly, friend. Life there would not have been as comfortable, or as fun, without her help. Scott Eck, boat captain and diver extraordinaire, made fieldwork possible. Without Scott’s assistance, I would have spent too much time trying to sort out logistics and not enough time diving. His knowledge and experience of weather on the lagoon not only kept me safe, but added depth to my interpretation of events that night in 1945.

I would like to thank my parents for their sagely advice and understanding throughout the cycle of hope, worry, frustration, hopelessness and finally jubilation that is inherent in writing a Master's thesis. Having both been through the process themselves, they offered advice, and encouragement, when needed.

Finally, I would like to thank my wife, Sakura, for always being there for me. She has supported me every step of the way, beginning with my decision to enroll in a graduate program. She never complained, even when I was somewhere else conducting research, and was always a happy voice on the other end of the line. Thank you for coming on this adventure with me.

Table of Contents

Acknowledgements	iv
List of Tables.....	x
List of Figures	xi
Abbreviations	xvi
1 Introduction.....	1
1.1 Problem Orientation	1
1.2 Research Questions	2
1.3 Justification.....	4
1.4 Site Introduction.....	7
1.5 Previous Work.....	11
1.6 Thesis Outline.....	12
2 Background.....	14
2.1 Definitions	14
2.2 Site Formation Process Study Literature Review	16
2.3 Submerged Aircraft Studies	22
2.4 Submerged Aircraft Site Formation Studies	28
2.5 Submerged Aircraft Management.....	32
3 Methodology	39

3.1	Survey Methodology	39
3.1.1	Site Plan Creation.....	40
3.1.2	Photographic Survey.....	41
3.1.3	Environmental Survey.....	42
3.2	Archival and Historical Research	43
3.2.1	Historical Research.....	43
3.2.2	Archival Research.....	45
3.3	Analytical Methodology	50
3.3.1	Depositional Analysis.....	50
3.3.2	Post-Depositional Analysis.....	51
3.4	Limitations	53
4	History	56
4.1	Development of PB2Y Coronado	56
4.1.1	XPB2Y-1.....	58
4.1.2	PB2Y-2.....	61
4.1.3	PB2Y-3.....	62
4.1.4	PB2Y-4.....	65
4.1.5	PB2Y-5.....	66
4.1.6	PB2Y-6.....	70
4.2	PB2Y Coronado Patrol Squadron Assignments	71
4.2.1	VP-1.....	72
4.2.2	VP-102/VPB-4.....	72

4.2.3	VP-13.....	73
4.2.4	VP-15.....	74
4.2.5	VP-100.....	75
4.3	PB2Y Coronado in Naval Air Transport Services.....	75
4.4	Air Ambulance Service.....	77
4.5	Saipan	78
4.6	PB2Y Coronado Use in Saipan	81
4.7	Conclusion	83
5	Archaeological Data and Analysis	86
5.1	Fieldwork Observations.....	86
5.1.1	General Site Description	86
5.1.2	Site Features.....	90
5.1.3	Presence/Absence Analysis	105
5.2	Research Results	107
5.2.1	Archival/Historical Research Results.....	107
5.2.2	Geographic Survey	115
5.2.3	Magnetometer Survey Results	118
5.3	Faux Site	119
5.4	Identity and Justification	127
5.5	Site Formation Processes	139
5.5.1	Natural Impacts	140
5.5.2	Cultural Transforms.....	145

6 Discussion	152
6.1 Primary Research Question	152
6.2 Secondary Research Questions	155
6.3 Management Considerations	161
6.3.1 Relevant Issues	161
6.3.2 Protection	162
6.3.3 Management Suggestions	165
6.4 Suggestions for Future Research	167
6.5 Conclusions	170
References Cited	171
Appendix A: National Register of Historic Places Registration Form	186

List of Tables

Table 1. PB2Y Coronado losses recorded on Aircraft Accident Reports	107
Table 2. PB2Y Coronado losses not recorded on Aircraft Accident Reports	109
Table 3. PB2Y Coronado losses reported in Saipan	109
Table 4. BuNo 7070 Personnel during crash.	114
Table 5. Probe survey results	142
Table 6. Historical typhoon data for Tanapag Lagoon, 1959–2013	143

List of Figures

Figure 1. Location of the Commonwealth of the Northern Mariana Islands (Burns 2008:3).	9
Figure 2. Location of Tanapag Lagoon outlined in red (USGS Topographic Map, 1999).....	10
Figure 3. Flow diagram illustrating the evolution of a shipwreck (Muckelroy 1976: 282).....	17
Figure 4. Ward, Larcombe, and Veth's modified flow diagram (Ward et al. 1999:564).....	20
Figure 5. Gibbs's "cultural factors in shipwreck site formation" (Gibbs 2006:16).....	21
Figure 6. Flow diagram modified for application to submerged aircraft (Bell 2010:124).	32
Figure 7. Original XPB2Y-1 tail configuration with single vertical stabilizer (Consolidated). ...	59
Figure 8. XPB2Y-1 on takeoff with second tail configuration: elliptical fins added to horizontal stabilizer (Consolidated).	59
Figure 9. XPB2Y-1 in flight with final tail configuration (Consolidated).	60
Figure 10. PB2Y-2 BuNo 1633 December 1940. Note the teardrop-shaped upper gun blister and the side waist windows: these were unique to the PB2Y-2 variant (Consolidated).	62
Figure 11. PB2Y-3. Note the new ball turret in the nose and upper waist, and the square rear waist hatch (National Archives).....	63
Figure 12. PB2Y-3R transport conversion. All guns have been removed (Consolidated).	64
Figure 13. PB2Y-5 with radome installed above flight deck (US Navy).	66
Figure 14. PB2Y-5 with radome performing a Jet Assisted Takeoff (JATO) (USCG).....	68
Figure 15. PB2Y-5R transport conversion interior. <i>Left</i> , cargo platforms; <i>right</i> , seats installed (US Navy).	69
Figure 16. PB2Y-5H air ambulance conversion interior (Consolidated).	70
Figure 17. Flag officer's cabin (Consolidated).	70
Figure 18. The last remaining PB2Y Coronado (National Naval Aviation Museum).....	85

Figure 19. Location of Tanapag Lagoon PB2Y Coronado site (Google Earth, accessed 28 November 2014).	87
Figure 20. Site plan of main assemblage of the Tanapag Lagoon PB2Y Coronado.	88
Figure 21. Site plan of entire site of the Tanapag Lagoon PB2Y Coronado. Features are circled and labeled in red.	89
Figure 22. Feature 1. Cockpit canopy windows, pilot's escape hatch, and aerial mast. Plan view, 1 m scale.	91
Figure 23. PB2Y-5 during conversion. Note cockpit windscreen window configuration and open escape hatches. Aerial mast is located on top of radome, aft of escape hatches; the Tanapag Lagoon Coronado was not equipped with a radome, so aerial mast was installed between escape hatches (Hoffman 2009:63).	92
Figure 24. "Radio wall," Feature 2, <i>center</i> , and radio equipment scatter, <i>right</i> . Scatter is outlined in yellow, while individual units (Feature 3) are circled. Unscaled plan view.	94
Figure 25. Contemporary ART-13B transmitters from B-29 flight deck (Photograph aafradio.org).	95
Figure 26. Radio panel (Feature 3) with two ART-13B transmitters. Details millimeter scale. ..	95
Figure 27. Port vertical stabilizer (Feature 4). Plan view, 1 m scale.	96
Figure 28. Engine (Feature 5). Profile view, facing south. 1 m scale.	97
Figure 29. <i>Left</i> , seat leaning against reef, 50 cm scale (Feature 6). Profile view, facing west. <i>Right</i> , seat as temporarily installed at navigator's station in XPB2Y-1 (National Archives). ..	98
Figure 30. <i>Left</i> , Coronado from rear resting on wingtip float (US Navy). <i>Right</i> , a Coronado capsizes after losing a wing float (Warbird Information Exchange).	99

Figure 31. Float strut (Feature 7) with visible paint. <i>Inset</i> , serial number and Consolidated Aircraft Stamp (J. Carpenter 23 February 2012).	100
Figure 32. Wing (Feature 8). Plan view, 1 m scale.....	101
Figure 33. Hatch cover (Feature 9), plan view. 1 m scale.	102
Figure 34. Navigator's astrodome (right) and hatch cover (left), inside restored PB2Y-5F BuNo 7099. (National Naval Aviation Museum Facebook page, accessed 30 December 2014).	102
Figure 35. Navigator's astrodome (Feature 10). Oblique view, facing southeast. 60 cm scale. .	103
Figure 36. Forks and spoons (Feature 11). <i>Top</i> , entire scatter, 1 m scale. <i>Bottom right</i> , concreted forks, centimeter scale (top) and millimeter scale (right). <i>Bottom left</i> , detail of handle inscription, millimeter scale.	104
Figure 37. <i>Above</i> , hull section with port anchor hatch (Feature 12), closed, on right side. Panels missing on left. Plan view, 1 m scale. <i>Below</i> , position of anchor hatch, open, below and forward of the cockpit (National Museum of Naval Aviation).	105
Figure 38. <i>Top</i> , Hydrographic Office chart 6062 (1948) and <i>bottom</i> , NOAA chart 81076 (2013). Both illustrate the location of seaplane runways (center), seaplane anchorage (lower right between reef and mooring circles), and overlaid site location of the Tanapag Lagoon PB2Y Coronado (blue symbol).	116
Figure 39. Tanapag seadrome runways, labeled, and overlaid site location of the Tanapag Lagoon PB2Y Coronado (blue symbol). (HO chart 6062, 1948).	117
Figure 40. Tourist submarine and tender as seen from Coronado site.....	119
Figure 41. Faux wreck site overview, with two propellers (top left and center), two seats (center), a machine gun (center), various hatch covers, and ammunition scatter (center to bottom right). (Photograph J. Carpenter, 24 February 2012).....	120

Figure 42. <i>Left</i> , faux site in 2012 (photograph J. Carpenter, 24 February 2012). <i>Right</i> , Similar view in 2014 with submarine in background. Note positions of seats, hatch covers, and machine gun have changed since 2012.	121
Figure 43. <i>Top left</i> , Coronado seat on faux site, as placed by the machine gun in 2012. Oblique view, 25 cm scale. (Photograph J. Carpenter, 24 February 2012). <i>Top right</i> , suspected Coronado pilot or copilot seat, oblique profile view, 25 cm scale. (Photograph J. Carpenter, 24 February 2012). <i>Bottom left</i> , back of copilot's seat (Hoffman 2009:163). <i>Bottom right</i> , seat back of suspected pilot or copilot seat. Oblique view, 10 cm scale increments.....	122
Figure 44. Examples of hatch covers on faux site. <i>Left</i> , oblong interior hatch, plan view, 1 m scale. <i>Right</i> , damaged escape hatch, plan view, 50 cm scale.....	123
Figure 45. <i>Left</i> , front beaching gear attached to Coronado (Hoffman 2009:183). <i>Right</i> , beaching gear tire to north of faux site. Plan view, 1 m scale.....	124
Figure 46. Unknown propeller hub component with serial number. Oblique view, 25 cm scale. (Photograph J. Carpenter, 24 February 2012).....	125
Figure 47. Unscaled view of machine gun from rear. Note that barrel of gun is resting on wreckage; the gun is not mounted.	127
Figure 48. Detail of vertical stabilizer surface, showing sparse marine growth over bare aluminum; no paint remains. 50 cm scale.....	129
Figure 49. <i>Top</i> , location of manufacturer's data plate (Consolidated). <i>Bottom</i> , buried cockpit at Tanapag Lagoon Coronado site. Note top edge of starboard main cockpit window is not visible above sand. 1 m scale, oblique view facing southeast.....	130
Figure 50. Line drawing showing Coronado diagnostic features.	133
Figure 51. Engine with external oil cooler (circled). Profile view, facing north, 1 m scale.....	134

Figure 52. Positions of site (oval), runway (red), and anchorage (yellow) (HO chart 6062, 1948).
..... 136

Figure 53. Comparison of site distribution (black) to scaled PB2Y Coronado line drawing (red
overlay) 137

Figure 54. Deteriorated aluminum skin on suspected horizontal stabilizer. *Top*, 23 February 2012.
(Photograph J. Carpenter). *Bottom*, 11 November 2014, 20 cm scale..... 145

Figure 55. Propellers purchased by scrap company. (Photograph Saipan HPO, 15 January 2008).
..... 150

Abbreviations

AAR Aircraft Accident Report

AHC Aircraft History Card

BuAer Bureau of Aeronautics

BuNo Bureau Number

CNMI Commonwealth of the Northern Mariana Islands

CNO Chief of Naval Operations

NAB Naval Air Base

NAS Naval Air Station

NATS Naval Air Transport Service

NARA National Archives and Records Administration

NHC Naval Historical Center (now NHHC)

NHHC Naval History and Heritage Command (former NHC)

PB Patrol Bomber

RG Record Group

VP Patrol Squadron

VPB Patrol Bombing Squadron

VR Air Transport Squadron

1 Introduction

1.1 Problem Orientation

The study of submerged aircraft is becoming increasingly important to maritime archaeologists and cultural resource management personnel, as well as the government and military sectors (Cooper 1994; Coble 2001; Holyoak 2001). This was illustrated by a two-and-a-half hour session dedicated to submerged aircraft at the 2014 Society for Historical Archaeology Conference (Society for Historical Archaeology January 8-12:83–84). The US Navy has particularly expressed a growing interest, as the Sunken Military Craft Act (2004) reasserts the Navy's ownership of all sunken navy craft. As this includes submerged aircraft, there is a rising demand for the Naval History and Heritage Command's Underwater Archaeology Branch (NHHC-UAB) to identify, research, and manage aircraft wrecks as well as shipwrecks. In 2001, there were more than 12,000 known aircraft wrecks worldwide (Coble 2001:27). In 2014, the database exceeded 14,000 known aircraft losses, with research indicating that a large number of unknown losses may exist (Alexis Catsambis 2014, pers. comm.).

For an archaeological site to be effectively interpreted, the archaeologist must have a complete dataset of what artifacts are on the site and multiple working hypotheses of they came to be there. The study of how a site forms and what may have affected the site post-deposition is called site formation studies. In a maritime archaeological context, site formation studies cover both "the processes of transformation from ship to wreck and to wreck-site," (Gibbs 2006:4) and the human and natural forces that subsequently alter the site. Keith Muckelroy (1978:157) and Michael Schiffer (1987:7) argued that understanding the site formation processes of shipwreck

sites is crucial to the interpretation of shipwreck remains. Similarly, a thorough understanding of submerged aircraft site formation process studies is a mandatory preliminary step to furthering our ability to interpret submerged aircraft sites (Bell 2010:1–2; Cooper 1994:138; McCarthy 2004; Jung 1996:175).

This thesis will examine the submerged remains of a Consolidated PB2Y Coronado (a four-engine flying boat with a 35 m (115 ft.) wingspan and 24.2 m (80 ft.) hull length) through the lens of site formation process studies, in order to advance archaeologists' knowledge of what processes affect submerged aircraft. Although this thesis will only examine one aircraft lying in Tanapag Lagoon, Saipan, Commonwealth of the Northern Mariana Islands (CNMI), the site formation processes understood as a result of these studies will be applicable on three different levels: specific (Consolidated PB2Y Coronado), general (flying boats), and broad (aircraft wreck type and artifact distribution).

The significance of this research, then, is diverse. It will add to the database of knowledge of how WWII submerged aircraft wreck sites are created and how they are altered through time by humans and nature. It will also provide a crash scenario that can be applied to other similar submerged aircraft wreck sites. Finally, this research will result in the identification of management issues and proposed solutions, so that appropriate actions may be taken to protect and manage the PB2Y Coronado lying in Tanapag Lagoon.

1.2 Research Questions

How do site formation process studies contribute to our understanding of submerged WWII aircraft and their subsequent management? The primary goal of this thesis is to answer

that question through the examination of a case study: a submerged WWII US Navy Consolidated PB2Y Coronado flying boat located in Tanapag Lagoon, Saipan, CNMI.

Tied to this primary research aim are two additional questions. Is it possible to identify this aircraft more specifically than type—that is, can it be identified to an individual Bureau Number? If so, can that identity further explain details of the site formation process, from wrecking event to today? These arguments come precariously close to resurrecting the “Is archaeology a handmaiden to history?” argument fought in the 1960s by historical archaeologists, notably Ivor Noel-Hume (1964; 1966) and Stanley South (1966). Archaeological evidence may produce clues that can be confirmed in the archives, yet archival evidence might offer details about the wrecking event and post-depositional salvage attempts. This thesis shall not entertain that theoretical debate; rather, it will use both the historical record and archaeological record to work towards a common goal—to identify the aircraft and synthesize a site formation model for the site.

Also inextricably connected to the primary research question are issues of management of this site. A thorough understanding of the site is required to make important decisions in regards to the models used for its protection and preservation. This includes decisions based on whether or not the site is a war grave, if and how the site has been affected in the past by cultural or natural events, determining who are the stakeholders for this site, assessing what statutory protective measures may apply, and deciding if the site is at risk for further disturbance. Cultural resource managers must carefully consider all of these details before an effective management plan can be created. The archaeological study of this site and its formation processes can directly answer many of those questions.

To accomplish these goals, the following is a list of individual questions that shall be considered during research:

- How can the site be identified? Which particular aircraft is it? Can the crash cause or wrecking type be identified?
- What cultural or natural events have taken place that may have affected the site? How can these be identified?
- What management programs for submerged United States WWII aircraft are currently available for the world, the Pacific, and Saipan?
- Who are the stakeholders of this site, both inside and outside Saipan?

1.3 Justification

The study of aircraft wreck sites as archaeological and cultural heritage resources is a more recent area of study, and this is even more so for submerged aircraft wreck sites. The reluctance to study aircraft wreck sites has been compounded by the exclusion of recent history from archaeological research. This attitude can be traced back to statements such as Muckelroy's (1980:10) declaration that:

Since the development of the aqualung, divers have undertaken a great deal of work on early steamships, American Civil War gunships, World War I battleships, and even World War II aircraft. But while such enterprises are interesting, and sometimes furnish useful displays for museums, they are not archaeology.

This stance has thankfully been largely overturned throughout the years, including some direct refutations such as Michael McCarthy's (1998:99) statement that Muckelroy's argument was

“not a sustainable position” and Richard Gould’s (2000:8) retort that Muckelroy’s “view categorically rejects the archaeological record as a primary and legitimate source of information...whenever written documents are available.” Further, writing about battlefield archaeology, Carmen and Carmen (2009:48) asserted that a “bottom-up approach” rather than a “top-down approach” is required, “grounded not in history but in archaeology.” Thus, while the basis for studying WWII-era archaeological sites was affirmed more than a decade ago, the study of such sites has become even more critical today, as the oral records and living memory of WWII is quickly fading with the dwindling number of people directly involved in those events.

More specifically, a myriad of archaeologists and historians have held that historical aircraft wrecks, especially WWII sites, are valid topics for archaeological investigation. Vince Holyoak (2001:259), arguing that airfields should be studied as battlefields and aircraft as an archaeological resource, stated that “given the vast amount of documentary source material available...it might be expected that early twentieth century military aircraft represent an extremely well defined and understood phenomenon... [but] closer analysis suggests otherwise.” McCarthy (2004:81, 90) examined the processes that “led to a broader recognition of the submerged aircraft as a maritime archaeological site,” concluding that “above all it is evident that lost aircraft can be an archaeological site and that it needs to be treated accordingly.” Most recently, Heather Brown (2014:281) asserted that it is possible to “tie the material culture of aircraft...to the broader socio-cultural and historical context, making the study...more relevant to historical archaeology as a whole.”

The study of site formation processes of submerged aircraft wreck sites is even more recent for the field of maritime archaeology. As Muckelroy (1978) and others (for example, see (Schiffer 1987; Gibbs 2006; Murphy 1983) have argued, the formation processes of the site itself

must be understood before any archaeological interpretation takes place, for “the past—manifest in artifacts—does not come to us unchanged” (Schiffer 1987:5). A multitude of changes may have happened to the site, both “scrambling” and “extracting” the information contained therein (Muckelroy 1983:268). For present-day maritime archaeologists, these site formation processes have been largely documented, and a wealth of information for ships and shipwrecks exists. By looking at clues such as the ship’s remains, artifact scatters, and the presence or absence of artifacts and their locations, a maritime archaeologist can come to an understanding of how a ship became a shipwreck site, and what changes occurred since its demise.

This is not so for submerged aircraft, because this database of knowledge is still in its infancy. While there have been a few broad studies (Bell 2010; Wessex 2008) and some specific studies (Jung 1996; Jung 2007a; Jung 2009a; Rodgers et al. 1998; Dagneau 2014), the understanding of site formation processes as they apply to submerged aircraft are far from complete. This research contributes further information to that site formation process database of submerged aircraft.

This thesis also contributes to the historical knowledge of the Consolidated PB2Y Coronado flying boat. As Richard Hoffman (Hoffman 2009:i) noted, there was no complete history of the aircraft that was known to exist before the publication of his book. While his book finally fills that role, it does leave significant gaps about both the aircraft and its history. These gaps vary from specific information about model and equipment changes (all aircraft were to be outfitted with certain equipment, yet some were not, or were subject to field modifications), to the loss and disposition of aircraft (marked as “unknown”), to the history and use of the aircraft in specific areas (such as Saipan). Hoffman’s work was based entirely on archival research, so these gaps are left to be filled largely by archaeological research. This is one example of the

strength of historical archaeology: the information found in the archaeological record may be different from that in the historical record, affording deeper understanding of topics impossible to pursue in the historical record. Further, as only one PB2Y Coronado remains intact (restored and on display at the National Naval Aviation Museum [Andrews 1989:23; Naval Aviation Museum]), archaeological research has the potential to yield information on the Coronado, its various models and the roles they performed, and the actual equipment issued to aircraft at the leading edge of the Pacific war effort.

Finally, a secondary goal of this thesis is to examine issues relevant to the creation of a management plan for the Tanapag Lagoon PB2Y Coronado site. As of the last survey in 2012, the site was still relatively intact. The presence of small artifacts such as forks and instruments with a high likelihood of being taken as souvenirs indicates that the site has not seen widespread diver impact. This belief is further strengthened by the fact that the site was shown to the research team by a local captain of tour submarines, as opposed to being found through diver reports, research or prior surveys. The identification of issues relevant to this site, and subsequent suggestions, will hopefully assist the stakeholders create an informed and effective management plan.

1.4 Site Introduction

Saipan is the largest of the 15 islands that constitute the Commonwealth of the Northern Mariana Islands (CNMI). Located 201 km (125 mi.) northeast of Guam and 2,414 km (1,500 mi.) southeast of Japan (Figure 1), it measures 20.9 km (13 mi.) in length, northeast to southwest, 6.4 km (4 mi.) in average wide, and covers approximately 74 km² (46 mi²) (Carrell et al. 2009:39–42). Sometimes called the “D-Day” of the Pacific and considered the “decisive battle of

the Pacific offensive,” Saipan was the location of an intense 25 day battle that left almost 55,000 dead (Goldberg 2009:vi; Rottman 2004:9, 89; Brooks 2005:229).

The PB2Y Coronado site (UTM 55P 0363014 1685191) is located in Tanapag Lagoon, on the northwest side of Saipan (Figure 2). The lagoon housed a seaplane base, developed by the Japanese, and later used by the US Navy. Today, Tanapag Lagoon encloses a large conservation area (Managaha Marine Conservation Area) as well as the WWII Maritime Heritage Trail – Battle of Saipan. The Coronado site lies within the boundaries of the conservation area, and is located between two sites that are on the underwater heritage trail (although the Coronado is not included).

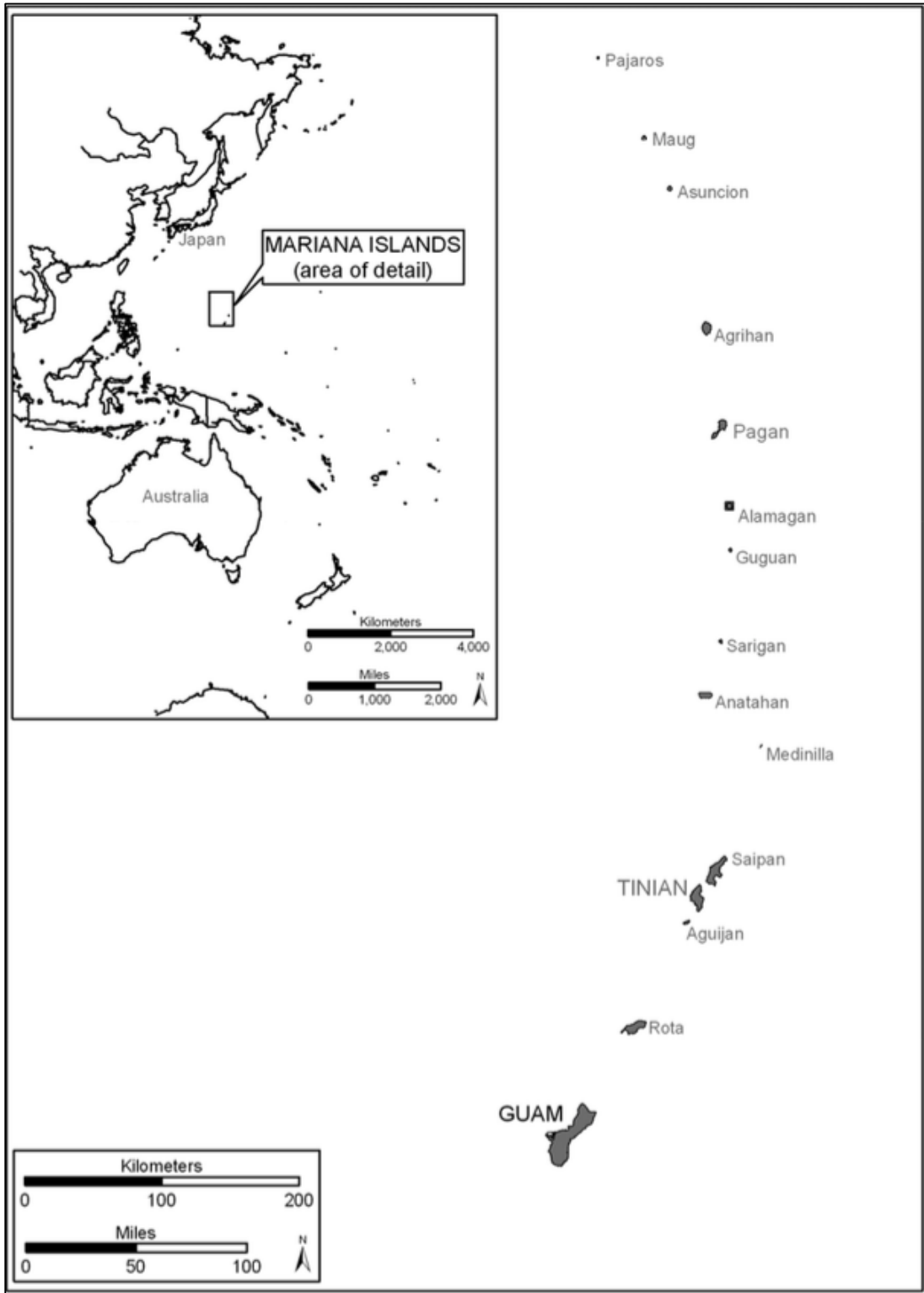


Figure 1. Location of the Commonwealth of the Northern Mariana Islands (Burns 2008:3).

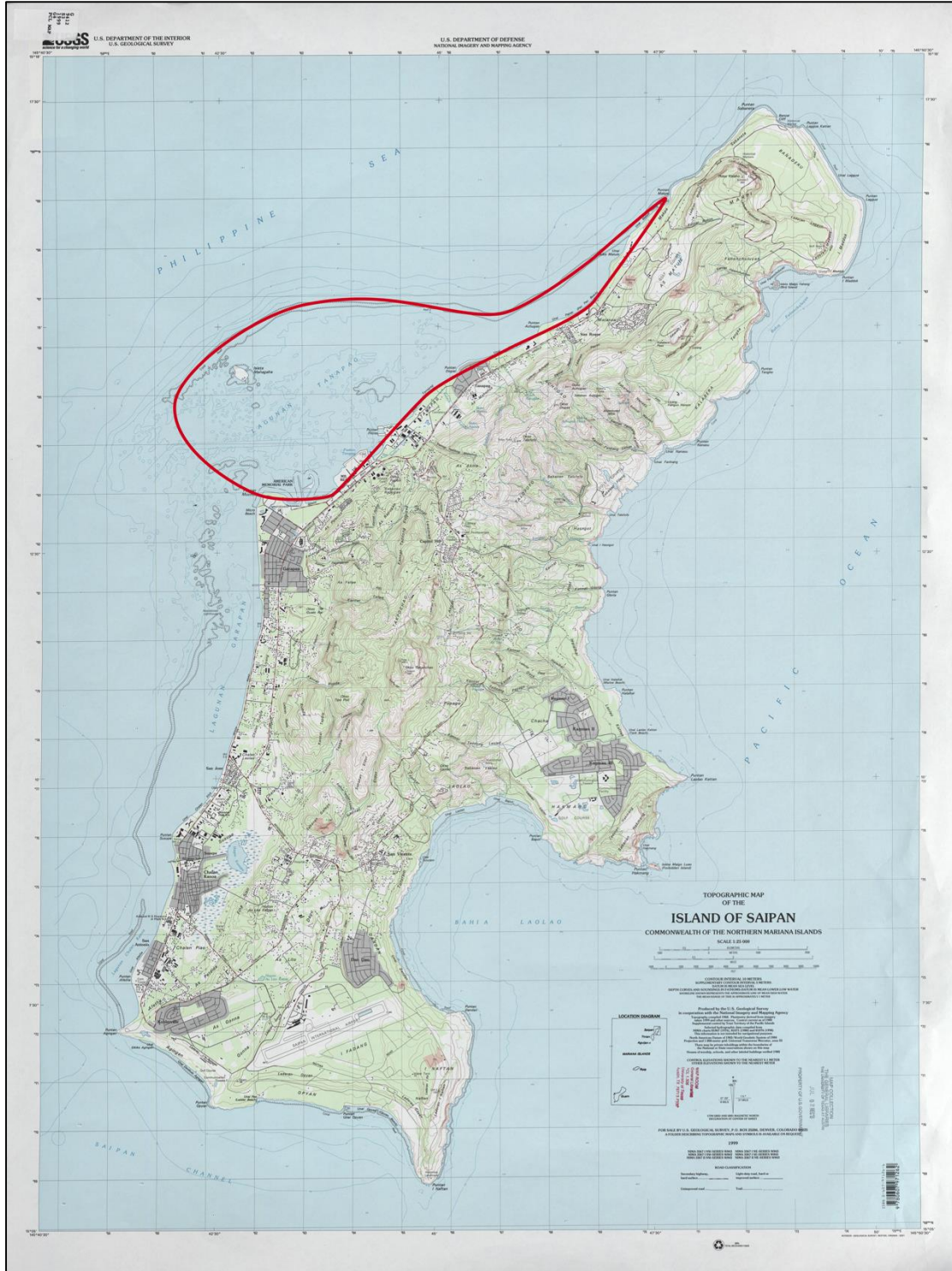


Figure 2. Location of Tanapag Lagoon outlined in red (USGS Topographic Map, 1999).

The site is generally disarticulated and scattered around a main wreckage assemblage. The main assemblage measures approximately 10 m (33 ft.) long by 6 m (20 ft.) wide, and contains the most identifiable parts of the aircraft, including the cockpit canopy, radio equipment, and a tail fin, with one detached engine lying nearby. The main assemblage also contains the largest continuous piece of wreckage: the cockpit canopy, flight deck ceiling, and flight deck walls. Scattered about the main assemblage in a 100 m (328 ft.) radius are approximately 40 large pieces of wreckage (larger than 1 m (3 ft.) on one axis) and countless smaller pieces, including hatch covers, a float support, a seat, and a cluster of concreted forks and spoons.

The remains are located approximately 8 m (26 ft.) deep on a generally flat, undulating seabed comprising primarily of fine calcareous sediment. Most of the remains are exposed; the site averages 50 cm (20 in.) profile above the seabed, with maximum relief occurring at the engine (1.5 m, 5 ft.). A layer of fine sediment covers the lower areas, while a mucilaginous layer covers the aluminum surfaces (McKinnon and Carrell 2014:39). As the site lies in a lagoon, it is generally protected from wave action and rough seas. McKinnon and Carrell (2014:39) noted “a steady and generally light current [that] did not visibly move sediment” in February 2012. This author experienced heavy current on most days in November 2014, demonstrating that the conditions change with seasons.

1.5 Previous Work

Archaeological research has been conducted in Saipan since at least the 1880s, both of a prehistoric and historic nature (Russell and Fleming 1986:116). Interest in submerged WWII sites began in the 1980s, with surveys conducted by Thomas and Price (1980) and the Pacific Basin Environmental Consultants (PBEC) (1984). Underwater surveys and research were

conducted as recently as 2011 and 2012 (McKinnon and Carrell 2014; Richards and Carpenter 2012). Despite the number and breadth of surveys conducted, the PB2Y Coronado only appears in two (McKinnon and Carrell 2011; McKinnon and Carrell 2014).

The PB2Y Coronado site was shown to project staff from Flinders University/Ships of Discovery by a captain of the local tourist submarine in 2012. Although only a handful of research dives were conducted on the site, enough evidence was gathered to positively identify the aircraft remains as a Consolidated PB2Y Coronado (McKinnon and Carrell 2014:39). Research included a visual (photograph and mapping) and corrosion survey (Richards and Carpenter 2012:77–81). A magnetometer survey in 2008 did not identify the site, despite the presence of one engine (Burns 2008). While the site was known to the local tourist submarine crew, the presence of moveable objects such as forks and instruments indicate that the site is not frequently visited by divers, and that human interference with the archaeological record has been minimal (McKinnon and Carrell 2014:39).

1.6 Thesis Outline

This chapter provides an introduction to the topic of the thesis. The importance of studying site formation processes to understand submerged aircraft wreck sites is emphasized. Research questions are presented along with justifications. The site is introduced, complete with location, physical conditions, and a brief history of previous research.

Chapter Two reviews literature pertinent to the study of site formation theory and shipwreck site formation processes. Previous work involving submerged aircraft wreck sites are investigated. Finally, recent steps towards expanding our knowledge of site formation processes as they apply to submerged aircraft wrecks are examined.

Chapter Three outlines the methodologies used to gather data for this thesis. Fieldwork methods, including site plan creation, are described in detail. Historical and archival research methodology is presented, particularly addressing which archival sources were used and their main contents.

Chapter Four provides a firm background on the development of the Consolidated PB2Y Coronado. After describing the development of the aircraft, its roles and use in the US Navy is examined in detail. Finally, focus then shifts to the Battle of Saipan, which serves as the backdrop for the site this thesis examines.

Chapter Five presents and analyzes the data collected during the course of this thesis. Observed site distribution is given, including site plans and photographs. The results of historical, archival, geographic, and field research are used to propose an identity for the site. Following this, the wreckage scatter distribution is analyzed and compared to the proposed aircraft's crash report. Finally, cultural and natural impacts are described.

Chapter Six completes this thesis, culminating in final thoughts and research conclusions. The primary and secondary research questions are answered in light of data analysis from the previous chapter. Issues relevant to the management of this site are examined, and potential solutions are proposed. Finally, suggestions for future research are provided.

2 Background

This chapter provides a background to the research conducted during the course of this thesis. After introducing definitions of terms frequently used throughout the following chapters, this chapter performs a literature review of site formation process studies. Upon developing a theoretical framework that forms the basis of this thesis, the chapter will then review previous underwater archeological work focusing on aircraft. The two topics will be combined, cumulating in an examination of site formation studies performed on submerged aircraft sites. Finally, a brief overview of literature focused on submerged aircraft site management will conclude the chapter.

2.1 Definitions

Site formation process: first vocalized by Schiffer (1972), site formation processes are best defined as the “factors that create the historic and archaeological records” (Schiffer 1987:7). As traditionally applied to maritime archaeology, the “process through which that organized assemblage of artifacts comprising a ship and its contents will have passed to produce the collection of items excavated on the seafloor” (Muckelroy 1978:158).

C-transforms: short for cultural transforms, these describe the cultural formation processes of the archaeological record. They are the “processes of human behavior that affect or transform artifacts after their initial period of use in a given activity” (Schiffer 1987:7; Schiffer and Rathje 1973:170).

N-transforms: short for noncultural transforms, these “specify the interaction between culturally-deposited materials and variables of the environment in which those materials were deposited” (Schiffer 1975:838; Schiffer and Rathje 1973:170). Stated more simply, they are “all events and processes of the natural environment that impinge upon artifacts and archaeological deposits” (Schiffer 1987:7).

Extracting filters: Extracting filters are elements, cultural or natural, that remove material from the wreck assemblage (Muckelroy 1976:283).

Scrambling devices: Scrambling devices are processes that rearrange the patterns in artifact materials of a site (Muckelroy 1976:283).

Systematic salvage: the systematic removal of all or some of the cargo, fittings, and structural elements of a wrecked vessel following the conclusion of the disaster event. While the owners of the vessel or their authorized agents usually conduct systematic salvage, other groups including contemporary salvors or looters, as well as archaeologists also extensively strip vessels or sites (Gibbs 2006:14).

Opportunistic salvage: the non-systematic removal of vessel contents and material, either during or following the wrecking event. Characterized as low-intensity and short duration, opportunistic salvage generally focuses on accessible fixtures, fittings, and minor structural elements (Gibbs 2006:14).

Environmental processes: Essentially a more concrete definition of n-transforms, environmental processes are the site formation processes that are closely linked to the depositional environment and include physical, biological, and chemical classes (Ward et al. 1999:561).

2.2 Site Formation Process Study Literature Review

Developed in the milieu of 1960s and 1970s archaeology, the study of site formation began as a processual study. Stated simply by Schiffer (1987:5), “the past...does not come to us unchanged.” The site that archaeologists observe today is not a perfect reflection of the past; certain processes have occurred between its deposition and later excavation that may have changed the structure, layout, or composition of a site. We cannot accept, at face value, that “the proveniences of artifacts in a site correspond to their actual locations of use in activities” (Schiffer 1972:156). Archaeologists created a theoretical framework, which they called site formation process studies, in order understand how the archaeological record changes and allows “genuinely intersubjective statements to be made about the past,” (Schiffer 1972:157).

Schiffer (1987:7) stated that “neither the historic nor the archaeological record gives up its secrets about the past easily.” The archaeologist cannot just read those records; instead, we must investigate the formation processes involved and correct for their effects. These formation processes fall into two categories: cultural and noncultural transformations, respectively abbreviated c-transforms and n-transforms (Schiffer and Rathje 1973:170). Cultural transformation processes are those “processes of human behavior that affect or transform artifacts after their initial period of use in a given activity,” while noncultural processes are “simply any and all events and processes of the natural environment that impinge upon artifacts and archaeological deposits” (Schiffer 1987:7).

While Schiffer was concerned with the theory of site formation processes as it applies to archaeology in general, Muckelroy (1976; 1978; 1983) theorized about site formation processes specific to shipwrecks. Developed during his study of the Dutch East India Company merchant

ship *Kennemerland*, Muckelroy developed a flow diagram (Figure 3) representing the process through which “that organized assemblage of artifacts comprising the ship and its contents has passed to produce the collection of items which recent excavations have uncovered on the sea-floor” (Muckelroy 1976:281). He refined these ideas in his 1978 book *Maritime Archaeology*, which were later included in Lawrence Babits and Hans Van Tillburg’s 1983 compilation *Maritime Archaeology: A Reader of Substantive and Theoretical Contributions* (Muckelroy 1978; Muckelroy 1983).

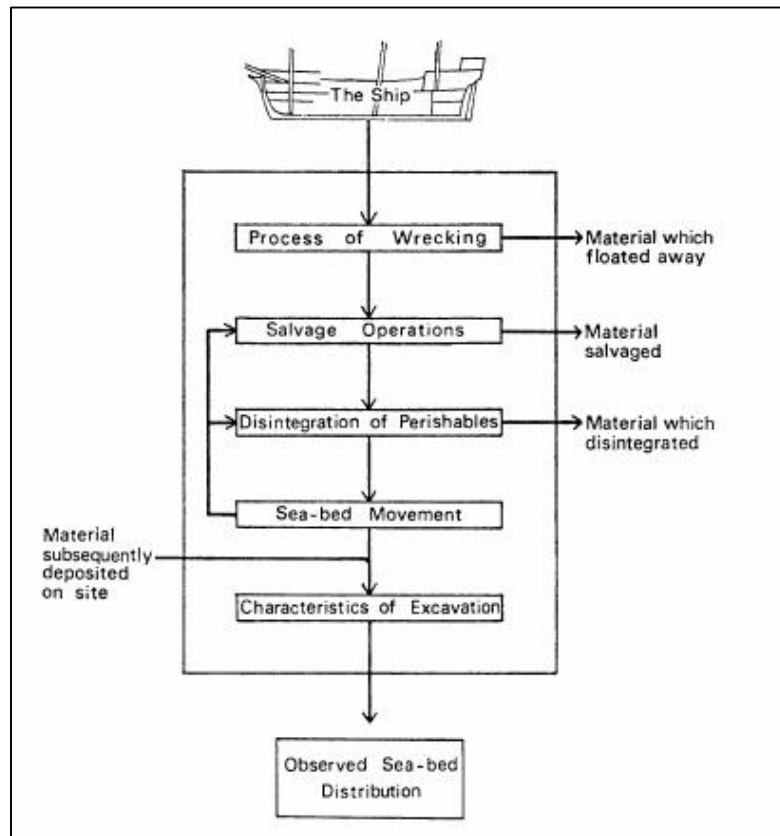


Figure 3. Flow diagram illustrating the evolution of a shipwreck (Muckelroy 1976: 282).

Muckelroy divided the five elements inside the box in Figure 3 into two groups: extracting filters and scrambling devices. Extracting filters are elements that remove material from the

assemblage. As shown in the flow diagram, the three processes that act as extracting filters are the process of wrecking, salvage operations, and the disintegration of perishables. All of those extracting filters generate a unique output shown on the right of the diagram (Muckelroy 1978:165). Scrambling devices are those elements that rearrange the distribution of an archaeological site, and include seabed movement and the process of wrecking (also just described as an extracting filter) (Muckelroy 1983:278, 283). Through the examination of these, he argued, the archaeologist could more fully understand the evidence contained in the archaeological record (Muckelroy 1978:153). As the first work to specifically apply site formation process theory to shipwrecks, Muckelroy's flow diagram formed the basis for later studies in both site formation processes and middle-range theory in maritime archaeology (Keith and Simmons 1985; Ward et al. 1999; Gibbins and Adams 2001; Gibbs 2006; Bell 2010).

Donald Keith and Joe Simmons III (Keith and Simmons 1985) utilized Muckelroy's flow diagram, with a twist, in their interpretation of the remains of a sixteenth-century shipwreck on Molasses Reef. As created by Muckelroy, the flow chart operates in a deductive mode, driving forward from shipwreck event to the present. Keith and Simmons argued "reversing the order of events in this flow chart provides a model for an inductive reconstruction"(Keith and Simmons 1985:420). By analyzing the data in this fashion, they successfully created a hypothetical reconstruction of the hull section. Ultimately, they disagreed with Muckelroy's belief that human interference underwater is minimal and identifiable, as the effects of extracting filters and scrambling devices caused by modern salvors limited their ability to identify the shipwreck (Keith and Simmons 1985:424).

Ward, Larcombe, and Veth (1999) both expanded Muckelroy's diagram and examined it in an alternative light. They argued that the flow charts thus far produced remained descriptive

rather than prescriptive, and failed to distinguish between process-related and product-related attributes (Ward et al. 1999:561). The goal of their paper was to apply that alternate approach to a heretofore unexplored area of submerged site formation processes: environmental processes. They examined the effects of physical, biological, and chemical processes on wreck disintegration as well as how variable sedimentation processes affected site depositional history (Ward et al. 1999:563). Physical processes that can cause a site to deteriorate include forces applied by waves (both regular and storm) and currents, and also the movement of sediment associated with them. Organisms constitute the biological processes, consisting of both direct action by organisms and the indirect action of microorganisms affecting the sediment around the site. These processes are quantified in terms of the “change in population and diversity of organisms which contribute to deterioration over time” (Ward et al. 1999:565–566). Chemical processes include both the direct reaction of wreckage with seawater and the indirect biochemical reactions within the surrounding sediments. Chemical deterioration can be quantified in terms of the rate of corrosion of a wreck (Ward et al. 1999:565–566). They study these three processes in the context of a sediment budget, which they define as the “rate of net supply or removal of different types and sizes of sediment grains to the wreck area” (Ward et al. 1999:564). By studying it as such, they split sediment supply and hydrodynamic environment, allowing separate discussion. Their research resulted in a modified version of Muckelroy’s flow chart, illustrated in Figure 4.

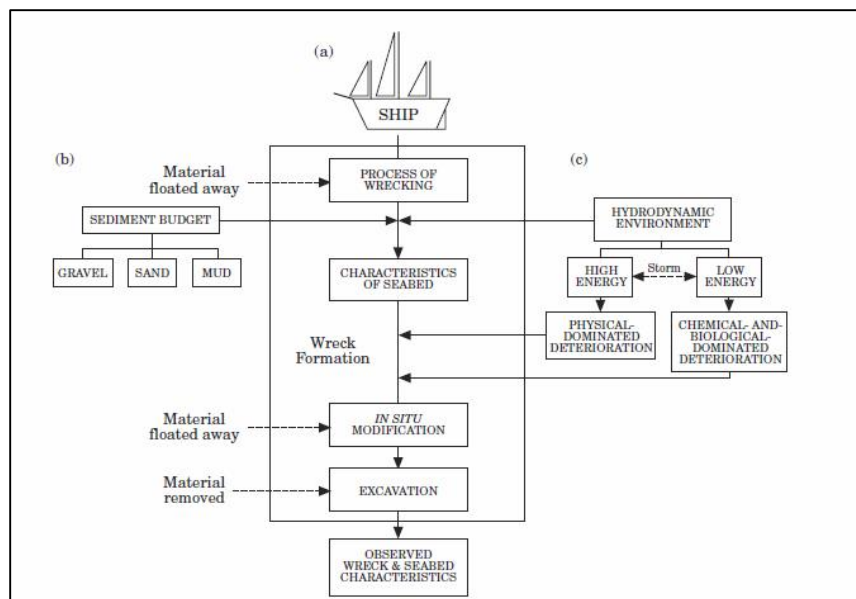


Figure 4. Ward, Larcombe, and Veth's modified flow diagram (Ward et al. 1999:564).

Yet another adaptation of Muckelroy's flow chart was published by Martin Gibbs (2006), focusing on the human elements involved in site formation. Gibbs's purpose was to "expand upon Muckelroy's themes and to consider in greater depth the range of cultural processes acting upon shipwreck sites" (Gibbs 2006:4). In particular, Gibbs concentrated on the process of wrecking and salvage operations, both cultural factors that act as extracting filters. Gibbs drew on disaster response models to create a structure to examine the wrecking process itself, examining the human reaction to various stages during a shipwreck and its subsequent impact to the archaeological record (Gibbs 2006:7). He also studied salvage operations, dividing them into two categories: opportunistic and systematic. Opportunistic salvage is the non-systematic removal of vessel contents, and is conducted from groups ranging from shipwreck survivors to local inhabitants. Systematic salvage, on the other hand, entails the systematic removal of cargo, fittings, and structural elements (Gibbs 2006:14). Through these studies, Gibbs developed Figure 5, representing another expansion of Muckelroy's flow chart. As noted by Bell (2010:17), Gibbs

did not include salvage by recreational divers (opportunistic) or treasure hunters (opportunistic and systematic).

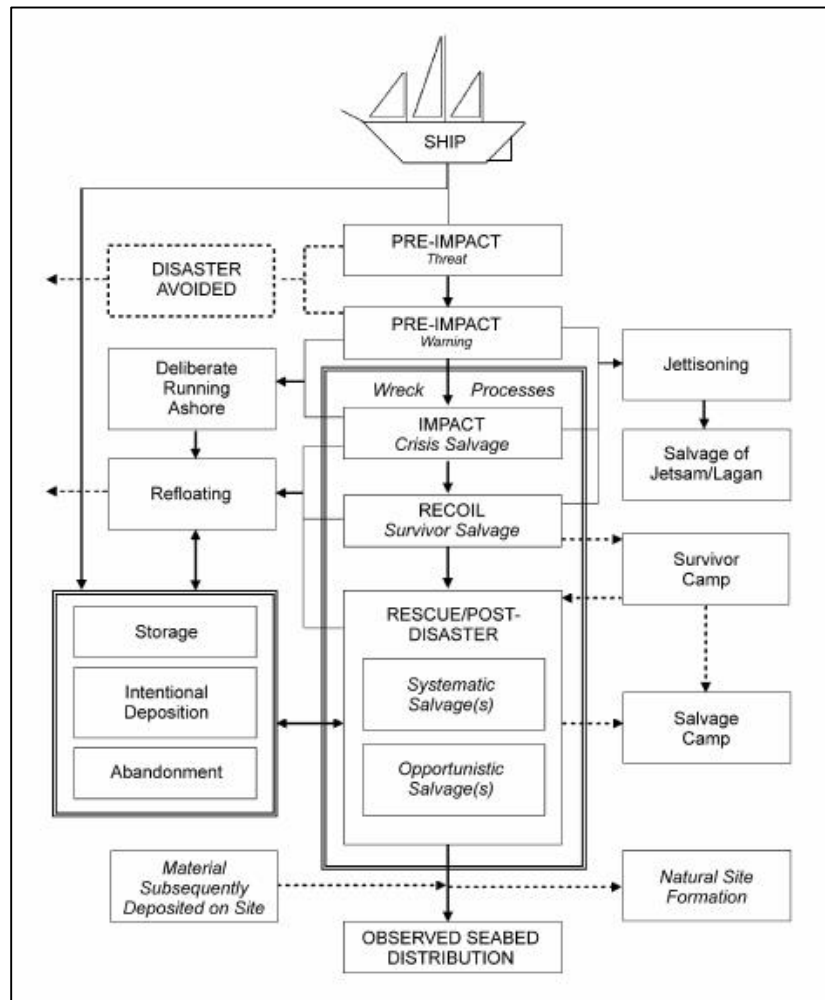


Figure 5. Gibbs's "cultural factors in shipwreck site formation" (Gibbs 2006:16).

These studies form the basis for understanding site formation processes as they occur underwater to shipwrecks. Not mentioned here were studies concerning site formation processes due to geologic or sea level change, as it is believed that these have little to no impact on the PB2Y Coronado site in Tanapag Lagoon. Also not mentioned in this section were site formation process studies on submerged aircraft; these will be examined separately.

2.3 Submerged Aircraft Studies

This section seeks to provide an overview of archaeological work conducted on submerged aircraft. Unlike shipwreck archaeology, which can be traced back hundreds of years, the study of submerged aircraft by archaeologists began relatively recently. Maritime archaeologists published some of the first reports concerning submerged aircraft in the 1990s, at the same time that interest began to grow in preserving aircraft as historical resources. This section will take a brief look, chronologically, of selected studies in the development of the archaeological study of submerged aircraft.

Perhaps one of the first projects was conducted by East Carolina University's (ECU) Program in Maritime Studies as a field school in June and July 1994 (Rodgers et al. 1998:8). ECU, in partnership with the University of Hawaii at Manoa's Marine Option Program and the National Park Service, planned to conduct a pre-disturbance survey and archaeological documentation of a sunken flying boat in Kaneohe Bay, Oahu. This was undertaken with "some trepidation," as their "combined past experience related to the survey, excavation, and documentation of abandoned ships, boats, and submerged land sites; but no aircraft" (Rodgers et al. 1998:8). They located the sunken aircraft and identified it as a PBY Catalina during their reconnaissance dive. They also located and mapped a section of fuselage, wing, and tail, as well as a submerged buoy matching the description of PBY mooring buoys. Based on aircraft configuration, damage to the airframe, and the mooring buoy, they determined that the PBY was likely destroyed on 7 December 1941 (Rodgers et al. 1998:15). This information was later confirmed by relatives of the pilot, who did not survive the attack (Bradley Rodgers 2015, pers. comm.).

The same year, David Cooper (1994) published an article examining the then-current state of US Naval aviation resources and archaeology. Written after temporary assignment to the Naval Historical Center's Underwater Archaeology Branch (now Naval History & Heritage Command, NHHHC), Cooper touched upon issues relevant to both cultural resources management and archaeology. Although this article was not an archaeological report, it did ask (and answer) several important questions such as "Is it worth it?" and "What can we learn?" (Cooper 1994:136–138).

In 1996, the Naval Historical Center Underwater Archaeology Branch (NHC-UAB) conducted two different archaeological projects concerning submerged aircraft. The first was an investigation of three unidentified aircraft wreck sites in Puerto Rican waters. Performed in partnership with the Puerto Rico Council of Underwater Archaeology and the Institute of Nautical Archaeology, the project team conducted site assessments of the sites with several archaeological and CRM-related objectives. Circumstantial evidence gathered from the investigation led to the probable identification of two of the sites; the third, consisting of only a single engine, was not identified. It is unfortunate that although the sites were visually documented with still and video imaging equipment, neither an official project nor a site report was published, and additional work has not been conducted (Naval History and Heritage Command 2009a).

Also in 1996, the NHC-UAB renewed a project to recover a Martin PBM Mariner from Lake Washington in Renton, Washington (Naval History and Heritage Command 2009b). The flying boat sank in May 1949 while being ferried across Lake Washington from NAS Seattle. It has been the object of a number of salvage attempts. In 1980, a large number of artifacts were removed and placed into the custody of the National Museum of Naval Aviation at NAS

Pensacola. Mobile Diving Salvage Unit One (MDSU-1) and the Naval Reserve Mobile Diving Salvage Unit One's Detachment 522 (NRMDSU-1 Det 522) unsuccessfully attempted to recover the aircraft in 1990. The mission was revisited in 1996. Only the tail section was recovered and documented, then turned over to the National Museum of Naval Aviation for restoration (Naval History and Heritage Command 2009b). Divers also successfully placed mesh screens or blanking plates over penetration points on the wreckage, in order to make the site safe for sport divers. While management strategies were presented, it appears that this project, like the Puerto Rico survey, has not been the subject of further work or publication.

Matthew Holly published two reports in 2000, prepared for the Republic of the Marshall Islands Historic Preservation Office, with the results of surveys of both Majuro and Kwajalein Atoll lagoons (Holly 2000a; Holly 2000b). The reports are similar in format and execution, with the main difference being the lagoon surveyed. The surveys were "Phase II archaeology reconnaissance survey...[with] information collected to be used by the Historic Preservation Office to develop and/or protect the sites, primarily, and obviously, for SCUBA diving and tourism" (Holly 2000a:9). Both surveys included several submerged aircraft. Unfortunately, Holly's background is in SCUBA instruction, not archaeology, and his reports are accordingly more akin to dive guides than archaeological reports (Holly 2000b:10). While Holly provided a brief history of each site along with photographs, he did not analyze them archaeologically. Excerpts from one site's conclusions include "the B-24 wreckage is an easy and interesting dive" and "I would recommend any tour guides to the area restrict any visitors from walking on the wings" (Holly 2000a:14). Thus, while serving as a starting point for future archaeological work, these reports lack the depth of analysis expected from an archaeological survey. Further, as Holly

admits, the survey was not exhaustive—sites were chosen for their perceived tourism value or high risk of disturbance (Holly 2000b:10).

Ian MacLeod (2006) produced the first published corrosion studies on submerged aircraft in 2006. In conjunction with Bill Jeffrey's (2006) research on submerged resources located in Chuuk Lagoon, Federated States of Micronesia, MacLeod conducted in situ corrosion measurements of five Japanese naval aircraft. This study provided baseline knowledge for submerged aircraft in various settings in a protected lagoon environment. While MacLeod concluded that further work is necessary to develop a unifying corrosion-model and predict the life-time of the submerged aircraft, this study constituted an important first step (MacLeod 2006:135).

Bill Jeffery's (2006; 2007) survey of submerged resources in Chuuk Lagoon included MacLeod's corrosion survey as one component. This survey formed the basis of a 2006 article as well as his 2007 doctoral dissertation (Jeffery 2006; 2007). Jeffery's primary focus was to "investigate the meanings behind the conflicts in values and uses of the submerged WWII sites" (Jeffery 2007:7). Survey targets included 20 shipwreck and eight aircraft sites, culled from a list of 48 shipwrecks and 11 aircraft obtained from historical research (Jeffery 2007:168–169). Although Jeffery did not provide detailed site drawings for the aircraft studied, he did identify several aircraft wrecks, and produced an in-depth analysis of the values, uses, and impacts of the aircraft sites.

Following this philosophy of viewing not only submerged ships but also aircraft and other vehicles as submerged cultural heritage resources, Jennifer McKinnon and Toni Carrell (2011; 2014) included aircraft, landing craft, and tanks in addition to ships for their development of an underwater heritage trail in Saipan. Conducted as a partnership between Ships of Discovery

and Flinders University, the project team performed a full archaeological investigation of several sites. The resulting products included an underwater heritage trail, complete with interpretive posters and slates for each site, and a lengthy management plan for all sites investigated. Vicki Richards and Jonathan Carpenter (2012) published a conservation assessment report on the sites studied, setting a baseline for further in situ conservation and corrosion study, much like MacLeod's work in Chuuk. In addition, five of the Flinders University field school participants wrote their Master's theses based on research conducted during the project (McKinnon and Carrell 2011:xvi). This thesis project, as well, is based on initial research conducted by that team in 2012.

Dave Conlin and Bert Ho, presenting at the 2014 Society for Historical Archaeology (SHA) conference session dedicated to the archaeology of sunken aircraft, spoke of the documentation of a B-29 Superfortress submerged in Lake Meade, Nevada (Society for Historical Archaeology January 8-12:83–84). After multiple field seasons working in the cold, dark waters of Lake Meade, the NPS Submerged Resources Unit created a lengthy National Register of Historic Places (NRHP) nomination that resulted in the addition of B-29 number 45-21847 to the National Register of Historic Places in 2011(National Park Service 2011).

During the same SHA session, Charles Dagneau of Parks Canada's Underwater Archaeology Service (UAS) presented fieldwork undertaken by UAS in 2012 on a submerged Catalina OA-10 (PBY-5A) in Longue-Pointe-de-Mingan, Quebec, near Mingan Archipelago National Park Reserve of Canada (Dagneau 2014:291). Parks Canada located the aircraft wreckage in 2009 in conjunction with a Submerged Cultural Resource Inventory in Mingan Archipelago. Parks Canada UAS conducted a pre-disturbance survey in June 2012, documenting and assessing the condition of the aircraft and completing site plans and photomosaics. Because

the work demonstrated high potential for human remains conservation, the US Joint POW-MIA Accounting Command (JPAC) stepped in to conduct salvage operations (Dagneau 2014:292–293). Excavation to recover the human remains commenced soon thereafter. Human remains of several individuals were recovered and exported back to the United States, while 76 of 179 catalogued artifacts were recovered and transferred to the Province of Quebec for conservation (Dagneau 2014:294). JPAC returned the human remains to their base of operations in Hawaii, and are currently studying them for identification.

The US Navy's NHHC-UAB's Heather Brown also presented during this session, using the recent location of two WWII-era aircraft wrecks off the coast of Florida to illustrate the challenges of documenting, identifying, and managing aircraft wreck sites (Brown 2014:277). Brown first examined how “value” is assigned to aircraft wrecks, and determined that it traditionally has been closely linked to knowing the aircraft's identity and history. Brown suggested that by broadening our perspective beyond the aircraft itself, unknown aircraft wreck sites have great potential for assigned value through interpretation (Brown 2014:277–278). She bolstered this argument with the cases of two WWII-era aircraft wrecks, a SB2C Helldiver off Jupiter, FL and a F6F Hellcat off Miami, FL. Though the aircraft types were determined, both remained unidentified. While efforts to identify the aircraft are still ongoing, she argued that the wrecks have broader value, acting “as points of entry for the general public to become interested not just in naval aviation, but also in Florida's role in World War II and the changes in the area that came as a result” (Brown 2014:281). By moving away from focusing solely on the identification of aircraft, Brown argued, and examining the wrecks in a broader socio-cultural and historical context, the study of these sites become more relevant to historical archaeology as a whole and more accessible to a wider audience.

While not inclusive of all archaeological work conducted on submerged aircraft, this review demonstrates that a wide range of individuals, groups, and organizations have conducted research on submerged aircraft wreck sites. It exhibits a maturing of the field, as research has slowly moved away from efforts to identify and salvage aircraft to understanding the wreck sites in situ. Conversely, this review also reveals the infancy of the field, and the necessity to study the application of core underwater archaeological concepts, such as site formation studies, cultural resource management, and interpretation, to submerged aircraft wreck sites.

2.4 Submerged Aircraft Site Formation Studies

Maritime archaeologists have extensively studied site formation processes as they apply to shipwrecks (see section 2.2 for key studies), but they have been slow to investigate and apply these concepts to submerged aircraft wrecks. While site reports for submerged aircraft wrecks may speculate as to the cause of crash and depositional events (for examples, see (Rodgers et al. 1998:15–17; Dagneau 2014:293)), few studies have directly studied the “processes through which that organized assemblage of artifacts comprising a ship [aircraft] and its contents will have passed to produce the collection of items excavated on the sea-floor” (Muckelroy 1978:158). Although Silvano Jung (1996; 2001; 2007a; 2007b; 2008; 2009a; 2009b) wrote prolifically on the topic of aircraft site formation processes, specifically for PBV Catalina aircraft located in Darwin Harbor and Roebuck Bay, Australia, other scholars have just begun to study the topic. Ian MacLeod (2006) and Vicki Richards and Jon Carpenter (2012), writing on corrosion studies of submerged aircraft, helped advance the knowledge of the environmental side of site formation processes of submerged aircraft. More recently, Samantha Bell (2010)

dedicated her Master's thesis to the study of site formation processes of four aircraft wrecks in Tanapag Lagoon, Saipan.

Jung's (1996) foray into the archaeological study of sunken flying boats began with the PBY Catalina wreck sites located in Darwin Harbor, Northern Territory, Australia. Jung's focus for this project lay in locating and then determining the model of each aircraft, in an attempt to establish the identity of some or all of the aircraft (Jung 1996:23–24). After locating four of the six aircraft reported lost in Darwin Harbor, Jung began by narrowing down the possible model variants, until he determined that the wrecks located in Darwin Harbor were either PBY-4, -5, -5A, or PB2B-1 variants. The features of these aircraft that changed between models were classified diagnostic, and Jung created a line drawing that illustrated the difference between the models (Jung 1996:27–28). Using a combination of these diagnostic features, and comparing the site wreckage to depositional factors taken from historical accounts, Jung tentatively identified the four aircraft (Jung 1996:33–36). He concluded that further research is necessary to confirm their identities, and that as a consequence archaeologists need to “follow-up [on] collaborative evidence and to record site features that are diagnostic of the Catalina models lost in Darwin Harbor as well as tak[e] into account what evidence remains of how they were lost,” emphasizing the need for further site formation process studies of these aircraft (Jung 1996:36).

Jung later applied these ideas to a series of flying boat wrecks located in Roebuck Bay, Broome, Western Australia. Broome was the site of a Japanese air raid on 3 March 1942, resulting in the loss of fifteen flying boats and 100 lives (Jung 2007a:26; Jung 2008:1). Using a wide variety of terrestrial, underwater, and aerial survey techniques, including a photographic survey from a helicopter, georectification of post-raid photographs with modern admiralty charts,

and analysis of previous side-scan sonar data, ten flying boat sites were located and surveyed (Jung 2007a; Jung 2007b; Jung 2009a).

To assist in the rapid recording of six of the wreck sites that were exposed during spring low water (SLW) tides, Jung developed a deconstruction method he coined “defabrication” (Jung 2007a:26–27). This method “utilizes a set of historical aircraft line drawings, which are altered according to archaeological data, to develop wreck site plans that illustrate the condition of surviving airframes” (Jung 2007a:26). By recording the basic layout of wreck sites, then basing the site plan on a deconstruction of historical line drawings, the defabrication method determines what is missing, what is out of place, and what are the diagnostic attributes of type and model in the archaeological record (Jung 2007a:28). Jung also argued that the defabrication method “provides an insight into the circumstances of post-depositional events” that affected wreck sites (Jung 2007a:26).

Jung concluded in his 2007 results of the Broome survey that “whilst it is beyond the scope of this research to investigate the site formation processes that may have impacted on the wreck sites, it is evident that this is the subject of another investigation” (Jung 2007b:42–43). This would come in 2009, with the publication of an article dedicated to the wing inversion site formation process observed in the Roebuck Bay PBY Catalina wrecks. Wing inversion, described as “where the port wing settles upside-down on the starboard side of the fuselage (upside down) and vice versa for the starboard wing,” is a unique depositional process for parasol wing aircraft in which the fuel tanks are located in the center section of the mainplane (Jung 2009a:23).

Jung determined that in the Broome examples, the ruptured fuel tanks leaked burning fuel down the wing and into the blister compartment, causing the tail section to break away. As the

wing plane's structural integrity failed, it collapsed around the fuselage, resulting in wing inversion (Jung 2009a:22–23). He further refined this process into two types, center-of-mass and engine-wing damage, that produce distinct wing inversion wreckage patterns depending upon whether the aircraft was damaged at the fuel tanks (center-of-mass) or at the wing or engine mounts (engine-wing) (Jung 2009a:24–27). This created a predictive model that can be applied to PBV Catalina and similar flying boats destroyed at mooring, an important milestone in the understanding of site formation processes of submerged aircraft wreck sites.

Samantha Bell, in her 2010 Master's thesis, also examined the application of site formation processes to submerged aircraft. Her research objectives, as opposed to Jung's quest for identification and depositional models, were more theoretical in nature. Bell investigated four aircraft wreck sites in Tanapag Lagoon, Saipan, to determine whether shipwreck site formation theory could be applied to submerged aircraft sites (Bell 2010:3). Bell concluded that previous process-oriented frameworks for shipwreck site formation theory could be applied to submerged aircraft wreck sites, albeit with modification. Her research resulted in a flow diagram (Figure 6), based off of Muckelroy's original design, to apply to submerged aircraft wreck sites (Bell 2010:120–125).

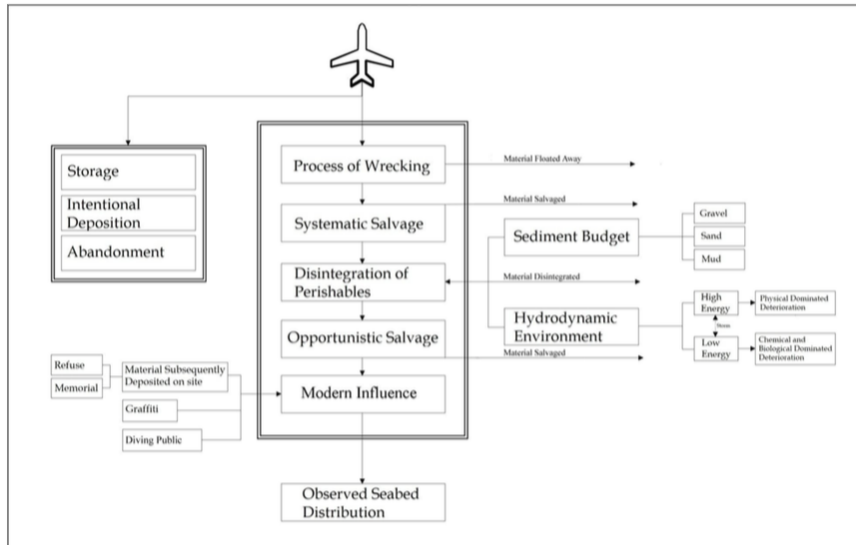


Figure 6. Flow diagram modified for application to submerged aircraft (Bell 2010:124).

These studies constitute the major efforts to understand the site formation processes that affect submerged aircraft wreck sites. Bell (2010:120–125) argued that post-depositional factors may be the same as shipwreck sites, allowing us to draw from that knowledge. The depositional process, though, certainly requires more study. Michael McCarthy (2004:83) pointed out, aircraft crash investigators have been studying this for years, albeit not in an archaeological sense. Jung (2009a:23) applied that idea to his studies, using the ‘wing clapping’ phenomenon described in an aircraft accident reconstruction manual to develop his wing-inversion model. Perhaps a cross-disciplinary approach, then, could provide valuable clues as to depositional site formation processes.

2.5 *Submerged Aircraft Management*

As with other topics concerning submerged aircraft wreck sites, the protection and management of them has also been a relatively recent development in the field of maritime

archaeology. This was exacerbated by the lack of recognition given to historic aircraft in general until the early 1990s (Diebold 1993; Foster 1993). The situation has thankfully changed since then, and both submerged and terrestrial aircraft sites are now viewed as historic cultural resources deserving protection. This section highlights the published ideas most relevant to the Tanapag Lagoon Coronado site.

Wendy Coble (2001), an archaeologist with the former NHC-UA (present NHHC-UAB), examined the threats to US Navy aircraft sites located in the Pacific. According to Coble, there are three main threats to those sites in general, and submerged aircraft wrecks in particular. These three are all human threats: threats from souvenir collectors, opportunistic salvage by native islanders, and professional salvage conducted by outsiders. Coble aptly summarized the threat from souvenir collectors by stating:

Aircraft hold particular interest and even the most circumspect, when faced with their remains, may feel compelled to own a piece of this history. Few casual collectors realize that by taking pieces, moving objects, or altering their environment they severely damage an investigator's ability to understand the story the site holds. (Coble 2001:28)

The second human threat was identified as opportunistic salvage by native islanders. From a postcolonial viewpoint, the war happened to the islanders—they were neither antagonists nor protagonists, yet it still altered their lives. In many cases, their islands were reduced to shambles, and they were left to rebuild by themselves after the war ended. The aircraft wrecks, left behind by the military, seemed like scrap. “It is little wonder that many aircraft crash sites were salvaged by islanders to rebuild their homes, villages, and towns” (Coble 2001:28). Coble justified this opportunistic salvage as necessary for “island life,” yet lamented that site integrity has been, and

still continues to be, damaged. “Ideally,” Coble wrote, “local islanders should be educated in how to study and protect these sites. Realistically, it is a difficult if not impossible task” (Coble 2001:28).

Commercial salvors and professional collectors pose the third, and most serious, threat. The historic aircraft parts business is very lucrative; many salvors, aware of the historical and emotional value attached to crash sites, are more concerned with the monetary value. Even while destroying sites for profit, they claim the US Navy is doing more harm than good by restricting access to these resources. According to Coble (2001:28), they believe that if they do not “save” the aircraft from the ravages of the ocean, those aircraft may disappear altogether.

Coble also notes, albeit in passing, that Pacific cultural resource managers may feel ill equipped to either document a site or perform research involving submerged aircraft. To aid them (and divers in general) in this process, the NHC-UAB hosted a policy fact sheet on their web site (Coble 2001:29). Further, Coble insisted that cooperation between the NHC-UAB and Pacific cultural resource managers was the only way to ensure that those resources can be protected and interpreted (Coble 2001:29). It is interesting to note that she wrote this article before the Sunken Military Craft Act (SMCA), yet the content is exactly what one would expect for a SMCA-influenced paper—the US Navy reiterates their claim of ownership of sunken naval vessels, and in situ conservation is the preferred course of action (Coble 2001:27–29)

Bill Jeffery’s (2006) article was slightly broader in scope yet more specific in location than Coble’s. The intent, however, was different: Coble’s paper meant to highlight the fact that there was a problem, while Jeffery’s article outlined what those specific problems were and offered solutions to them. While Jeffery concentrated on Chuuk, many of those issues exist throughout the Pacific Islands. In addition to conducting a general CRM investigation of Chuuk

Lagoon, Jeffery described four issues that affected sites in Chuuk. These were recognition of the sites as Japanese war graves, poor mooring practices, dynamite fishing, and diver impacts (Jeffery 2006:150). Jeffery also noted two areas that affect the sites but have seen little research: the stability of munitions and corrosion studies (Jeffery 2006:151).

The first of the four main issues Jeffery outlined was the recognition of Japanese war graves. The sites in Chuuk contain a number of Japanese human remains. Although some were recovered and cremated in the 1970s, skeletal material still exists on-site today. This has apparently been a point of contention, as Japanese guides and individuals have repeatedly made requests for divers to respect these sites as war graves. Despite that, many divers ask specifically to be shown such remains as the human skull found on *Yamagiri Maru* (Jeffery 2006:150). The resulting movement (and removal) of artifacts represents the second issue: diver impact. Divers also impact the sites in unintentional ways, such as their exhalation bubbles and deliberate or accidental removal of concretions accelerating the corrosion rates of iron and steel (Jeffery 2006:150–151).

The third issue Jeffery mentioned is mooring. While some sites have had permanent moorings attached, most do not. This anchor damage is compounded by the fact that some sites are still found by dragging a small boat anchor until it “hooks” the shipwreck (Jeffery 2006:150). This continuing practice continues to damage sites, not only by potentially tearing holes in the hull and breaking sections off, but also because it can cause corrosion to re-start in areas damaged by the anchor.

Dynamite fishing was also a significant problem in Chuuk, as it not only damaged the shipwrecks, but it also encouraged the removal of munitions from the sites to make dynamite

bombs for fishing. Dynamite fishing is not only illegal under the legislation protecting the shipwrecks, but also under other Chuuk Marine Resources legislation (Jeffery 2006:150).

Dirk Spennemann, acting in 1992 as the chief archaeologist and deputy director of the Republic of the Marshall Islands Historic Preservation Office, wrote about the cultural heritage left on central Pacific Islands. Although Spennemann concentrated on terrestrial sites, many of the same concepts and arguments apply to submerged sites, as illustrated by Coble and Jeffery above. Particularly interesting were the differing ethnographic descriptions of various groups' perceptions of cultural heritage: Pacific Islanders, Westerners, Japanese, and scholars (Spennemann 1992:280). Spennemann was careful to point out, in a post-colonial manner, that although Anglo-Saxons were the minority group in the Marshall Islands, a majority of the funding, programs, and outside interest have gone into that minority (Spennemann 1992:283). He further argued that the WWII sites are the most threatened sites, so should be prioritized (Spennemann 1992:285). He characterized the threat to WWII resources as the "four horsemen of the apocalypse," listed as:

- The first is war and the impact wreaked on sites and collections;
- The second is neglect and destruction, labelled modernization or development;
- The third is the army of avid collectors, pillaging sites, as well intentioned as some may be;
- The fourth of the horsemen of the apocalypse is about to visit upon these sites—the tourist. (Spennemann 1992:285)

Interest in the management submerged aircraft sites has not been limited to US aircraft. Vince Holyoak (2001), studying Great Britain's airfields, discussed the merits of studying airfields as battlefields and aircraft as archaeological resources. Holyoak noted that the construction of airfields throughout Great Britain from the beginning of WWI to the end of

WWII vastly changed the landscape, and a “close analogy” could be made between the casualties of WWI trenches and WWII airfields (Holyoak 2001:253–254). He also portentously predicted “submerged crash sites will come under increasing pressure in the future” (Holyoak 2001:263).

At about the same time, English Heritage (2002) published their report offering guidance on the significance and management of military aircraft crash sites. Where Holyoak’s discussion was theoretical, theirs was practical. Covering both terrestrial and submerged sites, the report explained the significance of aircraft crash sites, provided criteria for the selection of important sites, and offered management solutions and further resources. The report described the actions taken by salvage crews on terrestrial sites, but sadly did not discuss the salvage of submerged sites. It did, however, state that submerged crash sites “perhaps offer the best potential for the future” (Wessex 2002:3).

English Heritage continued to express interest in submerged military aircraft crash sites. Wessex Archaeology (2008), under contract to English Heritage, published the report “Aircraft Crash Sites at Sea: A Scoping Study.” A desk-based assessment, the study’s purpose was to “identify current gaps in data and understanding relating to aircraft crash sites at sea” (Wessex 2008:i). The report was spurred by the accidental recovery of aircraft remains during marine aggregate dredging, and sought to further elaborate upon the significance and management of submerged aircraft crash sites. This included the examination of several case studies, a review of existing guidance and legislative context (in the UK), and the identification of authorities and stakeholders of potential sites (Wessex 2008:37–60). The resulting conclusions and recommendations called for greater “attention and priority” of aircraft crash sites at sea, including further research of sites, updating databases to accurately reflect the numbers and

locations of submerged crash sites, and review and development of policies and laws concerning specifically aircraft crash sites at sea (Wessex 2008:62–64).

Finally, of great use to this thesis in particular, are McKinnon and Carrell's (2011; 2014) reports "Saipan WWII Invasion Beaches Underwater Heritage Trail" and its follow-up "Management Plan and Public Outreach for WWII Submerged Resources in Saipan" (McKinnon and Carrell 2014). The former describes the creation of an underwater heritage trail following WWII sites, complete with detailed history, archaeological analysis, and the process through which that information was made publicly accessible through an underwater heritage trail. The latter report outlines the conditions of those sites on the underwater trail (and several more, including the PB2Y Coronado studied in this paper), analyzes the imminent threats and impacts, and offers recommendations for both the management of the sites and the creation an overall management plan for the cultural resources located in the Commonwealth of the Northern Mariana Islands.

3 Methodology

This thesis represents the first systematic archaeological survey of the PB2Y Coronado site in Tanapag Lagoon. Although previously known by local people, archaeologists did not visit this site until 2012 (McKinnon and Carrell 2014:39). The survey team conducted an abbreviated survey over two days, succeeding in identifying the airplane type, taking corrosion parameter measurements, conducting a photographic survey, and creating a basic site plan. As the survey was preliminary in nature, a more thorough survey with complete dataset was desirable.

This chapter discusses the research and survey methods used in completing this thesis. First, the fieldwork survey methodology utilized to create site plans and collect archaeological data will be explained. This includes methods used during the site survey, photographic survey, and environmental survey. This chapter next provides details concerning archival and historical research. Aircraft identification techniques, as well as methods for analyzing the site formation processes and forming a wrecking model, are discussed. Finally, limitations to this research are acknowledged and their potential impact outlined.

3.1 Survey Methodology

Fieldwork for this thesis occurred in November 2014. As one of the primary goals of this thesis was to study the site formation processes that led to the current site distribution, and further extrapolate a wrecking event model, it was necessary to create an accurate site plan. Two sets of site plans were created: a 1:20 plan of the main assemblage, and a 1:100 plan of the entire wreck scatter. In this manner, not only could details of the main assemblage be studied but also the distribution of outlying wreck scatter could be analyzed in relation to high-concentration

areas of the site. Other goals for the fieldwork season included conducting photographic and environmental surveys, which were undertaken in conjunction with the site plan survey.

3.1.1 Site Plan Creation

Site survey and plan creation were deemed the first priority of the field investigation in order to allow for potential weather days. The initial survey compared the site against the 2012 site plan. Mapping then commenced, using different strategies for each plan. Baseline-offset measurements were utilized in the creation of the 1:20 site plan, while the 1:100 site plan used distance-angle measurements to extend the area of the 1:20 plan.

The baseline was set parallel to the longitudinal axis of the major airframe wreckage, along the starboard side of the aircraft. The baseline ends consisted of two pieces of rebar driven into the sand, 12.55 m apart and aligned at 310° orientation. A baseline support of 4 mm braided nylon rope was tightly affixed to the rebar ends. The baseline tape was firmly attached to the rope with cable ties. The zero end of the tape was positioned at the northwest end of the baseline.

Data was collected in the form of annotated sketches. Instead of creating scaled drawings on-site, a sketch of each area was made, and measurements to specific features noted. These, coupled with scale photographs taken, allowed an accurate site plan to be constructed as a result of data post-processing. As each major section was completed, any inconsistencies in measurements or relationships were double-checked on-site the following day.

To map the wreckage scatter outside of the baseline area for the 1:100 site plan, the distance-angle measurement method was used. In this method, a tape measure is run from a datum point to the object to be measured, and the distance and compass bearing is noted (Catsambis et al. 2011:128). For this thesis, a fixed point above the reef to the west of the engine

was set as the datum from which measurements were made. The 1:100 plan creation was conducted as a 100 m radial survey. Divers swam a circular pattern with spacing appropriate for the visibility (generally 15 to 20 m). When wreckage or artifacts were located, the distance and compass bearing were recorded and the features photographed. This method was utilized in taking measurements of wreckage scatter as far as 100 m away from the datum point.

Using these methods, the site was completely mapped in 25 dives conducted in 14 working days. Draft site plans were created on graph paper in the evenings during the fieldwork season. Both plans were finalized in ink-on-Mylar after fieldwork, which was then scanned and digitized as vector artwork in Adobe Illustrator in December 2014.

3.1.2 Photographic Survey

As stated in *Maritime Archaeology: A Technical Handbook, Second Edition*, photography “plays an essential part in underwater archaeology as it is an extremely practical method of recording information” (Green 2004:217). Accordingly, a photographic survey was performed as part of this thesis research. This allowed aspects of the site to be later examined for details. This proved to be a great aid in finalizing the site plans as well as studying the site formation processes active on the site.

The photographic survey was undertaken using an Olympus Tough TG-3 waterproof point-and-shoot camera. One full dive was dedicated only to the photographic survey; thereafter, photographs were taken as mapping progressed to new areas. The main site area was systematically covered, taking profile, plan, and detail photographs as appropriate. When documenting larger objects, a 1 m photographic scale was used, while smaller features were photographed with either 20 cm or 50 cm scales. A scale card with both 8 cm and 40 mm scales was used in capturing minute details.

3.1.3 Environmental Survey

In order to better understand what environmental conditions may have affected the formation of the site, as well as its post-deposition, an environmental survey was conducted. This survey examined the environment in which the site lies and the factors that affect that environment. NOAA weather forecasts were checked every morning and recorded into a field journal; actual site observations of wind, waves, and current were appended at the end of each day. Local knowledge was also collected by talking to boat captains and dive shop owners who regularly operate in the lagoon.

The seabed was also examined for burying potential. To determine to what extent the wreckage might be buried, an abbreviated probing survey was undertaken. Rather than probing for the presence of buried wreckage, the objective was to determine the depth of sediment cover above hard substrate. This was accomplished by pushing a 120 cm rebar probe into the seabed as deeply as possible, then measuring the depth of penetration. Care was taken to probe in areas unlikely to contain buried wreckage, so that site integrity would not be affected.

Potential impact by typhoons was also investigated. While an extensive survey of typhoons in Saipan is not available, Dirk Spennemann's (2004) *Typhoons in Micronesia* does have a section on the Mariana Islands. As this section only covers the years 1905 through 1914, its value lies in the ability to understand the general trend rather than as a direct reference. In that regard, the US Naval Observatory Joint Typhoon Warning Center (JTWC) provides "Best Track Data files for Western North Pacific tropical cyclones [sic]," (Joint Typhoon Warning Center 2014) for the years 1945 to the last typhoon season. This data provides tracking information on all typhoons JTWC recorded during that season. Beginning at 1959, JTWC provides KML files that can be imported into Geographic Information System (GIS) software such as ArcGIS.

Best track data for the years 1959 to 2013 were downloaded and imported into ArcGIS. The data was filtered by location, and datasets were created for typhoons that passed directly over Saipan, as well as those passing within 10, 50, and 100 km of the island. These datasets allowed the prediction of possibility of storm-related damage to the site. They also provided the wind speeds for typhoons within range, allowing a more accurate prediction of effects of each typhoon (for example, a typhoon with maximum wind speed of 130 kt may have passed the island at the beginning of its formation, only producing 30 kt winds on Saipan).

3.2 Archival and Historical Research

Prior to the commencement of fieldwork, extensive historical (secondary source) and archival research (primary source) was conducted. Research proceeded from broad to specific areas, covering the following topics:

- WWII in the Pacific Theater
- Histories of individual squadrons and aircraft
- History of early flight
- History of flying boats
- PB2Y Coronado.

Historical research was conducted before archival research, allowing time spent in the archives to be focused on more specific topics.

3.2.1 Historical Research

Historical research consisted of an extensive study of many topics. WWII in general, the Pacific Theater, and the Battle of Saipan were the first topics studied. After a thorough

understanding was gained, more subtle topics were studied, including: the history of Saipan and its people; Japanese and American political atmospheres up to and through the war; American strategy concerning the central Pacific; the importance of Saipan to both sides and reactions to its capture/loss; Japanese, American, and native islander views of the colonization; battle for, loss, and subsequent occupation of Saipan; US Army and Marine Corps rivalry that erupted during the battle; and finally the tale of Captain Oba, who continued conducting guerilla warfare for more than a year after Saipan was secured. This provided a background to understanding the importance of WWII and the Battle of Saipan throughout history from various perspectives.

Next, historical research of the PB2Y Coronado was conducted in a similar fashion. The broad history of flight was first consulted, leading to a comprehensive study of the history of flying boats. Flying boats played an important role in the history of early flight and exploration through WWII, so a considerable amount of time was spent studying this topic. The history of Consolidated Aircraft Corporation and its founder Reuben Fleet provided a background to an exhaustive study of the PB2Y Coronado aircraft itself.

In addition to secondary sources, other avenues of historical research were pursued. Oral histories and written memoirs were consulted. This provided a personal touch to the research and allowed a trace of post-processual multivocality to flavor the results of this study. Memoirs of PB2Y Coronado pilots and crew helped to elucidate the conditions in which they operated during the war as well as the hardships they suffered, and the perceived importance of the aircraft to themselves, the navy, and the war effort.

Museum visits constituted another avenue of research. The National Air and Space Museum of the Smithsonian Institution, in Washington, DC, was visited to gain a greater understanding of both early flight and air superiority in WWII. Of particular interest was the display of a Pratt &

Whitney Twin Wasp R-1830-92 engine. Although the display unit came from a different aircraft, it is the same model engine installed on PB2Y-5 model aircraft. Also visited was the National Museum of the US Navy, located in the Washington Navy Yard. This museum imparted a sense of the US Navy's pride in its history. It also maintains an expansive exhibit of WWII, divided into Atlantic and Pacific Theaters.

Although not visited, the National Naval Aviation Museum in Pensacola, Florida, which houses the last remaining PB2Y Coronado, proved to be of great assistance. The museum's website and Facebook page host an assortment of photographs of the Coronado restoration project. Staff there was helpful, and graciously responded to requests for additional photographs of the interior of the restored aircraft. These were particularly helpful, as they were able to indicate the location of the manufacturer's data plate inside the cockpit, as well as later confirm the original positions of the hatch cover and astrodome found on the site in Saipan.

3.2.2 Archival Research

Historical research illuminated several topics that were best pursued in archival primary sources. Two main repositories of primary sources were visited: the US National Archives & Records Administration (NARA) Archives II in College Park, Maryland, and the Naval History & Heritage Command (NHHC) archives in the Washington Naval Yard, Washington, DC. Internet searches were also useful in procuring specific primary sources such as photographs and operations manuals for equipment.

As the NHHC archives house specific aircraft, unit, and ship history, research there had two main goals: to create a shortlist of PB2Y Coronado aircraft that were recorded lost at Saipan, and to uncover details of any salvage operations undertaken for those aircraft. A shortlist was created by examining the Aircraft Accident Reports (AARs), commonly referred to as "crash cards,"

contained on microfilm reel 28. These are the official reports submitted after an accident, and contain information such as date, time, aircraft number, squadron, location of accident, names and ranks of crewmembers, cause of accident, accident description, level of damage, severity of personnel injuries, and other details.

Aircraft History Cards (AHCs), contained on microfilm reel 16, were also consulted. These were the logistical record of aircraft. Each individual aircraft was issued its own card that recorded to which squadron the aircraft had been issued or transferred, dates of issuance or transfer, dates of maintenance, and finally the date when the aircraft was stricken from official record. These provided a cross-reference to the accident cards, and uncovered several aircraft that were lost but did not have a corresponding accident report.

Additionally, unit histories were studied for those units known to have flown PB2Y Coronados. The NHHC archives house narrative histories for these squadrons. These histories are more akin to journalism than detailed historical records, containing only significant or unusual events. These histories were useful as they recorded squadron base movements, deployments, and the loss of aircraft. In some cases, the information contained in these narrative histories was more detailed or more accurate than that in accident reports, suggesting that someone intimately involved with the squadron may have written the narrative history, while someone not involved in the squadron's day-to-day operations may have written accident reports.

NHHC archives also house ships' histories. The Dictionary of American Naval Fighting Ships (DANFS) was consulted to determine which salvage vessels operated in the Northern Mariana Islands during and shortly after the war. The history of each of these vessels was then examined for any mention of either salvage of PB2Y Coronados or any activity within Tanapag Lagoon.

Finally, the NHHC archives' aviation history section archives files on aircraft models. These contain information pertaining to an aircraft's development and performance. The PB2Y file was extensively studied, as it contained correspondence between the US Navy and Consolidated Aircraft Corporation pertaining to the development of the PB2Y Coronado, especially the changes and upgrades to the different variants. This file also contained original photographs of the aircraft, both for internal and public use.

Several days were also spent at NARA II in College Park, Maryland. NARA II houses records that originated after 1900 in civilian and military departments of the Executive branch of government (US National Records and Archives Administration 2014). Staff was frequently consulted to determine where to search for specific information. As understanding of the contents of each record group is best described as esoteric knowledge, each consultant suggested different lines of query. This led to a variety of files in different record groups being studied, in hopes of finding information relating to PB2Y Coronado operations in Saipan, records of losses of aircraft there, and records of their salvage.

Record Group 38 (RG38), Records of the Office of the Chief of Naval Operations, was the most extensively studied. Of particular interest in RG38 was the subgroup "Records Relating to Naval Activity During World War II." This subgroup contains a variety of records created by the US Navy during WWII. Of these, two series were examined: War Diaries and Action and Operational Reports.

The War Diaries series of RG38 houses the monthly "war diary" report that each unit submitted to its fleet commander during the war. For aircraft squadrons, these reports contained detailed information on flights conducted, flight hours accumulated, ordnance expended, injuries, and aircraft gained, damaged, and lost. The war diary of each squadron that operated PB2Y

Coronado aircraft was surveyed. Entries of aircraft damaged or lost as well as squadron transfers and deployments were noted. In this fashion, it was possible to create a timeline of each, to determine which squadron had aircraft based at or deployed to Saipan throughout the war.

War diaries were useful in that they recorded when aircraft were lost both in accidents and otherwise, making it possible to verify the data contained in Aircraft Accident Reports. The war diaries also illuminated those aircraft that did not have an Aircraft Accident Report submitted. It is conjectured here that these aircraft were nonoperational losses, and did not require an AAR as they were not crewed at time of loss. Such accidents included losses due to fire, storms, and collisions.

Finally, the war diary of the Saipan Island Commander was consulted for an overview of activities on Saipan after it was established as a US base. This war diary contained entries related to base development, troop movement, and operational status. While it did not contain any specific information on aircraft lost or salvage missions conducted, it did instill a general perspective of US activities on Saipan in 1944 and 1945.

Also studied in RG38 were Action and Operational Reports, contained in the “WWII Action and Operational Reports” series. As with the war diaries, these reports were also grouped by squadron. They contained all pertinent information about an individual encounter with the enemy by an aircraft. Filed by the aircrew, the report specifies where and when the encounter took place and gives details about the enemy vessels (both aircraft and ships). It also includes a narrative of the encounter and actions taken by both sides. Ordnance expended, as well as damage sustained by both is listed and often photographs are attached. Each PB2Y Coronado squadron’s Action and Operational Reports were examined, which provided further detail to information contained in squadron narrative histories and war diaries. The Action and Operational Reports were yet

another way to verify both that an Aircraft Accident Report was present for each aircraft lost in action as well as the information contained in its Aircraft Accident Reports.

The World War II Casualty Lists and Related Records series of the Casualty Branch subgroup, contained in Record Group 24 (RG24) Records of the Bureau of Naval Personnel, was also reviewed. This series contains correspondence between squadrons and officials in Naval Personnel concerning personnel casualties. The records of each PB2Y squadron were studied for any details about the loss of crewmembers, especially any recovery or salvage operations.

Record Group 72 (RG72), Records of the Bureau of Aeronautics (BuAer), was also the subject of inquiry. The General Correspondence subgroup for the years 1943 to 1945 is separated into aircraft type and then organized using the *Navy Filing Manual*. At the advice of NARA staff, the records most likely to contain information pertaining to the loss of aircraft or subsequent salvage efforts would be filed under A9, Reports and Statistics, and L11-1, Casualties and Salvage (US Navy 1941:11–12, 64–65). Correspondence filed under A9 and L11-1 between 1943 and 1945 for aircraft models PB2Y-3, -3R, -5, and -5R were all examined.

The last record group to be examined was Record Group 313 (RG313), Records of Naval Operating Forces. Of particular interest were the records generated by the Trust Territory of the Pacific Islands, which officially administered Saipan from 1947 until 1978 (Carrell et al. 2009:348–350). These records also frequently contained files generated before 1947, when the island was still occupied by the US military. Filed according to the *Navy Filing Manual*, each record examined during research also contained a “Red” designation number, marking them as records from commands that oversaw large geographic areas or operational theatres (Ligon 2011). They were searched for records about base development, in the hopes that they may hold information about postwar salvage and harbor development.

The Cartographic and Architectural Section at NARA II was also visited. All charts within the Saipan Harbor section were viewed, ranging from the US Navy's original 1945 chart #6062 to NOAA's latest updated chart #81076. These were studied to understand how the boundaries of the seaplane base at Tanapag Lagoon, including the runway and anchorage areas, changed over time. They were also checked for the inclusion or removal of wreck or submerged obstruction symbols, possibly indicating the awareness and/or salvage of this thesis site. Finally, notes were taken of harbor development projects shown on the charts, such as dredging or wire-dragging activities.

3.3 Analytical Methodology

In order to understand the site formation processes in effect on this site, several analytical methods were utilized. These were divided into the depositional and post-depositional phases. Depositional phase analysis centered on site identification: if the aircraft could be identified, then historical records might elucidate the cause of crash and a crash scenario could be created. Post-depositional analysis focused on identifying and understanding events that affected the site after the wrecking event.

3.3.1 Depositional Analysis

As this thesis aims to re-create a wrecking model based on historical records, aircraft identification is a crucial component of this research. Because specific identifiers such as the manufacturer's data plate or markings on the vertical stabilizer were not located, several different approaches were used to aid in aircraft identification. Extensive historical research was conducted. The presence/absence test was used, as well as Silvano Jung's (2007a:26; 2009a:25–

26) theory of defabrication to determine model variant. Finally, geographical evidence was used to compare the site location against known crash locations.

Historical and archival research, conducted using the methodology described above, was used to narrow down the possible aircraft Bureau Numbers (BuNos). Based on this research, a shortlist was created of all PB2Y Coronados reported to have crashed or otherwise been destroyed at Saipan. These BuNos were entered into a table along with information obtained from Aircraft Accident Reports. The resulting table could then be sorted by parameters such as crash date, aircraft model variant, specific crash location, etc., to assist in further research.

Jung's (2007a:26; 2009a:25–26) method of defabrication was next applied to the site. Line drawings of both combat and non-combat configurations were deconstructed. These were compared to the site, in order to better understand the wreckage. Specific features were identified. Following identification of features, a presence/absence test was conducted to determine aircraft model variant. Main indicative features tested were weapons (both offensive and defensive) and engines.

Geographical evidence was also considered while attempting to identify the aircraft. The wreck site was plotted in ArcGIS. Next, an overlay of georectified charts was added. Both period and contemporary charts were used. The location of the wreck site was studied in relation to main features of Tanapag Lagoon, including the seaplane base and ramps, seaplane anchorage, runways, and barrier reef.

3.3.2 Post-Depositional Analysis

Post-depositional analysis consisted of historical and archival research as well as fieldwork. Historical and archival research was conducted in order to determine whether any record exists

of salvage, either by the US Navy or other parties. Records were also consulted to determine whether any harbor improvement work may have affected the site.

Local knowledge was also accessed through inquiry at dive shops, submarine tour operators, and the Historic Preservation Office. As Saipan is a small island, and dependent on the diving tourism industry, it is likely that these groups would have knowledge of any salvage activities, either systematic or opportunistic.

A presence/absence test allowed researchers to identify what sections of aircraft were present or absent on-site. This test, combined with the method of defabrication (described below), was a useful method to quantify site formation processes.

The method of defabrication, combined with a presence/absence test, was also utilized to perform post-depositional analysis. During site survey, researchers compared individual pieces of wreckage to line drawings of a PB2Y Coronado, in order to identify where those components were originally located on the aircraft. Likewise, researchers noted components that were absent from the site. Particular attention was paid to components that would identify the aircraft's bureau number, model type, or configuration. After survey, scaled line drawings were digitized and then analyzed using the software package ImageJ (<http://imagej.nih.gov/ij>) to measure lengths and areas of sections of the aircraft. After digitization of the site plans, ImageJ was used to determine the surface area of wreckage present on-site. The line drawings were also utilized to help identify wreckage, and to measure the distance between its original location on the aircraft and its actual position on the seabed, relative to the cockpit canopy. Through these methods, it was possible to quantify site formation processes by determining approximate percentages of fuselage and wing present and absent on the site.

The site was also examined for evidence of damage to or movement of components, as illustrated in Bell's (2010) Master's thesis. Bell documented both depositional and post-depositional damage to other aircraft located in Tanapag Lagoon, ranging from crash-related damage to post-depositional accidental anchor damage and vandalism. She also documented the deliberate movement of small and medium-sized artifacts, recorded in as short a time period as six months.

Finally, a "faux wreck site," as documented in McKinnon and Carrell's (2014:46-47) management report was visited. As this site was possibly created from wreckage of several different aircraft, it was carefully examined for evidence of PB2Y Coronado parts. Photographs were also taken for later study and comparison to the PB2Y site and plans. In addition, the local tour submarine company, suspected of creating the site as it is located on their tour route, was consulted about the site.

3.4 Limitations

Before presenting and analyzing the data collected in the next chapter, the limitations of this study must be acknowledged. Concerning historical and archival research methodologies, it must be noted that reference desk staff at the archives heavily influenced which records were consulted. Their breadth of knowledge of the archives' content affected the approach and thoroughness of archival research. This is especially true of the research conducted at the National Archives and its subject specialist staff. It is possible that further pertinent records that were not highlighted exist and failed to be examined in this study.

Surveys conducted during fieldwork were limited by many factors, including time, personnel, and scope of work. All fieldwork in Saipan was completed in one month. Although

several people assisted in various ways, only one or two assistants helped conduct the bulk of diving research. More time and people would have resulted in the collection of a greater quantity of data; for instance, a larger team would have enabled the collection of consistent data beyond the 200 m diameter survey area presented herein.

A further limitation imposed by time and personnel constraints was the distance-angle measurement system utilized during 1:100 site plan creation (see page 40). This method was chosen for ease of use: it allowed a single buddy team to cover a large area of the site, quickly taking measurements, while remaining together. The disadvantage of this method was that as the tape was extended across greater distances, the accuracy of the measurements became increasingly compromised by factors such as bowing of the tape. Had more time and personnel been available, a greater degree of accuracy would have been obtained using triangulation or trilateration to multiple datum points (as opposed to just one in distance-angle). For the 1:100 plan, however, concerned mainly with understanding the overall distribution of the site, such limitations were accepted.

To ensure that the personnel could collect quality data in the time allotted, the scope of work was accordingly limited: this research consisted entirely of non-disturbance survey. It is possible that excavation could shed more light on the aircraft identity, site distribution, or cultural and natural impacts; this remains for future researchers. Likewise, probing was conducted during this thesis research to determine the depth of sediment above hard substrate, in order to postulate the possibility of buried wreckage. Researchers did not search for buried wreckage; this would require either more systematic probing or remote sensing, neither of which were in the scope of this project.

Data analysis was limited by the nature of the site studied. Only one site was surveyed; this constitutes a case study. Thus, all data and conclusions are based on the interpretation of one widely scattered site. With the lack of a positive identifier, aircraft identity is concluded on the basis of geographic location and observed site conditions and distribution. Further, without record of salvage, it was only possible to hypothesize how and why significant sections of the aircraft were absent from the site.

The environmental survey was also limited to personal observations conducted every day for one month, bolstered by information gleaned from locals. The effects of typhoons and large storms in the lagoon have not been systematically documented, so storm-related impacts to the site are only implied. Further, the analysis of typhoon data was based on files from 1959 to 2013 imported into ArcGIS by a novice user and analyzed by an archaeologist. A trained meteorologist or oceanographer might well provide a different interpretation.

Finally, it must be acknowledged that this research is not multivocal in nature; in fact, it is closer to colonial archaeology as this author is an American conducting research about a US Navy plane that sank at a US base as a result of a war in which Saipan was involuntarily involved. While efforts were made to understand the war from American, Japanese, and native islander viewpoints, this research, although informed, may still retain levels of bias. It is possible that further knowledge does exist of the site and its salvage, but was not shared with researchers because of their “outsider” status.

4 History

WWII marked the beginning of the end of the golden age of the flying boat. All of the major combatants deployed large numbers of flying boats. The US Navy alone bought 3,290 PBV Catalinas; 1,300 PBM Mariners; and 217 PB2Y Coronados (Hoffman 2009:1). Germany had the Dornier DO-18, DO-24 and DO-26, and the Blohm and Voss Bv138. Russia produced as many as 1,500 Beriev MBR-2 short range reconnaissance aircraft, quickly developing the MDR long-range flying boat. Great Britain was known for its Short S-25 Sunderlands and their success in protecting convoys against German U-boats. Japan, mostly known for its fighters, also built the Kawanishi H6K Type 97 “Mavis” and H8K Type 2 “Emily”, which was “one of the finest military flying boats of the war” (Allward 1981:100–119).

4.1 Development of PB2Y Coronado

Although the US Navy already had the PBV Catalina, it decided in the 1930s to augment its patrol bomber force with a more capable four-engine aircraft to support fleet operations. Naval strategists determined that only patrol flying boats “capable of searching out at least 1,000 miles and staying in the air for a minimum of twenty-four hours could provide security against attack by Japanese carrier strike forces,” (Trimble 2005:10). They further decided that neither landplanes nor carrier aircraft were suited for such a task. BuAer's Plans Division stressed “big, long-range flying boats as a component of the air forces the navy would need to implement its Pacific strategy” (Trimble 2005:11). In 1935, a design competition held for the construction of prototypes resulted in proposals from three aircraft companies: the Glen L. Martin Co., Consolidated Aircraft, and Sikorsky Aircraft. The Sikorsky and Consolidated designs were

selected for immediate prototyping; Martin's Model 160 would become the Model 170 "Mars" and was awarded a separate prototype contract in 1938 (Hoffman 2009:1).

The remaining two prototypes were designated XPBS-1 (Sikorsky) and XPB2Y-1 (Consolidated) in the 1922 US Navy aircraft designation system. In this naming system, used until 1962, the initial "X" stands for experimental (Swanborough and Bowers 1976:14), while the following letters and numbers are determined using the system: [(Type or Class) (Manufacturer Type Sequence) (Manufacturer) – (Aircraft Configuration Sequence)] (Swanborough and Bowers 1976:8). PB means "Patrol Bomber," while "S" is the manufacturer code for Sikorsky. Consolidated was assigned the manufacturer code "Y," since "C" was already in use for Curtiss Aircraft (Creed 1985:15). Thus, XPBS-1 was Sikorsky's first prototype patrol bomber, first subtype, while XPB2Y-1 was Consolidated's second prototype patrol bomber (the first being the PBY Catalina), first subtype.

Sikorsky's XPBS-1 was ordered on 29 June 1935 and assigned BuNo (Bureau Number) 9995. It first flew on 9 September 1937. Powered by four 1,050 HP Pratt and Whitney R-1830 Twin Wasp engines, it had a wingspan of 37.8 m (124 ft.) and a gross weight of 22,017 kg (48,540 lbs.). It was the first American military aircraft to have a tail turret. It was also fitted with a nose turret and two waist guns. While it showed excellent aerodynamic performance, its hydrodynamics at heavy gross weight were poor. It was not chosen for production as a patrol bomber. The prototype operated as a flag transport until 30 June 1942, when it struck a submerged log while landing in San Francisco Bay and was stricken from records. Although the Navy did not show interest in the prototype, American Export Airlines ordered three civilian versions. Designated VS-44A, one survives to this day at the New England Air Museum (Hoffman 2009:1–2).

4.1.1 XPB2Y-1

Consolidated began development on the Model 29 on 23 July 1936. This was nearly a year after Sikorsky began development on its XPBS-1, which started on 29 June 1935 (Hoffman 2009:1–2; Creed 1985:43; Polmar 2013:14–15). Both were similar in design: high-wing, cantilever monoplanes, single tails and wing tip floats, nose and tail gun turrets, and bomb bays in the wings. Consolidated's prototype also used the 1050-hp Pratt and Whitney R-1830 Twin Wasp engines. Consolidated's aircraft design used the retractable wing-tip floats as seen on its PBY Catalina, while Sikorsky's used fixed floats (Andrews 1989:22). The XPB2Y-1 had a wingspan of 35 m (115 ft.), an empty weight of 12,178 kg (26,847 lbs.) and a gross weight of 22,568 kg (49,754 lbs.). Armament consisted of a .50 caliber nose and tail gun, and .30 caliber guns were located in the upper and lower waist. Range was stated to be 7,065 km (4,390 mi.) (Hoffman 2009:2–3).

Consolidated's Model 29, rechristened the XPB2Y-1 and assigned BuNo 0453, first flew on 17 December 1937 (Creed 1985:15, 43). Despite starting development over a year later than the Sikorsky XPBS-1, Consolidated's test flight took place only three months after the XPBS-1 test flight (Hoffman 2009:1). The XPB2Y-1 suffered from control and directional stability problems. Consolidated's engineers traced the problems to the tail assembly. Originally designed with a single large vertical stabilizer and rudder (Figure 7), elliptical fins were attached to the horizontal stabilizer for the fourth test flight on 28 February 1938 (Figure 8).



Figure 7. Original XPB2Y-1 tail configuration with single vertical stabilizer (Consolidated).

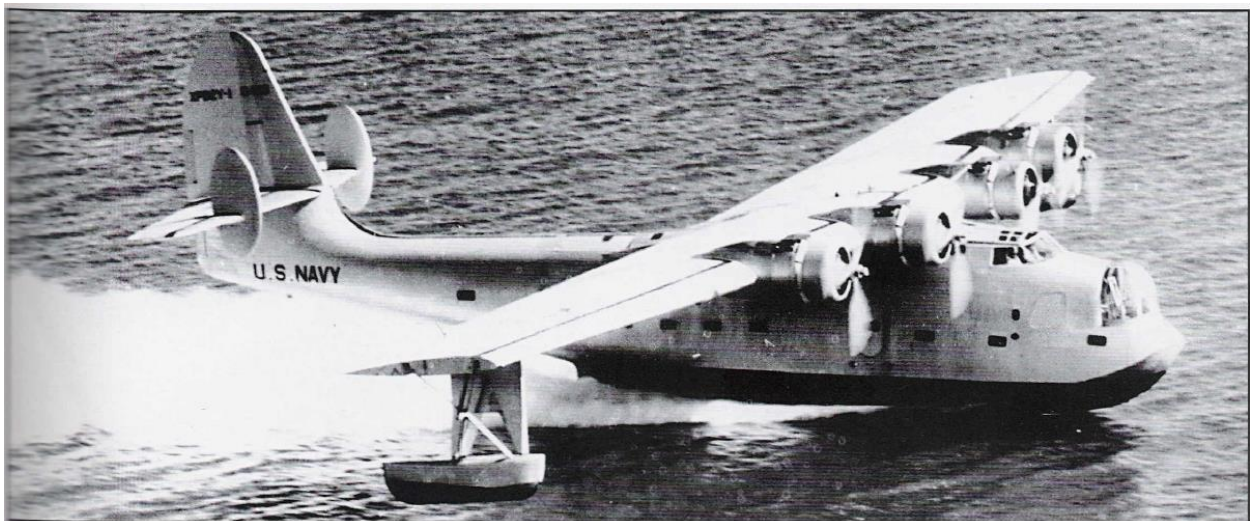


Figure 8. XPB2Y-1 on takeoff with second tail configuration: elliptical fins added to horizontal stabilizer (Consolidated).

Unusual flight attitudes resulted in hazardous spins, from which full power was required for recovery (Hoffman 2009:3). The tail assembly was completely overhauled, replacing the single large and two circular vertical stabilizers with twin circular tail fins attached to a 7.5 degree dihedral horizontal mounted to a stub fin (Figure 9) (Andrews 1989:22). The under-hull was also redesigned (Polmar 2013). These changes solved the stability problems, and the Navy Board of Inspection and Survey trials began in August 1938.

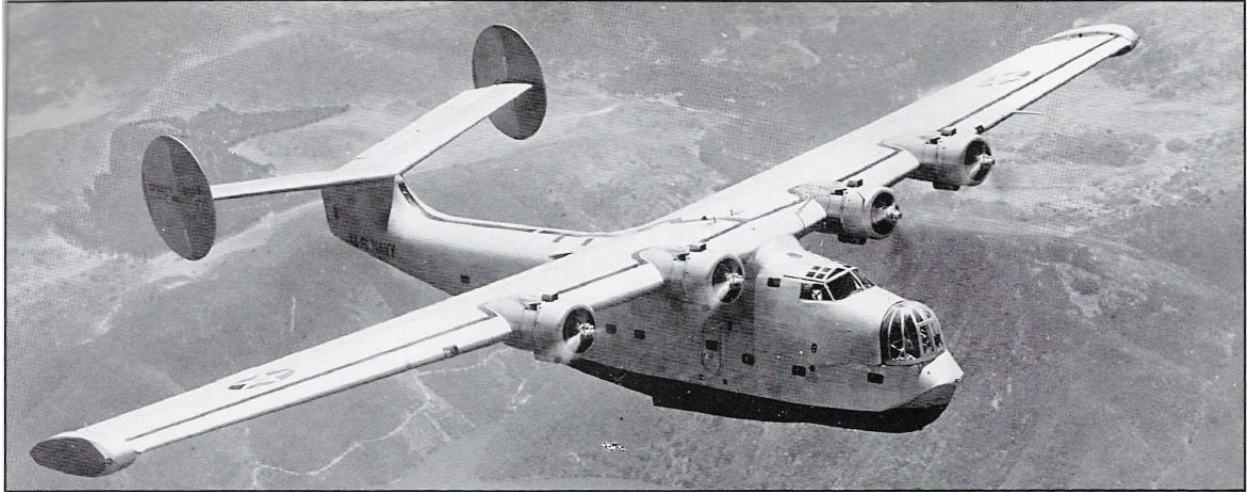


Figure 9. XPB2Y-1 in flight with final tail configuration (Consolidated).

The XPB2Y-1 made a cross-country round trip to Naval Air Station (NAS) Anacostia, DC, on 27 October 1938 (Andrews 1989:22; Hoffman 2009:3), where President Roosevelt inspected it. Simultaneously, the uniqueness of a large flying boat making a transcontinental flight gained considerable media attention. When the design was finalized, the Navy accepted the prototype and selected Consolidated for a production contract in March 1939. The contract called for six to be delivered (Andrews 1989:22). The prototype XPB2Y-1's interior was then modified for use as a Flag Officer's Flagship transport. On 24 August 1939, RADM A.B. Cook moved his flag from USS *Memphis* to the XPB2Y-1, making it the first airplane to be officially designated as a Flagship of the US Navy (Hoffman 2009:10).

The XPB2Y-1 would continue to serve in this capacity throughout the war. Because it was eventually repainted a dark sea blue, the aircraft was nicknamed the "Blue Goose." It operated as a VIP transport from 1942-1945, flying primarily between Hawaii and the west coast. Its record included the transport of 299 admirals and 916 passengers. Returning to San Diego in August 1945, it was retired from service and scrapped (Hoffman 2009:10).

4.1.2 PB2Y-2

The US Navy awarded Consolidated a production order for the PB2Y Coronado, contract number C65870, on 31 March 1939 (Polmar 2013:14–15). The contract was limited to six aircraft because of the high cost (Andrews 1989:22). Each Coronado cost \$300,000, roughly three times the cost of a PBY Catalina (Hoffman 2009:14). Some officials questioned this production decision, because Consolidated was heavily committed to PBY production (Polmar 2013:14–15).

The production model, designated PB2Y-2 (BuNos 1633-1638), were almost an entirely new design (Andrews 1989:22; Hoffman 2009:18). They retained the XPB2Y-1's wing with four engine nacelles and wing-tip floats. Bomb-carrying capacity was increased from the original internal bomb bays for eight 1,000-lb bombs to include provisions for carrying four more bombs or two torpedoes in underwing racks (Andrews 1989:22). Armament was also modified from the XPB2Y-1's five gun configuration: one .50 caliber each in the nose and tail turrets, two .30 caliber guns in the upper waist position, and one .30 caliber gun in the tunnel (Hoffman 2009:136–139). The PB2Y-2 was armed exclusively with .50 caliber machine guns, and removed one gun from the upper waist to add one gun in each side waist position. In addition, the new hull was deeper and straight-sided, and the vertical tail fins and rudders were enlarged (Figure 10) (Andrews 1989:22). Empty weight grew to 15,603 kg (34,399 lbs.) and gross weight was increased to 26,140 kg (57,630 lbs.). To compensate for the added weight of these modifications, more powerful Pratt and Whitney R-1830-78 Twin Wasp engines were installed. These engines were equipped with two-stage superchargers, and produced 1,200 HP. The increase in weight and horsepower resulted in a decrease in range, reducing it to 5,005 km (3,110 mi.) (Hoffman 2009:18).

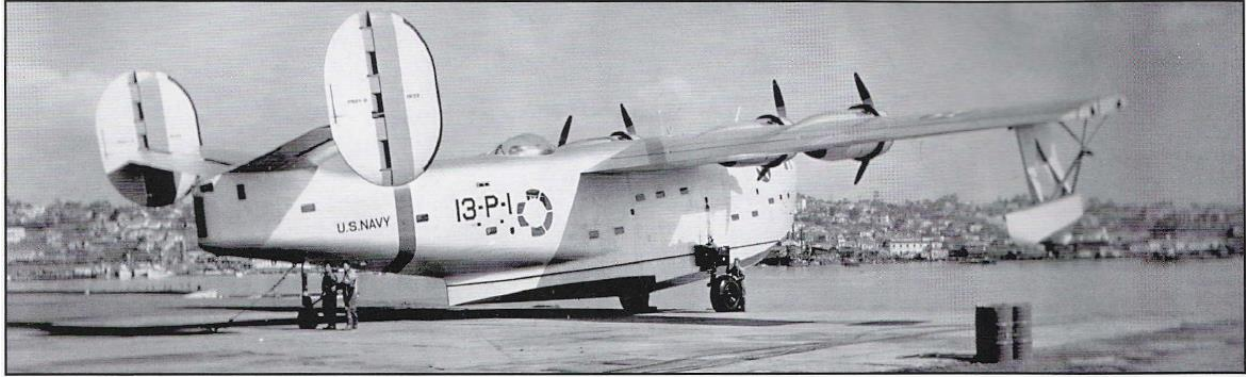


Figure 10. PB2Y-2 BuNo 1633 December 1940. Note the teardrop-shaped upper gun blister and the side waist windows: these were unique to the PB2Y-2 variant (Consolidated).

VP-13 (Patrol Squadron 13) received the first PB2Y-2 built, BuNo 1633, in December 1940. Preliminary and final demonstrations were deemed “successful,” and Consolidated delivered four more PB2Y-2s to VP-13 throughout the spring and summer of 1941 (Andrews 1989:22; Hoffman 2009:18). The sixth PB2Y-2, BuNo 1638, was retained by Consolidated for modification and prototyping for the next generation model XPB2Y-3. This was necessary because the US Navy placed another order on 19 November 1940 (contract number C78903) for 200 PB2Y-3s (Hoffman 2009:24). While only five PB2Y-2s existed, VP-13 Coronados played a key role in the early Pacific Theater, serving as VIP transports from the west coast to Hawaii to Australia. These duties were taken over by Naval Air Transport Service (NATS). The PB2Y, now officially named “Coronado” after the island off southern California following a British custom of naming their flying boats after islands, played a major role in supplying US troops around the world (Ramsey 1941; Andrews 1989:22).

4.1.3 PB2Y-3

VP-13 began to receive the new PB2Y-3 (Figure 11) in June 1942. The new model featured a number of improvements, including increased armament, pilot armor, self-sealing fuel tanks, and updated engines. Armament was once again significantly modified. Power-operated

twin mounted .50 caliber turrets replaced the single turrets in the nose and tail. The upper waist gun was yet again changed, this time switching the single-gun blister for a twin-mount ball turret. The side waist ball turrets were removed, replacing them with a wide cargo door with swing-out single gun turrets (Hoffman 2009:24). The total number of guns for this variation is listed as eight, which suggests that the tunnel position was removed (Holmes 2005:140). These modifications increased the empty weight to 18,568 kg (40,935 lbs.), gross weight to 40,935 kg (68,000 lbs.), and decreased range to 3,720 km (2310 mi.) (Budge 2007).

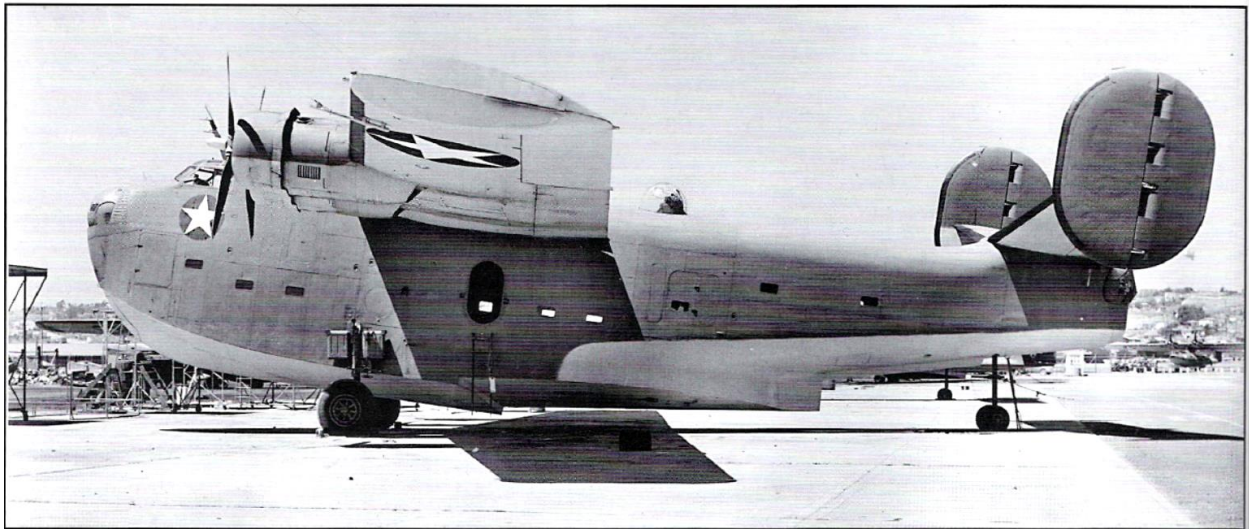


Figure 11. PB2Y-3. Note the new ball turret in the nose and upper waist, and the square rear waist hatch (National Archives).

The production of PB2Y-3 models totaled 210 aircraft (Polmar 2013:14–15). With the urgent need for transports, 29 of the first 60 were stripped of combat features and configured as transports (Figure 12), designated PB2Y-3R (the trailing “R” is the Navy suffix for “transport conversion” (Swanborough and Bowers 1976:16; Cornwell 1944)). Great Britain received 10 through the Lend-Lease Act, where they operated as long-range transports with the RAF Transport Command (Polmar 2013:14–15). One would join the XPB2Y-1 as a flag transport. VP-13 received 12 of the new model as the first combat squadron, while others were used in

training (Andrews 1989:23). By the spring of 1943, three of the four planned PB2Y patrol squadrons were flying Coronados: VP-13, VP-15, and VP-102 (Hoffman 2009). Pan American and American Export Airlines, operating as part of NATS, both were using the early PB2Y-3R transports (NATS would eventually receive 98 in total) (Andrews 1989:23).



Figure 12. PB2Y-3R transport conversion. All guns have been removed (Consolidated).

With production of the PB2Y-3 variant in full swing, several design flaws began to surface. Although a newer model engine was used, no increase in power was gained. With the increased weight of the aircraft, mission performance suffered (Andrews 1989:22). More seriously, the main internal tanks leaked, while the self-sealing tanks provided inadequate range. These problems culminated in the summer of 1943. Recurring fuel leaks caused VP-15, deployed to Bermuda for Anti-Submarine Warfare operations, to be recalled to New York. Production acceptance of the remaining PB2Ys stopped until the problem could be solved (Hoffman 2009:24).

Attention focused on solving the main (wing) tank leakage problem. Different solutions were applied to different groups of aircraft; synthetic rubber cells were installed in tanks of some, while new sealing compounds were applied to others. Self-sealing fuel cells were installed in combat airplanes. Fuel tanks were also added in the hull to account for lost fuel volume of the self-sealing tanks. This increased the range to 4,136 km (2,570 mi.) (Andrews 1989:23). Both Consolidated and Rohr Aircraft performed the rework (Andrews 1989:23). By the end of 1944, the fix programs were well under way. The last 41 Coronados off the production line were transferred to Rohr Aircraft, where they would be completed as transports (Hoffman 2009).

4.1.4 PB2Y-4

By the time the first PB2Y-3s began to be delivered, June 1942, Consolidated was already planning for the next variant. The prototype XPB2Y-3, BuNo 1638 (created from one of the six original PB2Y-2s), was further modified. It was redesignated, again, as the XPB2Y-4. This aircraft featured more powerful engines: four 1,600 HP Wright R-2600 Double Cyclone propellers (Hoffman 2009:28). Of 626 Coronados on order by this time, 54 would be PB2Y-4 variants, with the increased power restoring the desired performance (Andrews 1989:22). The more powerful engines would enable a higher service ceiling, shorter takeoff time, and longer range than the PB2Y-3. In addition, the gross weight would be increased from the PB2Y-3's 29,900 kg (66,000 lbs.) to 34,500 kg (76,000 lbs.) (Engineering Division 1941). In the spring of 1943, the order was reduced to 200 aircraft because of changing interests in both American and British requirements (Hoffman 2009:24). As a result, the XPB2Y-4 remained a prototype, and no further aircraft were configured as such (Hoffman 2009:28).

4.1.5 PB2Y-5

Engineers also finally tackled the problem of lack of engine power. The Pratt and Whitney R-1830-92 Twin Wasp replaced the two-stage supercharged Pratt and Whitney R-1830-88 Twin Wasp engine of the PB2Y-3. Although both produced 1200 HP, the -92 was a single-stage non-supercharged engine. The weight savings helped offset the increased weight of armament, armor, and electronics in the combat versions, and allowed increased payloads in transport versions. The re-engineered variant would be designated the PB2Y-5 (Cornwell 1944) (Figure 13). New aircraft were built as PB2Y-5s, while PB2Y-3 were recalled, upgraded, and re-designated. Additionally, the outer wing panels were reinforced as larger wing tip floats were installed (Andrews 1989:23; Hoffman 2009:28).



Figure 13. PB2Y-5 with radome installed above flight deck (US Navy).

The new PB2Y-5 had only one major external identifier, apart from the larger floats. The -5 models were equipped with a 4-bladed propeller on the inboard engines and a 3-bladed propeller on the outboard engines, while earlier models (XPB2Y-1, PB2Y-2 and PB2Y-3) had 3-bladed propellers on all engines. The reason for this remains a source of debate. One source explained that the PB2Y-5's design called for reversible-pitch propellers, but a shortage resulted in the equipping of each aircraft with reversible-pitch propellers on only the inboard engines

(Scott 2001). A second explanation, and one given by pilots many years later, was that shorter four-bladed propellers could reduce damage caused by heavy bow spray being thrown through the propellers during heavy-load takeoffs. Once again, shortages led to aircraft flying with four-bladed propellers on only the inboard engines (Scott 2001; Polmar 2013:14–15; Bucholtz 2011). A final explanation states that the single-stage R-1830-92 engine was a smaller diameter, and offered a decrease of 38 to 50 cm (15 to 20 in) in extension from the wing. This shortened installation placed the propellers closer to the fuselage, dictating a smaller diameter propeller. The standard three-bladed propellers on inboard engines were replaced with smaller diameter four-bladed propellers (Hoffman 2009:28).

An interesting letter chain pertaining to this matter is housed in the Naval Archives, dating from the early 1970s. A perspicacious reader of *All Hands*, the official magazine of the US Navy, noticed the different propellers in a photograph of a PB2Y-5, and wrote the editor to inquire as to the reason for such a configuration. The editor forwarded the letter to the Public Affairs Office of the naval aviation branch (PAO-NAIR 09D). Its reply confirms the pilot's explanation. The original three-bladed propeller configuration was designed for the XBP2Y-1 hull, with a takeoff weight of 24,000 kg (53,000 lbs.). By the PB2Y-3 variation, overload takeoff weight increased to 32,700 kg (72,000 lbs.). The increased weight caused heavy spray to fly through the inboard propellers, causing pitting and other damage. Six months were devoted to improving hull lines to decrease the amount of spray; these attempts were unsuccessful, and engineers resorted to using shorter-length four-bladed propellers. Aluminum propellers required frequent replacement, so engineers concluded that four-bladed steel propellers should be used. Production of such propellers was limited, though, and the compromise solution included installing them on inboard engines only (Carter 1972; Pearson 1972).

PB2Y-5s received other upgrades during the conversion process besides new engines. Many aircraft were fitted with a radar dome directly behind the cockpit (Figure 13), which also required a modified interrupter cam on the top turret to prevent the dome from being accidentally shot. New or overhauled nose and top turrets were installed, and the tail turret was replaced with a new model. The electronics were updated by replacing the DZ direction finder with the following package: two Type 800-1C alternators, two Type A condensers, a SCR 522 VHF unit, AN/APN-1 radio altimeter, SCR 269-F automatic direction finder, and an RL-24C interphone (Hoffman 2009:32). The PB2Y-5 conversions were also modified for Jet Assisted Takeoff (JATO), which was regularly used to get heavily loaded Coronados off the water (Figure 14). The hull structure was reinforced, and eight pairs of brackets for attaching JATO canisters were installed to the outside of the hull, adjacent to the side waist gun hatches. Four switches and an indicator light was added to the pilot's pedestal for control of the system (Hoffman 2009:32–33, 188).



Figure 14. PB2Y-5 with radome performing a Jet Assisted Takeoff (JATO) (USCG).

Stripped of offensive and defensive armaments, transport configurations were designated PB2Y-5R (Cornwell 1944). After conversion, the standard transport PB2Y-5R was configured to operate as a cargo or personnel transport, hospital vessel, or flagship. Control surface cables were re-routed from the center of the plane's interior to along the ceiling to maximize cargo space. Smooth aluminum and wood decking replaced the corrugated decking. Cargo and seat

platforms were built (Figure 15). Hoisting eyes located both inside and outside for loading and unloading as well as hundreds of tie-downs prepared the aircraft for its role as a transport. The mid-fuselage hatches were framed by larger cargo hatches. The galley, auxiliary power unit, rear cabin heater, and emergency water still were moved from the main cargo compartment to the “C” deck above the crew quarters. In the forward sleeping compartment, bunks were installed that could be let down during the day to form seats with backrests. Once converted, the PB2Y-5R weighed 3,630 kg (8,000 lbs.) less than the combat version (Hoffman 2009:26).

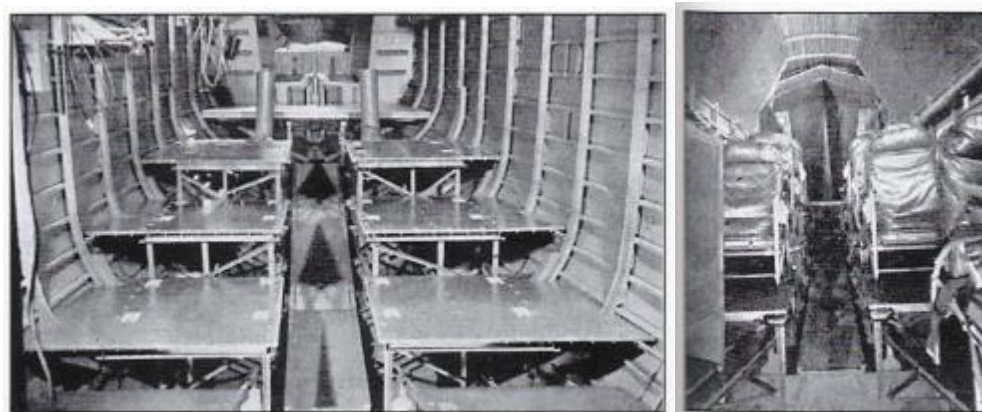


Figure 15. PB2Y-5R transport conversion interior. *Left*, cargo platforms; *right*, seats installed (US Navy).

With seats installed, and carrying no cargo, 44 passengers (plus a crew of five) could be carried. With a cargo of 3,900 kg (8,600 lbs.), 24 passengers could be carried. If only cargo was loaded, the PB2Y-5R could transport 7,260 kg (16,000 lbs.) (Hoffman 2009:26). In hospital plane configuration (Figure 16), The Coronado, designated PB2Y-5H (“H” representing “hospital conversion”) in air ambulance configuration, carried 25 stretchers (Swanborough and Bowers 1976:16; Cornwell 1944). The PB2Y-5H was instrumental in evacuating the wounded from the Pacific Islands (Polmar 2013:14–15; Hoffman 2009:91).

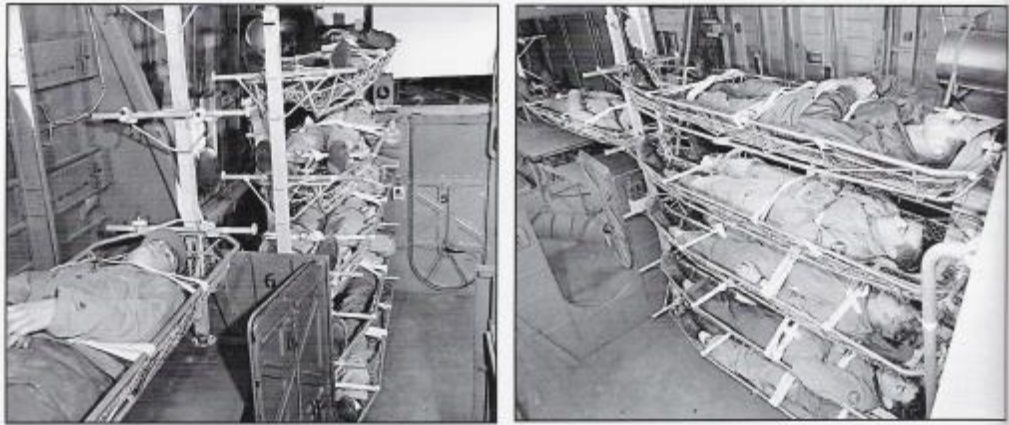


Figure 16. PB2Y-5H air ambulance conversion interior (Consolidated).

A few PB2Y-5s were also configured as flagship transports, designated PB2Y-5F (Swanborough and Bowers 1976:15). These were later reclassified as administrative aircraft, and redesignated PB2Y-5Z (Dahl 1945). Configured similarly to the XPB2Y-1, these featured cabins for flagship officers (Figure 17), officers' quarters, and more luxurious seating throughout (Hoffman 2009:127–131).

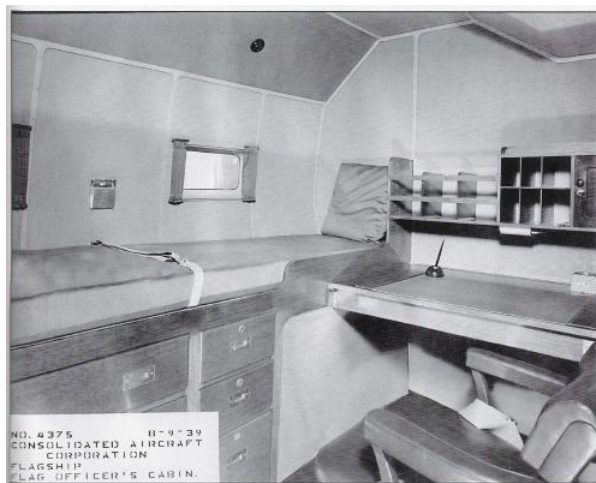


Figure 17. Flag officer's cabin (Consolidated).

4.1.6 **PB2Y-6**

Consolidated continued experimenting with the development of the PB2Y Coronado. Records show that by 21 February 1945, Consolidated converted one prototype to feature the

Pratt & Whitney R-1830-94 (1350 HP) engines (Ramsey 1945). In March, the US Navy officially accepted the PB2Y-6 designation for this aircraft (Gallery 1945). Although one model was made, both Consolidated and Rohr were busy finishing the PB2Y-5/5H conversions to produce more PB2Y-6's, while the Navy would soon start the process of discontinuing the use of PB2Y Coronados (Cassady 1945).

4.2 PB2Y Coronado Patrol Squadron Assignments

There were five PB2Y Coronado Patrol squadrons deployed during WWII. These were originally designated VP, with "V" indicating heavier-than-air (as opposed to lighter-than-air airships, identified by the letter "Z") and "P" indicating a patrol squadron (Swanborough and Bowers 1976:5, 34). The Coronado patrol squadrons were later designated VPB (Patrol Bombing Squadron) on 1 October 1944 (US Navy 1970:132).

PB2Y Coronados were initially assigned to four VP squadrons: VP-1, VP-13, VP-15, and VP-102 (Hoffman 2009:45). The fifth squadron, VP-100, was created later in the war (1 April 1944), and would ultimately function as a training, replacement, and rotational squadron for several patrol aircraft (Roberts 2000:505). The original four squadrons all deployed to some area of the Pacific, but only VP-15 and VP-1 also served in the Atlantic (Caribbean Sea). By the fall of 1944, a shortage of spare parts caused the US Navy to reconsider its deployment of PB2Y Coronados. Chief, BuAer issued a memorandum on 19 October 1944 stating that "careful planning will be required to insure that combat-ready aircraft are available for Pacific operations," and "concentration in one area is highly desirable, thus permitting the concentration of available spares" (Marston 1944). No American PB2Y Coronado squadrons were deployed to Europe,

although 10 were allocated to the British Royal Air Force under the Lend-Lease Act (Swanborough and Bowers 1976:85).

4.2.1 VP-1

VP-1 was established at NAS San Diego on 15 April 1943, as a large seaplane squadron flying the PB2Y-3 (Roberts 2000:389). By 10 October, VP-1 was transferred to NAS Coco Solo, Panama, with orders to conduct antisubmarine patrols and provide convoy coverage in the Caribbean. Mechanics modified the PB2Y-3 while at Coco Solo to better operate in the tropical conditions. All interior heating units, de-icing equipment, armor plating, and engine superchargers were removed (Roberts 2000:390). While stationed at Coco Solo, VP-1 deployed to Salinas, Ecuador, and the Galapagos Islands, Ecuador, to fly east-west patrols for interception and identification of merchant shipping operating on the Pacific side of the Panama Canal. VP-1 returned to San Diego in February 1945, and was disestablished on 6 March 1945 (Roberts 2000:390).

4.2.2 VP-102/VPB-4

VP-102 was established at NAS San Diego on 1 March 1943 as a patrol squadron flying the PB2Y-3 (Roberts 2000:392). Upon completion of training, VP-102 moved its home port to KAS Kaneohe, Hawaii, on 8 November 1943. Combat training began for all hands in preparation for the squadron's first combat tour. Six aircraft were sent to Midway Island to augment VP-13 in the bombing raids on Wake Island in January-February 1944. A second detachment of six aircraft was deployed to the Marshall Islands in February 1944, conducting patrols between NAB Ebeye and NAB Eniwetok. Six new crews were assigned to VP-102 in April 1944, bringing the total to 24 (six at Midway, six in the Marshalls, and 12 at NAS Kaneohe). The six new crews remained at NAS Kaneohe for combat training, while the six experienced crews were deployed

to NAB Kwajalein Atoll in June 1944. By July, the Kwajalein and Ebeye detachments were deployed to Eniwetok, bringing the forward-deployed units together again. VP-102 conducted nuisance bombing attacks on Japanese positions on the island of Ponape in late August (Roberts 2000:392).

On 30 August 1944, the entire VP-102 squadron moved to Saipan, supported by the seaplane tender *Kenneth Whiting* (AV-14). There the squadron routinely conducted patrols and test flights, while special flights were made to carry passengers, mail, and equipment between forward and rear areas (Patrol Bombing Squadron Four 1945b). Re-designated as VPB-4 on 1 October 1944, it continued routine duties on Saipan until 1 December 1944. Returning to NAS San Diego, VPB-4 trained replacement crews in the operation of PB2Y-5/-5H and -3R aircraft. VPB-4 remained in San Diego until disestablishment on 1 November 1945 (Patrol Bombing Squadron Four 1945a).

4.2.3 VP-13

VP-13 was the earliest PB2Y Coronado patrol bombing squadron, established on 1 July 1940. As such, it has the longest and most illustrious history of the five VP squadrons. VP-13 was almost continuously deployed to either the southern or western Pacific, while its official home port stayed at NAS Kaneohe or NAS San Diego. VP-13 was also the only squadron to operate all combat versions of the PB2Y Coronado: XPB2Y-1, PB2Y-2, PB2Y-3, and PB2Y-5 (Roberts 2000:409). VP-13 also conducted air evacuation missions in PB2Y-3H air ambulance conversions in Tarawa, Majuro, Apamama, Kwajalein, and Eneweitok. VP-13 (along with a detachment from VP-102) carried out heavy bombing raids on Wake Island in January-February 1944. These raids were historic because they were the first ever bombing raids conducted by heavy seaplanes over a long distance (Bracho 2005:73). They also conducted mine-laying sorties

on Chuuk on 17-18 April 1944. Dumbo missions, rescue missions for aircrew of bombers and fighters that were forced to ditch into the ocean, were also one of VP-13's responsibilities. VP-13 would remain deployed through the end of the war, assigned to Okinawa, then Sasebo (both Japan) before being assigned to NAS Sangley Point, Philippines on 28 September 1945. The squadron returned to San Diego for disestablishment in late November (Patrol Bombing Squadron Thirteen 1945a). The squadron was officially disestablished on 21 December 1945 (Patrol Bombing Squadron Thirteen 1945b).

4.2.4 VP-15

VP-15 was established on 15 March 1943, the same date as VP-1 (Roberts 2000:414). Originally assigned PB2Y-3 Coronados, it would later be assigned the updated PB2Y-5 model in December 1944. Transferred to NAS Bermuda on 15 May 1943, VP-15 principally conducted anti-submarine warfare, patrol searches, and convoy coverage along the eastern seaboard. It performed these duties in Bermuda for nearly a year, until VP-15 transferred to NAS Coco Solo, Panama, on 21 April 1944. One detachment deployed to Corinto, Ecuador, and another to the Galapagos Islands. The squadron reunited on 15 October 1944 when it transferred to San Diego, in preparation of transfer to the South Pacific. New PB2Y-5 Coronados replaced VP-15's PB2Y-3 models on 1 December 1944. The squadron transferred to NAS Kaneohe on 2 March 1945, and soon deployed to Saipan (on 12 April) (Patrol Bombing Squadron Fifteen 1945). VP-15 remained in Saipan, conducting patrols, until it was disestablished on 23 November 1945 (Roberts 2000:414). Squadron aircraft were "scrapped" in the Marianas either by scuttling or as targets for P-51 fighters. Personnel returned to the United States aboard the carrier USS *Boxer* (CV-21) (Hoffman 2009:81).

4.2.5 VP-100

VP-100 was established on 1 April 1944 at NAS Kaneohe as a seaplane squadron flying the PBY-5 and PBY-5A Catalina. The squadron's mission included training replacement crews, ferrying aircraft to advance bases, and maintaining two aircraft and one crew for around-the-clock standby and rescue work. There were no overseas deployments (Roberts 2000:505). VP-100's aircraft inventory expanded in July 1944 to include PB2Y-2 and PB2Y-3 Coronado flying boats. They also received the PBM-3D Mariner in July 1944, and would continue to receive new aircraft with which to train new crews. A merger with VPB-200 on 24 October 1945 nearly doubled its training capacity. When VP-100 was disestablished on 15 December 1945, VP-100 was equipped with: PBY-5/5A, PBM-3D, PB2Y-2/3, PB2B-2, PBM-5, PB4Y-1/2, and PB-1/2 (Roberts 2000:505).

4.3 PB2Y Coronado in Naval Air Transport Services

Consolidated Aircraft and Rohr Aircraft converted over half of the PB2Y Coronados produced into transport PB2Y-3Rs and PB2Y-5Rs. These aircraft were the mainstay of the Naval Air Transport Service, although many other aircraft types were also used. The history of NATS remembers the "famed Coronado" as a "giant transport that performed magnificently in NATS overwater operations" (Lee 1947:140). The flying boats, although slow by today's standards, were well suited to their role in NATS (Niderost 2012).

Five days after the attack on Pearl Harbor, the US Navy created NATS in order to provide specialized organic airlift services throughout the service. Prior to this, utility transports and utility squadrons assigned to each base provided organic airlift capabilities. NATS commissioned three squadrons: VR-1 (Norfolk, VA, to serve the Atlantic), VR-2 (Alameda, CA,

to serve the Pacific), and VR-3 (Olathe, KS, to serve the continental areas). The Navy recalled reservists to fill the rosters; most of these were experienced airline personnel (Hoffman 2009:86).

NATS was responsible for establishing scheduled air transport operations and developing an organization capable of engaging in and supporting tactical operations. To expedite these, the Navy turned to commercial airlines. NATS developed along the model of a commercial airline, and in some cases operated side-by-side with commercial airlines (Hoffman 2009:86–87). Pan American Airlines (PanAm) and American Export Airlines were two such examples of this cooperation. The Navy bought all Pan American Airways' flying boats, including their famous Boeing B-314 "Clippers" (Hoffman 2009:86; Lee 1947:141). Both airlines operated PB2Y Coronados under the aegis of NATS (Andrews 1989:23). Civilian PanAm crews operated and serviced the PanAm aircraft, which retained their civilian markings (Hoffman 2009:86).

Upon establishment of VR-2 on 1 April 1942, VP-13 transferred its PB2Y-2 Coronados to VR-2. VR-2 began to conduct flights along the Pacific routes, with the first Coronado flying for VR-2 starting in July 1942 (Transport Squadron Two War Diary, July 1942). PanAm's Pacific Division received 12 new aircraft by February 1943, as PB2Y-3 production increased. They received eleven more Coronados, originally allotted to the Royal Air Force, between July and October 1943, and a further seven PB2Y-5s 1944. In total, PanAm's Pacific Division operated 30 PB2Ys, in addition to those operated directly by VR-2 (Hoffman 2009:87).

NATS's Pacific operational concept was to utilize PanAm Boeing 314s, Martin M-130s, and PB2Y Coronados to fly the California-Hawaii route. Both PanAm and VR-2, using Coronados and Martin PBM-3R transports, flew those routes west of Hawaii. While the types and number of aircraft assigned to VR-2 constantly fluctuated, the PB2Y variants were the workhorse of the operation. VR-2 reported 13 total aircraft in December 1943. Of those 13,

seven were PB2Y's, with four being the PB2Y-3R variant. Only the PB2Y-3R's were used for scheduled flights during this month; all other aircraft were used for training purposes (Air Transport Squadron Two 1945). By October 1944, VR-2's pool swelled to 67 total aircraft, of which 32 were PB2Ys. Once again, the Coronado was the favored aircraft—VR-2 reported it “operates 30 PB2Y-5R and one XPB2M (MARS) aircraft on scheduled flights,” (Air Transport Squadron Two 1945).

VR-2 continued to extend routes north and west throughout the end of the war. By the war's end, VR-2 alone reported 59 aircraft (of which 53 were PB2Y Coronados) and over 3,200 personnel (Air Transport Squadron Two 1945). VR-2 was still operating PB2Ys in 1946, and would continue to until eventually all Coronados were stricken from Navy inventory in mid-1946. JRM Mars and Douglas R5D Skymasters replaced them (Andrews 1989:23; Polmar 2013:15). The Coronado had performed magnificently in NATS service. In millions of miles flown, the Coronado only suffered three accidents with casualties: two by VR-2 and one by PanAm (Hoffman 2009).

4.4 Air Ambulance Service

The Navy commissioned Rescue Squadron One (VH-1) on 15 April 1944 at NAS San Diego, under Fleet Air Wing Fourteen (FAW-14). In May 1944, VH-1's assigned aircraft began to roll in. By the end of the month, VH-1 counted six Martin PBM-3D Mariners and 14 PB2Y-3 Coronados in its hangars (Rescue Squadron One War Diary, May 1944). VH-1 moved to Kaneohe Bay, Hawaii, in early June. It then deployed to the central Pacific later that month, conducting flights to Ebeye, Eniwetok, and Saipan. The Coronado's first assignment came on 25 June, as five planes carrying a total of 105 patients departed Ebeye for NAS Honolulu (Rescue

Squadron One War Diary, May 1944). Through the end of the year, VH-1 performed similar duties, transporting casualties throughout the Pacific islands, conducting “Dumbo” search and rescue flights, and making urgent calls to ships at sea (VH-1 evacuated appendicitis-stricken patients from ships in both September and October) (Rescue Squadron One War Diary, May 1944).

On 12 December 1944, VH-1 split into two squadrons: Rescue Squadron One (VH-1), operating PBM Mariners and PBY Catalinas, and Air Evacuation Squadron One (VE-1) operating PB2Y Coronados (Rescue Squadron One War Diary, May 1944). VE-1 established its base at NAB Saipan, operating six PB2Y-3 aircraft with 25 pilots, seven PPCs, and nine flight crews (Air Evacuation Squadron One War Diary, December 1944). Throughout December 1944, four planes were maintained at Ulithi and two at Saipan for evacuation purposes. VE-1 was formed specifically to support the invasions of Okinawa and mainland Japan (Hoffman 2009:90). VE-1 played a vital role in the invasion of Okinawa, conducting 446 round trip missions between 8 April 1945 and 22 June 1945 (when Okinawa was declared secured), evacuating 9,424 casualties. For these services, VE-1 received a Secretary of the Navy Commendation (Hoffman 2009:91).

4.5 Saipan

The history of human activity on Saipan can be traced back to over 3,500 years ago, when the indigenous people (called Chamorro after the language they spoke) first came to the Mariana Islands from Southeast Asia (Carrell et al. 2009:61). Magellan landed on Guam in 1521, establishing the Western world’s first contact with the islands. Angered by the theft of a boat, Magellan called the islands *Las Islas de las Landrones* (the Islands of the Robbers) (Yanaihara

1940:8). In November 1564, Don Miquel Lopez de Legazpi traveled to Saipan from Mexico, where he proclaimed the conquest of the Mariana Group and changed the name of the islands to *Las Islas de las Velas Latines* (the Islands of Latin Sails). Thus, the Marianas became a Spanish possession in 1564 (Yanaihara 1940:9). Europeans used this second name until Queen Maria Anna, the second wife of Philip IV of Spain, sent missionaries and soldiers there. In 1668 the Jesuit friar Diego Luis de Sanvitores traveled to the islands to conduct missionary work; he named the islands *Islas Marianas* (Mariana Islands) in her honor (Yanaihara 1940:9).

United States involvement with the Mariana Islands began in 1898 during the Spanish-American War. During the war, the United States captured the richest and largest of the Spanish possessions in the Pacific: Guam and the Philippines (Yanaihara 1940:20). The remainder of the Mariana Islands, the Marshall Islands, and the Caroline Islands were purchased from Spain by Germany in 1899 (Rottman 2004:9). At the outbreak of World War I in 1914, Japan seized Germany's Pacific possessions, which were subsequently mandated as class "C" territories to Japan in 1920 (Carrell et al. 2009:232; Yanaihara 1940:22–23). The Imperial Japanese Navy administered these new territories from 1914 to 1922. A civilian government, more acceptable to the League of Nations and its Mandate Charter, replaced the naval administration in March 1922 (Denfeld 1997:3–4).

The Japanese quickly colonized the Mariana Islands, particularly Saipan. In 1912, there were only 73 Japanese recorded in the West Carolines, Palau, and the Marianas (Yanaihara 1940:26). In 1920, now under Japanese control, the administration conducted the first complete census (and every five years thereafter). At the time of the first census in Saipan, the Japanese population had grown to 1,758. Chamorros numbered 2,512, while only 886 Kanakas (Carolinians) were present. In 1935, the last year the Japanese administration conducted an

official census, Saipan was home to 39,728 Japanese, 3,280 Chamorros, and 1,017 Kanakas. It is estimated that in 1937 those numbers were 42,688 Japanese, 3,143 Chamorros, and 1,037 Kanakas (Yanaihara 1940:30).

Economic development, especially the booming sugar production industry, brought many Japanese to Saipan. With it came the development of Saipan as a Japanese colony. Businesses, including ice cream shops, tofu factories, and sake breweries opened in the capital of Garapan (Denfeld 1997:5). By the time of the Battle of Saipan, there were roughly 25,000 Japanese civilians left on Saipan, even though more than 3,000 left during April and May 1944 (Sheeks 1945:109–110). In addition, there were about 31,650 Japanese troops on the island (Denfeld 1997:21). With Chamorro and Carolinian population estimated at only over 3,000, the Japanese outnumbered the native Chamorro and Carolinian Islanders by at least 15:1 (Sheeks 1945:109).

The Battle of Saipan, beginning 15 June 1944 and lasting 25 days, marked a pivotal point in the war for both the Americans and Japanese (Crowl 1959:1). The success and fast pace of the campaign allowed little time for reflection, and it was quickly surpassed in memory by more famous battles in the island-hopping campaign like those for Iwo Jima and Okinawa. Emphasizing its importance, it is remembered as the “first line of defense of the homeland” (Goldberg 2009:vii) by the Japanese and the “decisive battle of the Pacific offensive” by the Americans (Morison 1953:339).

In early 1944, Admiral Nimitz began planning for the invasion of the Mariana Islands, code-named Operation Forager. The invasion began on 15 June 1944 by US Marines, who were reinforced by the Army over the course of the following five days (Rottman 2004:9). After a 25-day battle, less than 1,000 of the original 31,650 Japanese soldiers surrendered or were taken prisoner; the rest perished. A further 22,000 Japanese, Okinawan, or Korean civilians were killed

or committed suicide (Rottman 2004:89). American troops suffered a staggering 25% casualty rate, with 3,225 killed, 13,061 wounded, and 326 missing out of the 70,000 who participated in the battle (Brooks 2005:229). During this intense fighting, the native peoples could only hide in caves; 933 of the estimated population of 3,000 were killed during the fighting (Cabrera 2015; Sheeks 1945:109). After the war, those who survived had to try to pick up their lives again, this time under American occupation.

4.6 PB2Y Coronado Use in Saipan

From shortly after the US declared Saipan “secured,” until after Japan’s surrender, PB2Y’s were a usual sight in the seadrome at Tanapag Harbor. Tanapag served as a base for not only combat PB2Y squadrons, but also rescue/air evacuation and transport PB2Y squadrons. In addition, Tanapag’s protected lagoon provided ample shelter during typhoon evacuations, while the Japanese-built seaplane base with ramps was quickly adopted by Combat Air Service Units, CASU(F), for maintenance, repairs, and overhauls on PB2Y Coronados and other flying boats.

Out of four PB2Y Coronado combat squadrons to deploy to the Pacific (VP-1, VP-13, VP-15, and VP-102/VPB-4), three (VP-13, VP-15, and VP-102/VPB-4) headquartered in Saipan at one time or another. VP-102/VPB-4 flew patrols and support missions from Tanapag between 30 August 1944 and 9 December 1944 before returning to San Diego and reforming as a training squadron (Roberts 2000:392). VPB-13 replaced VP-102/VPB-4 on 19 November 1944, flying up to three daily and one nightly patrols with search sectors as far as 800 km (500 mi.). VPB-13 briefly moved to Ulithi Atoll to provide coverage for the Iwo Jima invasion, and then returned to Saipan for reconditioning. By April 1945, VPB-13 moved to Kerama Rhetto, Okinawa (Roberts 2000:411). VPB-15 took over the duties of VPB-13, arriving in Saipan on 15 April and

commencing daily 12-hour patrols and nightly 13-hour anti-shipping and anti-submarine patrols. These patrols stretched to 1,500 km (900 mi.) by May (Patrol Bombing Squadron Fifteen 1945). Establishment of the Search and Reconnaissance Command at NAB Saipan on 4 May 1945 meant that VPB-15 would perform other tasks in addition to its scheduled patrols. VPB-15 was the last combat PB2Y Coronado squadron to serve in Saipan; it was disestablished on 23 November 1945 (Roberts 2000:414).

Transport Squadron Two (VR-2) also established a terminal at Tanapag Harbor. By November 1944, VR-2 conducted flights to Saipan (Air Transport Squadron Two War Diary, December 1944). The detachment continued to thrive, but by summer 1946 VR-2 began to discontinue the PB2Y Coronado. All spare parts for support of the aircraft operated by the squadron were turned in through September 1946 (Air Transport Squadron Two Squadron History, September 1946). Between December 1946 and March 1947 VR-2 discontinued operations west of Honolulu and as a result the Saipan detachment closed on 30 December 1946 (Air Transport Squadron Two Squadron History: December 1946, March 1947).

PB2Ys outfitted as air ambulances also frequented Saipan. Although no PB2Y-3H or -5H Coronados directly participated in the Battle of Saipan (VH-1 sent PBM Mariners to Saipan instead, and reserved the PB2Ys for the long leg across the Pacific), Coronados indirectly participated by ferrying those wounded in Saipan from Ebeye to Honolulu (Rescue Squadron One War Diary: June 1944). Coronados began flying to Saipan to pick up the wounded directly in August 1944, as the other aircraft in the squadron (PBM Mariners and PBY Catalinas) were busy conducting Dumbo missions (Rescue Squadron One War Diary: August 1944). When the squadron split in December 1944, the Coronado detachment (that became VE-1) established its headquarters at Saipan (Rescue Squadron One War Diary: December 1944; Air Evacuation

Squadron One War Diary: December 1944). The air ambulance PB2Ys of VE-1 operated from Saipan until 26 March 1945, when the seaplane detachment of VE-1 was decommissioned. Personnel were absorbed into the newly commissioned Air Transport Evacuation Squadron One (VRE-1), operating R5D land-based aircraft from Naval Air Base Agana, Guam (Air Transport Evacuation Squadron One War Diary: March 1945).

4.7 Conclusion

The Consolidated PB2Y Coronado, known affectionately as the “Big Flying Boat” (Bracho 2005) was developed for, reached its peak during, and slipped into oblivion shortly after WWII. Combat PB2Y-3s and -5s, operating in VP-13 and VP-102, had outstanding combat records in the Pacific. They accounted for 11 recorded enemies shot down (Andrews 1989). They also conducted countless long-range patrols, bombing and minelaying missions, many of which were often flown at night (Polmar 2013:14–15). These aircraft participated in raids on Wake Island, the longest over-water bombing mission yet attempted by the Navy, and mining runs on Chuuk Lagoon (Bracho 2005:73, 87). PBY-5Hs were instrumental in evacuating many of the seriously wounded during the battles in the Pacific Islands (Andrews 1989:23). The transports and flagships also served an important role in the Navy, as many tactical planners needed to visit newly-conquered islands that either did not have runways, or maintained runways that were too damaged from recent battle for safe operations. In these circumstances, flying boats like the Coronado were the only way to conduct air travel.

Although heavily used in both the Atlantic and Pacific theaters as patrol bombers, transports, air ambulances, and flagships, the PB2Y Coronado became obsolete by the end of the war. As the golden age of civil flying boats ended with the beginning of the war, the golden age

of military flying boats closed with the end of the war. With the proliferation of airfields throughout the world, a direct result of the war, the need for aircraft capable of operating from water bases diminished (Allward 1981:119). Land-based aircraft that were faster, could carry heavier loads farther, and were more cost effective in the pursuit of war would soon replace the once-prolific flying boat. The PB4Y-1 (B-24) Liberator and PB4Y-2 Privateer replaced the Coronado as long-range bombers, while the land-based R5D (C-54) Skymaster took over long-range transport duties; as early as 4 April 1945, CNO directed that PB2Y-5/5H aircraft in the forward area were to be stricken at the end of their serviceable life (Polmar 2013:15; Cassady 1945). Martin P5M Marlins assumed the seaplane VP role (Polmar 2013:14–15).

By 1946, the Navy had completely retired the PB2Y Coronado (Andrews 1989:23). With many aircraft reaching upwards of 4,000 hours in their flight logs, most met ignominious ends. They were summarily salvaged for spare parts and scrapped, scuttled, or used as targets (Andrews 1989:23). VPB-15, disestablished on 23 November 1945 at Saipan, disposed of its aircraft either by scuttling or as targets for P-51 fighters (Hoffman 2009:81). The Coronados delivered to the British through the Lend-Lease Act were scuttled variously off the coasts of Bermuda, Largs, and Little Cumbrae (Hoffman 2009:111). Of the 217 Coronados constructed, only one aircraft still exists: the PB2Y-5F that flew Admiral Nimitz to Tokyo Bay for Japan's surrender (Figure 18). The National Naval Aviation Museum at Pensacola, Florida, displays that last Coronado.



Figure 18. The last remaining PB2Y Coronado (National Naval Aviation Museum).

5 Archaeological Data and Analysis

Data collection for the PB2Y Coronado site in Tanapag Lagoon occurred in two phases: historical/archival research and fieldwork. This chapter presents the results of both of those endeavors, followed with an analysis of the data for aircraft identification and site formation processes.

5.1 *Fieldwork Observations*

5.1.1 General Site Description

The Tanapag Lagoon PB2Y Coronado site is located roughly in the center of Tanapag Lagoon, approximately 1.2 km (0.7 mi.) from Managaha Island and 1.8 km (1.1 mi.) from the ramps of former seaplane base NAB (sometimes called NAS) Tanapag (Figure 19). The remains lie on a slightly undulating, relatively flat seabed, averaging 8 m in depth. Variation due to tidal change rarely exceeded 50 cm (20 in.) throughout the course of fieldwork. The seabed is primarily made up of fine, calcareous sediment (McKinnon and Carrell 2014:39). Isolated coral heads dot the terrain throughout the site, but the only large formation is a patch reef to the southeast of the main wreck assemblage.

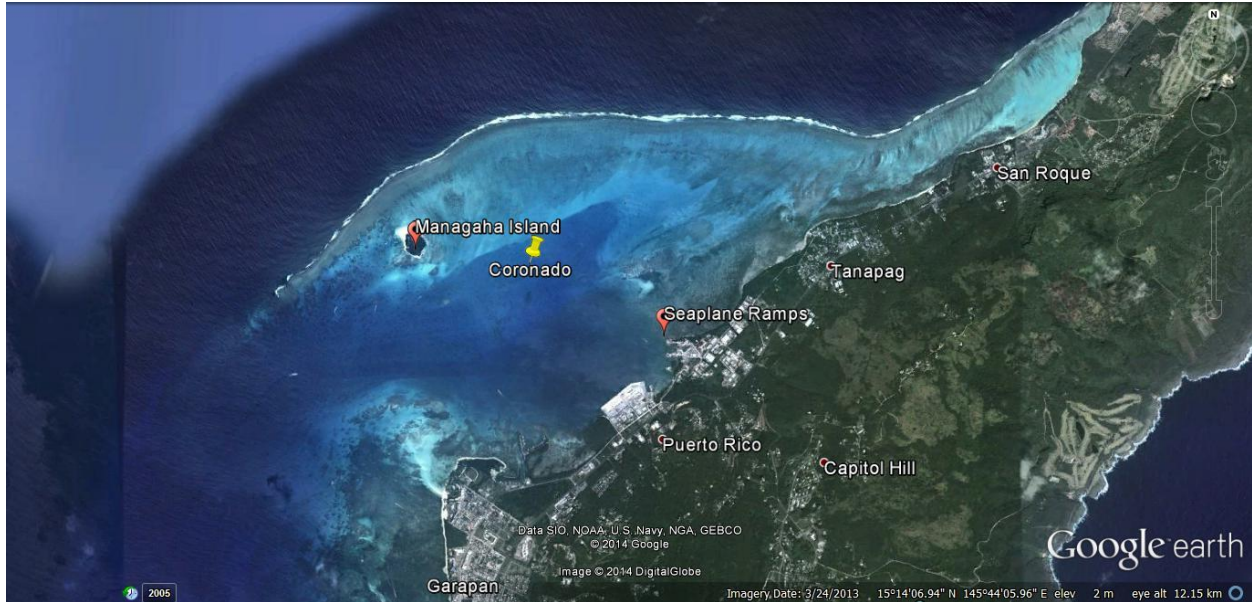


Figure 19. Location of Tanapag Lagoon PB2Y Coronado site (Google Earth, accessed 28 November 2014).

The remains are disarticulated and scattered. The PB2Y Coronado, as constructed, had a 35 m (115 ft.) wingspan and 24.2 m (80 ft.) hull length. The main wreckage assemblage (Figure 20) is 10 m (33 ft.) long by 6 m (20 ft.) wide, and consists of the cockpit canopy (complete with aerial mast), fuselage sections from both the port and starboard side of the flight deck, radio equipment, the forward section of the port vertical stabilizer, and other unknown structural elements. One engine, detached and sans propeller, lies 1.5 m (5 ft.) to the southeast of the site. Within this main assemblage, profile averages 50 cm (20 in.) above the seabed, with the engine constituting the exception reaching 150 cm (5 ft.) tall. Beyond the main assemblage, the aircraft remains are broken and widely scattered. Although the majority of overall wreckage lies within 60 m (197 ft.) of the main assemblage, significant debris is present beyond that. The site as a whole is contained within a 100 m (328 ft.) radius circle, with only a couple isolated pieces yet further away (Figure 21).

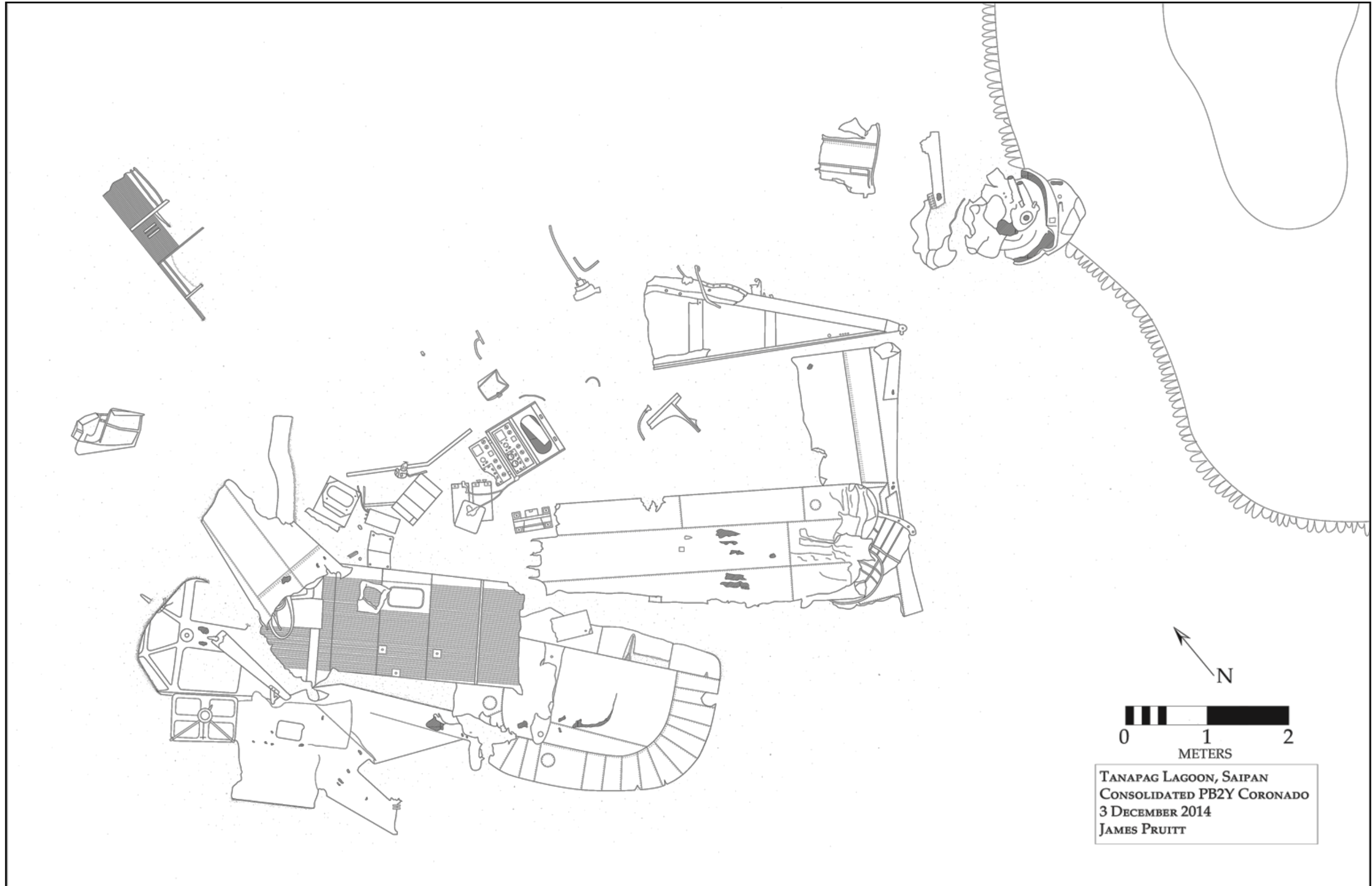


Figure 20. Site plan of main assemblage of the Tanapag Lagoon PB2Y Coronado.

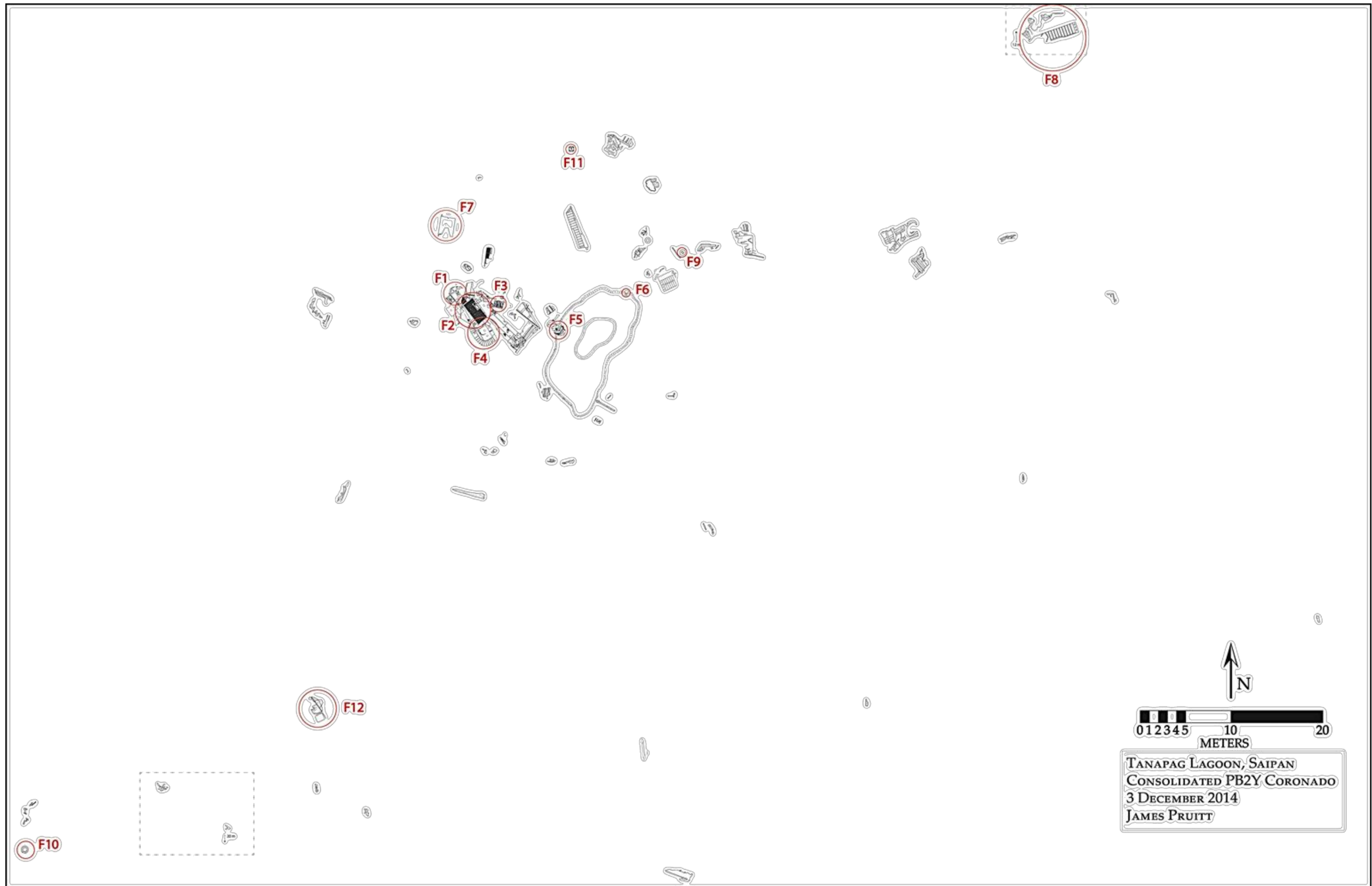


Figure 21. Site plan of entire site of the Tanapag Lagoon PB2Y Coronado. Features are circled and labeled in red.

Identifiable wreckage includes a seat, a hatch cover, a float support, the navigator's astrodome, and a cluster of forks and spoons. The bulk of the wreckage, though, is unidentifiable, and can only be categorized as fuselage, wing, or unknown.

5.1.2 Site Features

While much of the wreckage located in this site was damaged beyond distinction, there were several sections or pieces of aircraft that remain recognizable. These are significant, as they help in understanding the overall distribution of wreckage. Although no individual piece of wreckage directly confirmed the aircraft's identity, the presence and absence of certain features contributed to the process of identification. This section will describe those significant features, starting with the main assemblage then moving toward the outer limits of the site.

The main assemblage, measuring approximately 10 m (33 ft.) long by 6 m (20 ft.) wide, is actually a collection of several different pieces piled atop each other. Perhaps the most recognizable feature of the main assemblage is the cockpit canopy (Feature 1). Situated directly above the pilot and copilot seats, the top three windscreen windows are exposed, while the very tops of the port and center main windscreen windows are visible above the sand (Figure 22). A windscreen wiper, with rubber blade still attached, emerges from the sand on the starboard side. Directly aft of the upper windows, the escape hatches open into sand 40 cm (16 in.) below. The port (pilot's) hatch cover is present and in the open position, while the starboard (copilot's) hatch sill is buried and the cover is missing.



Figure 22. Feature 1. Cockpit canopy windows, pilot's escape hatch, and aerial mast. Plan view, 1 m scale.

The window layout is significant because this is one of the main features of the site by which the aircraft model can be identified; this particular shape of the upper cockpit windows is unique to the PB2Y Coronado (Figure 23).



Figure 23. PB2Y-5 during conversion. Note cockpit windscreen window configuration and open escape hatches. Aerial mast is located on top of radome, aft of escape hatches; the Tanapag Lagoon Coronado was not equipped with a radome, so aerial mast was installed between escape hatches (Hoffman 2009:63).

The location of the cockpit canopy raises an important question: where is the rest of the forward end of the aircraft? The bottom of the upper cockpit windows were 4.67 m (15 ft.) above the keel of the flying boat. Although the main cockpit windows continue into the sand, suggesting that additional wreckage is buried, it is unlikely that over four meters of aircraft are buried in this location. The presence of the anchor hatch, originally below and forward of the cockpit, located 45 m (147 ft.) south of the cockpit, bolsters this argument.

Between the escape hatches, the aerial mast lies twisted and bent to the port side. Since the mast is connected directly to the cockpit canopy, this aircraft was not fitted with a radome (radar dome) as many later model aircraft were (illustrated in Figure 23). The aerial mast served as the forward fixation point for many of the Coronado's antennae, including the Sense, G.F. Voice, V, and High Frequency V antennae (Hoffman 2009:39). Aft of the aerial mast, the cockpit canopy continues until it is buried under the sand. The port side canopy window is present, as is the mount for the D.Z. loop antenna (mount only, antenna is missing). Both are hidden from plan view by the overlying section of fuselage wall, which is supported by the D.Z. antenna mount.

Also attached to the cockpit canopy, making it the largest continuous piece of wreckage present on-site, is the port side fuselage wall of the flight deck. The wall split along the bottom edge and splayed upward. This section would originally have been aft and slightly below the upper cockpit windows, but now rests on the same level as the canopy escape hatches. The window aft of the cockpit is present and undamaged; the wall tore along the seam of the second window aft, leaving only a partial window frame.

Directly aft of the aerial mast, partially covering the cockpit canopy where it recedes into the sand, lies a section of fuselage wall (Feature 2). The wall is lying with the interior surface facing upwards (Figure 24). Judging by its position to the starboard side of the flight deck, the radio equipment scattered nearby, and the fact that the starboard side of the flight deck was the radio operator's station (Hoffman 2009:166–167), the research team postulated that this wall is the starboard wall of the flight deck. Comparison to interior photographs of the flight deck confirmed this. One window, undamaged, is present in the center of this wall, while a broken window lies at the extreme north corner of the wall, covered by a different section of wreckage.

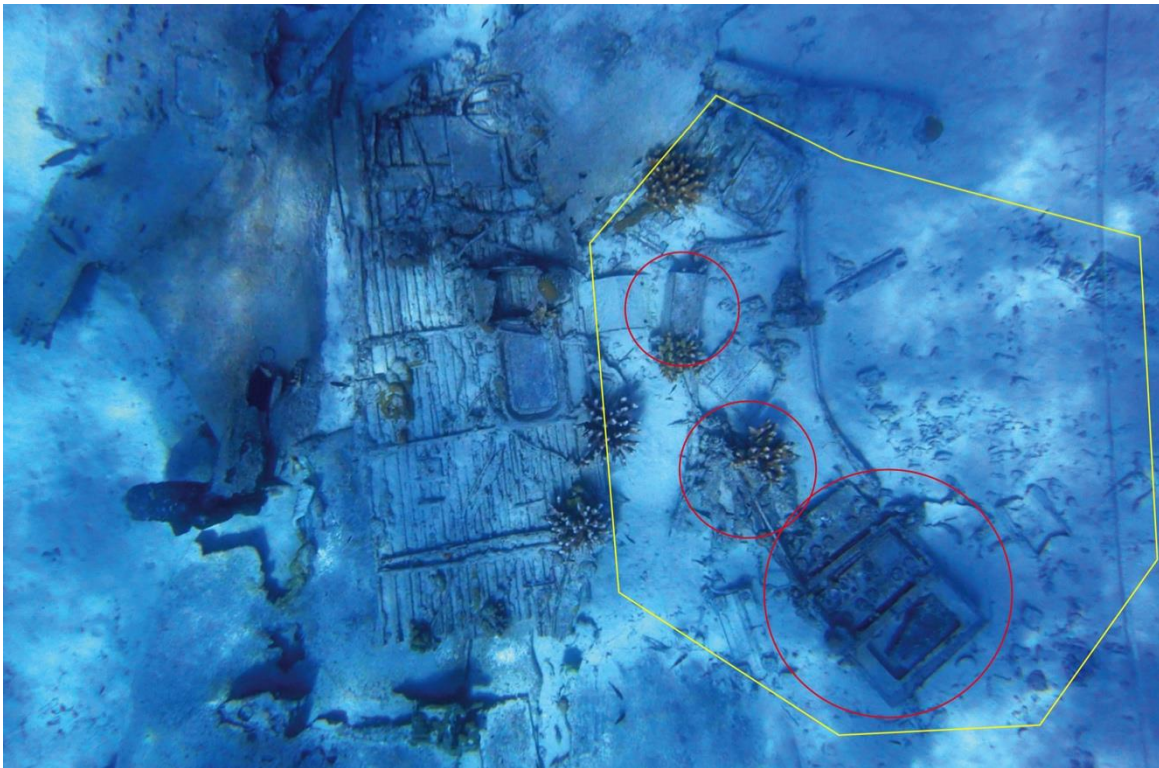


Figure 24. "Radio wall," Feature 2, *center*, and radio equipment scatter, *right*. Scatter is outlined in yellow, while individual units (Feature 3) are circled. Unscaled plan view.

East of that wall (hereafter the "radio wall"), a variety of radio equipment lies scattered across a roughly 2 m by 2 m (7 ft. by 7 ft.) area (Figure 24). Whole components include a panel containing two transmitters and one unknown unit (Feature 3), two unknown units connected to each other with a third stacked on top, and an unknown unit lying on its side. Cables connect all units to the panel. Broken sections of radio equipment and individual electrical components such as large capacitors are strewn throughout the area. Most units are covered by marine growth and cannot be identified. The two transmitters in the radio panel can be recognized, as there are several areas around the controls and transmitter face where the original markings are still legible. Judging by the layout of controls, the units are ART-13B transmitters (Figure 25). A serial number is also present at the bottom of the panel (Figure 26).



Figure 25. Contemporary ART-13B transmitters from B-29 flight deck (Photograph aafradio.org).

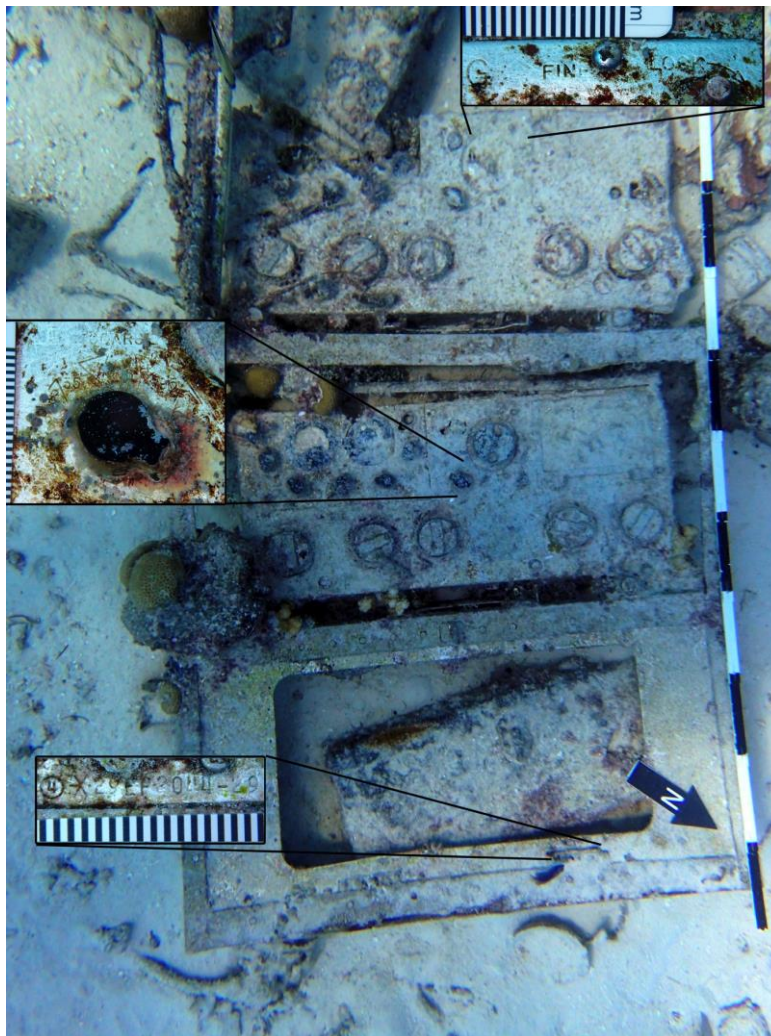


Figure 26. Radio panel (Feature 3) with two ART-13B transmitters. Details millimeter scale.

Southeast of the radio wall, and partially covered by it, lies the forward section of the port vertical stabilizer (Feature 4). The stabilizer is damaged, with tears in both the bottom and top leading edge (Figure 27). The connection to the horizontal stabilizer has been torn off, and only a small forward section of the rudder is present. The rear edge of the rudder bears evidence of being violently ripped apart. Slightly east of the vertical stabilizer is a section believed to come from the horizontal stabilizer, torn at one end, crumpled on the other, and lying atop at least two different layers of wreckage. These are the only identifiable pieces of aircraft on site that lay closer to the cockpit canopy than they should be; if the cockpit canopy were on an intact aircraft, then the stabilizers would be located 17 m (56 ft.) to the southeast.

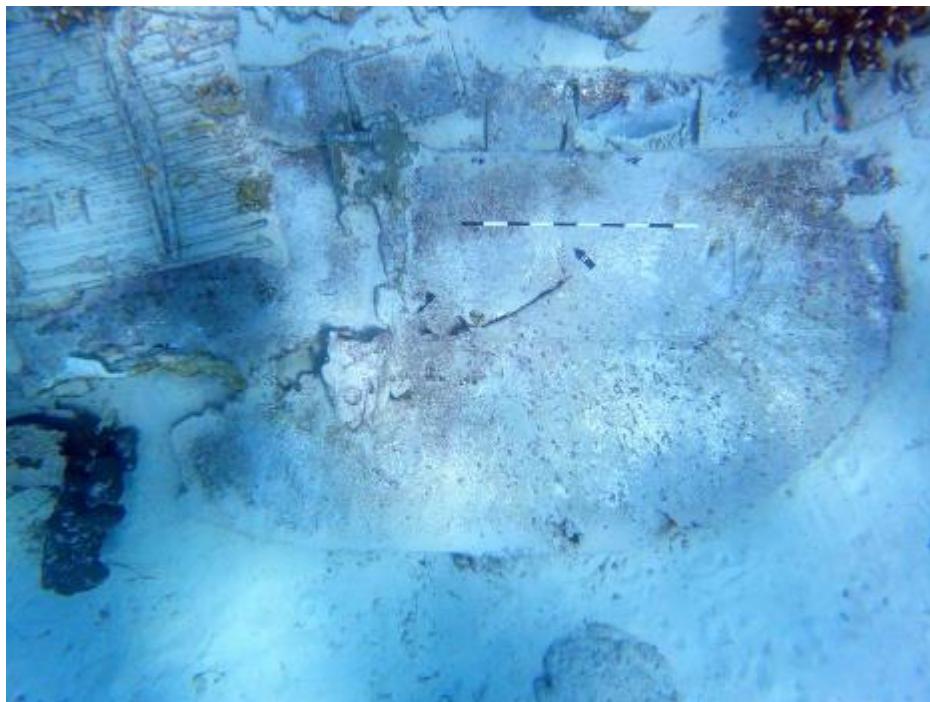


Figure 27. Port vertical stabilizer (Feature 4). Plan view, 1 m scale.

The final significant feature in the main assemblage area is the single detached engine, 11.80 m east of the cockpit (Feature 5). The engine rests on its forward surface, at an angle against a reef (Figure 28). This is the only engine present within a 200 m (656 ft.) diameter circle,

even though the PB2Y Coronado was a four-engine aircraft. There are also no propellers present in this site. As the engine rests on its forward surface, it was impossible to determine whether the propeller was detached during or after the depositional event. The nacelle is present, although some sections are missing (the access panel in Figure 28 is missing).

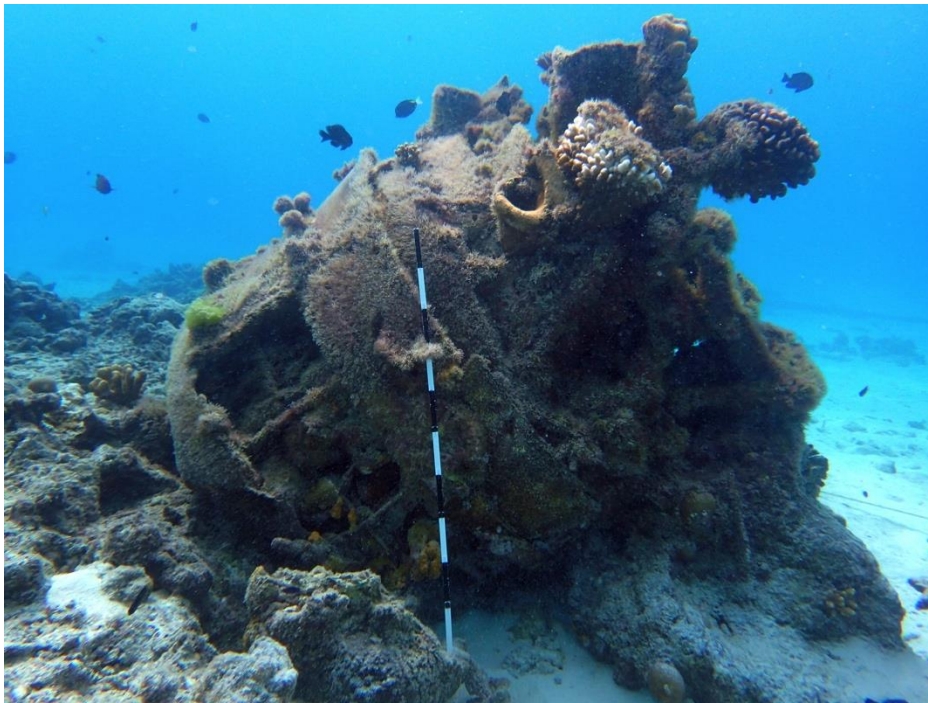


Figure 28. Engine (Feature 5). Profile view, facing south. 1 m scale.

Beyond the main assemblage, yet still visible from the engine, a seat constitutes another significant feature (Feature 6). The seat rests propped up against the northern edge of the same patch reef as the engine, 18 m (59 ft.) east of the cockpit canopy (Figure 29). Coral growth permanently attaching it to the reef indicates that the seat has been undisturbed for quite some time, yet its almost whimsical placement against the reef calls into question whether its position is a result of deposition, or a post-depositional event (see page 149). This type of seat was installed at non-flying crew member stations, such as the radio operator, navigator, and flight

engineer's stations. Passenger seats were of a different variety: Warren MacArthur seats (“Memorandum of a Conference at VPB Design, 8 December 1942”:4–5).

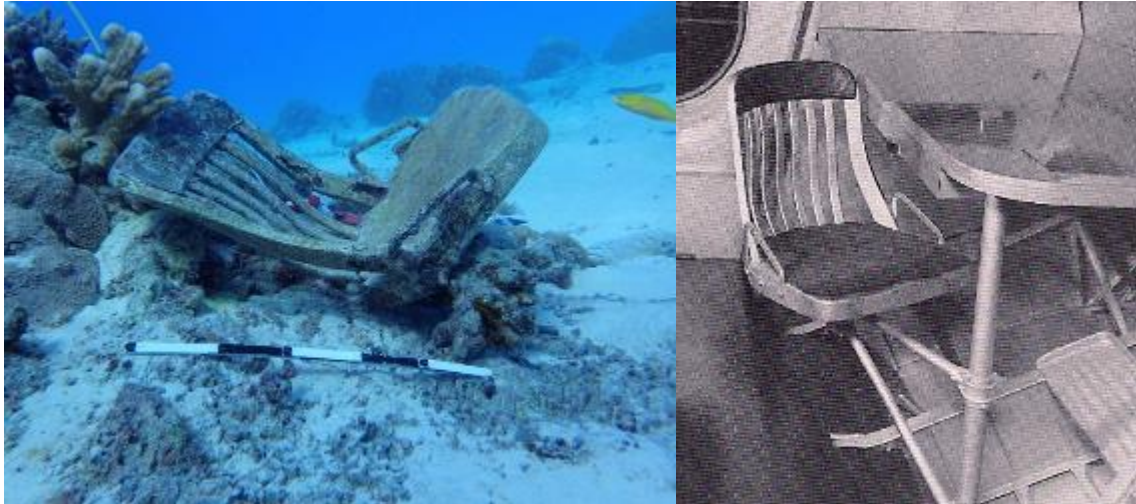


Figure 29. *Left*, seat leaning against reef, 50 cm scale (Feature 6). Profile view, facing west. *Right*, seat as temporarily installed at navigator's station in XPB2Y-1 (National Archives).

Also near the main assemblage, although not part of it, is a float strut (Feature 7), a structural component that connected the wingtip float to the wing (Figure 30, left). The Coronado featured retractable floats that folded up into the wingtip while in flight. Since flying boats are laterally unstable when at rest on the water, they require wingtip floats (or hull-mounted sponsons, as the famous *China Clipper*) to prevent capsizing (Jung 2009a:24; Gandt 1991:98).

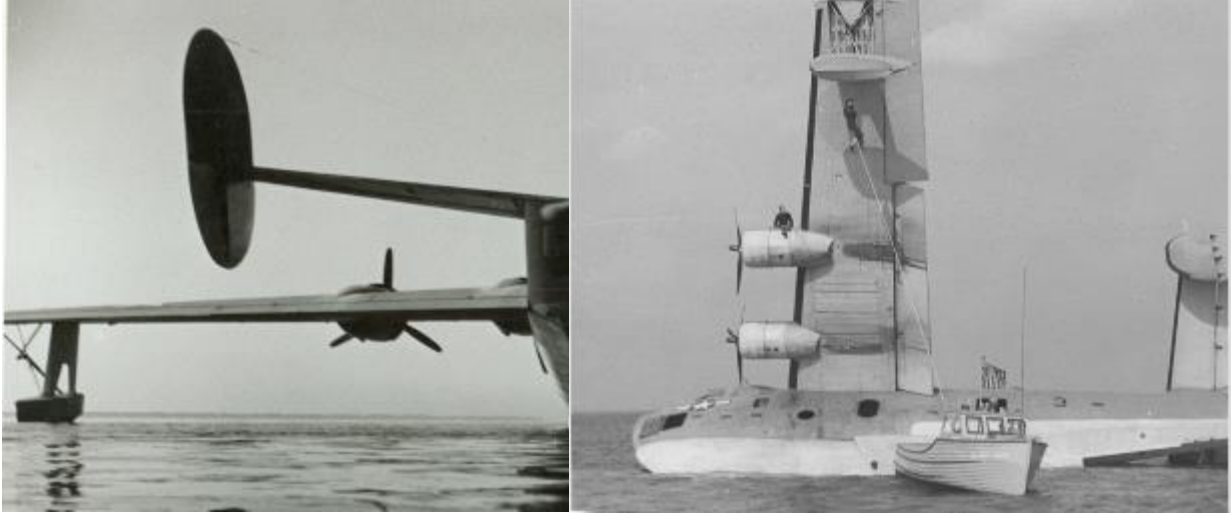


Figure 30. *Left*, Coronado from rear resting on wingtip float (US Navy). *Right*, a Coronado capsizes after losing a wing float (Warbird Information Exchange).

Only one float strut is present on this site, lying with its outer surface facing up. The strut shows evidence of being violently torn from both the wingtip and the float. This strut bears two important features. The first is paint: towards the top of the strut, green and black paint is visible. Along the extreme top edge, heavy white paint is present, with runs towards the bottom of the strut (Figure 31). This is significant, as this was the only evidence of paint found throughout the entire site. The second feature is a serial number, located along the side near the top. The serial number "29L5300-2" is readable, with a possible final digit or digits obscured by a rivet head. Below the serial number, the upside-down Consolidated Aircraft "CA" is stamped into the metal. Although researching the serial number did not return any further information (discussed on page 125), the presence of the number and stamp is conclusive evidence that the wreckage belongs to a PB2Y Coronado.

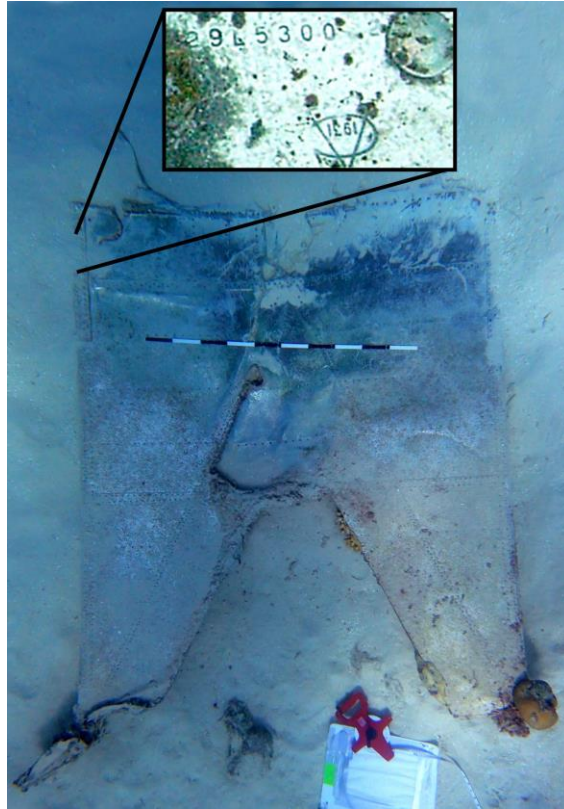


Figure 31. Float strut (Feature 7) with visible paint. *Inset*, serial number and Consolidated Aircraft Stamp (J. Carpenter 23 February 2012).

Slightly more distant, a large section of wing (Feature 8) rests partially buried 65 m to the northeast of the cockpit canopy (Figure 32). This represents the largest section of wing present on the site; other pieces are smaller and constitute control surfaces. The piece is 5.5 m (18 ft.) long, and undulates across the seabed, badly damaged. The west end appears to have been violently torn off, and only a structural support remains, bent straight upward at a right angle. The other end of the wing disappears into the sand, but likely does not continue as its exposed trailing edge stops. The leading edge is missing, also torn asunder.



Figure 32. Wing (Feature 8). Plan view, 1 m scale.

Another easily identifiable feature is a circular hatch cover (Feature 9), located 24 m (78 ft.) east-northeast of the cockpit canopy. The hatch cover is 70 cm (28 in.) in diameter, and has two semicircular windows. A handle that operates the latch protrudes from the center of the hatch. The hatch opened inward, as indicated by the position of the hinges underneath and a recessed sealing gasket on the top surface (Figure 33). The original location of this hatch cover was initially unknown. It was originally thought to have been used in lieu of an astrodome for the navigator, as shown in some pictures of Coronados. Finding the astrodome later during fieldwork discredited that theory. As line drawings show only one 70 cm (28 in.) diameter circular hatch, and the Coronado is equipped with either a hatch cover or an astrodome (but never both) in photographs, the presence of both on-site and the location of this hatch cover remained a mystery throughout fieldwork. The National Naval Aviation Museum finally provided the answer: a

photograph from the interior of their newly restored Coronado shows both the hatch cover and astrodome, mounted on opposite sides of the hatch (Figure 34). Both were installed on Coronados, but only one was closed at any given moment.

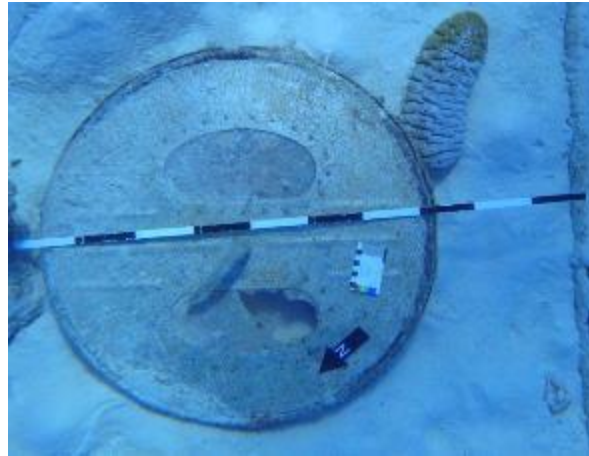


Figure 33. Hatch cover (Feature 9), plan view. 1 m scale.



Figure 34. Navigator's astrodome (right) and hatch cover (left), inside restored PB2Y-5F BuNo 7099. (National Naval Aviation Museum Facebook page, accessed 30 December 2014).

The navigator's astrodome (Feature 10) was found 73 m (240 ft.) southwest of the cockpit canopy and 92 m (302 ft.) southwest of the hatch cover discussed above. The base is intact,

complete with hinges and sealing gasket, while the dome itself is shattered (Figure 35). The dome material is discolored, turning an opaque white color; this was observed in other broken windows on-site, including the main cockpit windows.



Figure 35. Navigator's astrodome (Feature 10). Oblique view, facing southeast. 60 cm scale.

Representing a significant small find, a group of nine forks and four spoons (Feature 11) are located 19 m (62 ft.) northeast of the cockpit canopy (Figure 36). Two single forks and four single spoons are mixed amongst broken coral and rocks in a 100 cm by 50 cm (39 in. by 20 in.) area. A concreted cluster of seven forks is also present. Notably, the base of the handle of at least one fork is inscribed "USN." Based on the small number present, the artifacts here likely represent those from the Coronado's galley, rather than a cargo of eating utensils.

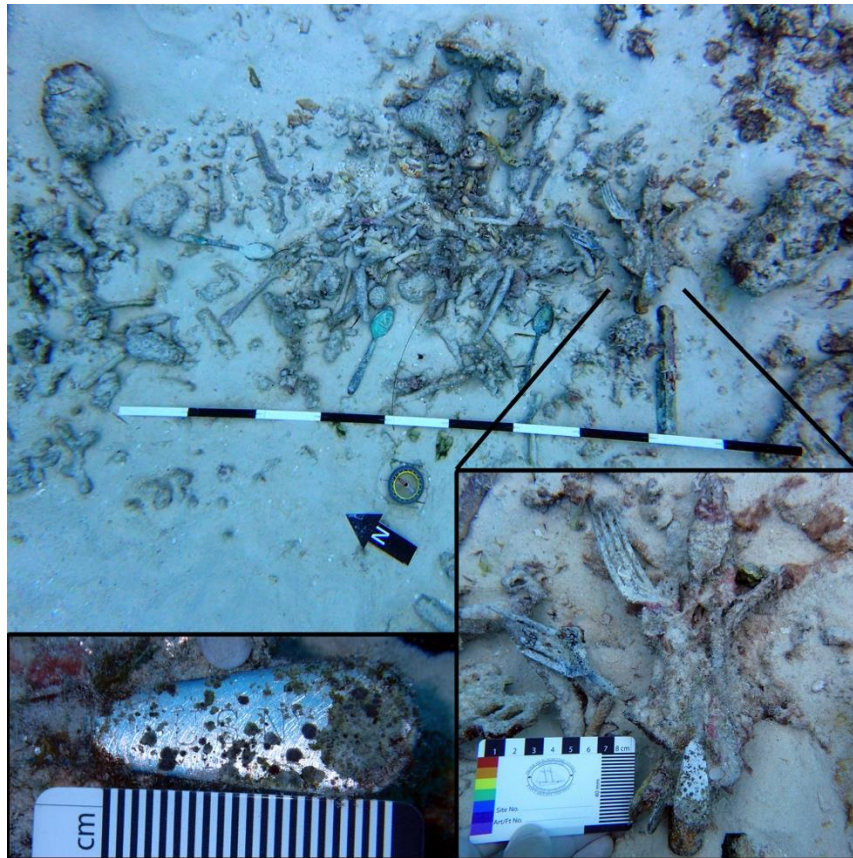


Figure 36. Forks and spoons (Feature 11). *Top*, entire scatter, 1 m scale. *Bottom right*, concreted forks, centimeter scale (top) and millimeter scale (right). *Bottom left*, detail of handle inscription, millimeter scale.

The final significant, identifiable, feature is a large section of fuselage complete with hatch and hatch door (Feature 12; Figure 37, top). The hatch size and shape identifies it as the anchor hatch, located on the port side beneath and forward of the cockpit. This section of hull is warped and damaged; at least one panel is missing completely. Identifying this piece of wreckage was significant as it offered insight to what happened to the rest of the cockpit. This hatch was originally located beneath and forward of the cockpit (Figure 37, bottom), yet was torn off and deposited 45 m (148 ft.) southwest of the cockpit canopy. This strengthens the argument that a significant amount of the aircraft body is not buried underneath the main assemblage, but was broken and scattered during the depositional event.

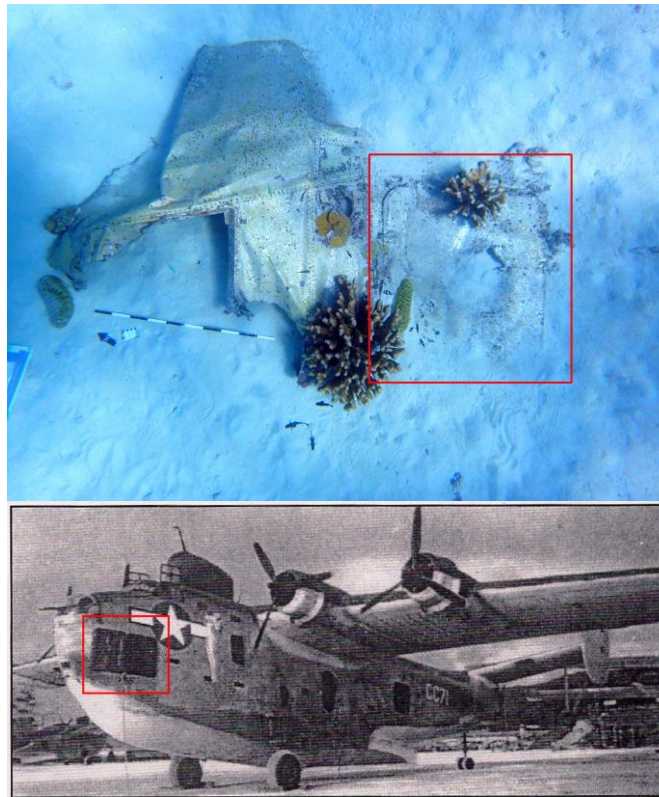


Figure 37. *Above*, hull section with port anchor hatch (Feature 12), closed, on right side. Panels missing on left. Plan view, 1 m scale. *Below*, position of anchor hatch, open, below and forward of the cockpit (National Museum of Naval Aviation).

Although the above does not cover the site in its entirety, the examined elements constitute its significant features. Beyond the main assemblage, over 40 disarticulated pieces of wreckage were found within a 200 m (656 ft.) diameter circle. The remaining wreckage, not discussed here, was impossible to identify beyond a simple classification of wing, fuselage, or unknown. This wreckage will be used later in the chapter during data analysis, including site distribution and presence/absence analysis.

5.1.3 **Presence/Absence Analysis**

A presence/absence analysis was conducted based on observations during fieldwork and later study of site plans and photographs. This data was then used for both depositional and post-depositional analyses, as well as to assist in aircraft model identification (discussed on page 130).

This analysis provided startling results. Comparing plan view area measurements from the site plan to area measurements taken from line drawings, 94% of the wing and 72% of the fuselage of the Coronado were not present on site. In addition, fieldwork observation indicated 75% and 100% of the engines and propellers (respectively) were absent.

The percentages based on plan view measurements are not exact; the method by which they were calculated imposed limitations on accuracy. All measurements were taken using the software package ImageJ to measure the polygonal area of each section. Although fast, and effective, for the purposes of this thesis, this method produced two limitations on accuracy. The first was the measurement itself; three-dimensional shapes were flattened into two-dimensional images to be measured. This meant that overlapping areas, or wreckage with substantial height above the seabed, were under-measured. This limitation was deemed acceptable, as there were few pieces of wreckage that fell into one of those categories. Additionally, measurements were taken using a polygon tool to create sided polygons to be measured. This resulted in areas being slightly over-measured, as not many pieces of wreckage fit neatly within rectangles, circles, or other polygons.

The results, however, were considered adequate for this analysis. They proved that large amounts of the aircraft are not present on site, either buried or removed. The potential causes for the absence of those are discussed in greater detail in section 5.5, Site Formation Processes.

The presence/absence analysis was also utilized to identify and locate key diagnostic features that could determine the model variant of the Tanapag Coronado. These key features included engines, gun turrets and other armaments, and internal cargo space accouterments. Of these features, only a single engine was present. The absence of the other features was also

carefully considered, and the results of this analysis are presented in section 5.4, Identity and Justification.

5.2 *Research Results*

While fieldwork data was discussed above and Chapter Four covered the general results of archival and historical research, this section will examine data specific to Saipan and the Tanapag Lagoon site. This will include detailed results of archival research, in addition to data gained from other non-fieldwork pursuits. Also presented are the results of analyses of geographic data and a previous magnetometer survey (Burns 2008).

5.2.1 Archival/Historical Research Results

According to records, Consolidated Aircraft and its partners produced 217 PB2Y Coronados. Through the Lend-Lease Act, the British took delivery of 35 aircraft; they returned 25 of these, which subsequently went into US naval service (Swanborough and Bowers 1976:85–86; Andrews 1989:22–23). Thus, the US Navy operated a total of 207 Coronados, of which 33 were recorded lost (classified as either "A" or "Strike" damage) in Aircraft Accident Reports (US Navy 1945a). These aircraft are listed in Table 1.

Table 1. PB2Y Coronado losses recorded on Aircraft Accident Reports.

BuNo	Type	Date Lost	Location
1633	PB2Y-2	5/6/42	Pearl Harbor, HI, USA
7058	PB2Y-3	12/27/42	Salton Sea, CA, USA
7054	PB2Y-3	3/21/43	Little Creek, VA, USA
7104	PB2Y-3	5/23/43	65 mi. north of Bermuda
7128	PB2Y-3	5/24/43	San Miguel Reservoir, Mexico
7113	PB2Y-3	5/25/43	Bermuda
7089	PB2Y-3R	8/14/43	Long Island Sound, NY, USA
7146	PB2Y-3	10/13/43	Salinas, Ecuador

7147	PB2Y-3	10/19/43	Puerta Castilla, Honduras
7108	PB2Y-3	11/7/43	Port Royal Sound, Bermuda
7057	PB2Y-3	12/21/43	Patuxent River, MD, USA
7106	PB2Y-3	1/1/44	Great Sound, Bermuda
7170	PB2Y-3	2/14/44	Kwajalein Atoll, Marshall Islands
1635	PB2Y-2	2/17/44	San Diego, CA, USA
7096	PB2Y-3R	5/7/44	Dakar, Senegal
7143	PB2Y-3	7/17/44	Galapagos Islands, Ecuador
7233	PB2Y-3R	7/31/44	Funafuti Atoll, Ellice Islands
7216	PB2Y-3R	8/5/44	East River, NY, USA
7068	PB2Y-3	9/14/44	Kwajalein Atoll, Marshall Islands
7180	PB2Y-3	9/27/44	San Diego, CA, USA
7221	PB2Y-5R	10/12/44	CA, USA
7051	PB2Y-5	10/17/44	Los Coronados Islands, Mexico
7075	PB2Y-5R	2/12/45	Kwajalein Atoll, Marshall Islands
7133	PB2Y-5	2/22/45	Corpus Christi, TX, USA
7152	PB2Y-5	3/31/45	Saipan, CNMI, USA
7195	PB2Y-5R	4/26/45	Honolulu, HI, USA
7160	PB2Y-5	5/10/45	Saipan, CNMI, USA
7072	PB2Y-5	5/23/45	Pacific Ocean, Japan
7132	PB2Y-5	6/2/45	Kagoshima Bay, Japan
7044	PB2Y-5R	6/22/45	Pacific Ocean, Saipan, CNMI, USA
7167	PB2Y-5	6/28/45	Kerama Islands, Okinawa, Japan
7070	PB2Y-5R	9/15/45	Saipan, CNMI, USA
7073	PB2Y-5Z	1/20/46	Honolulu, HI, USA

In addition to the aircraft recorded lost on Aircraft Accident Reports, Squadron Histories and Squadron War Diaries reveal a further nine aircraft lost (Table 2). The reason for the absence of Aircraft Accident Reports for these aircraft is unknown. Most of these losses appear to not be mission-related accidents, so perhaps they were not required to be reported via Aircraft Accident Reports. Perhaps the losses were reported, and the records were lost. Regardless of reason, this illustrates that even for a period from which ample records are available, errors and omissions still exist, and documents and collections of documents should be cross-referenced.

Table 2. PB2Y Coronado losses not recorded on Aircraft Accident Reports

BuNo	Type	Date Lost	Location	Cause
7125	PB2Y-3	7/29/43	San Diego, CA, USA	Ramp accident
7186	PB2Y-3	9/10/44	Saipan, CNMI, USA	Grenaded by Japanese
7119	PB2Y-5	2/22/45	Corpus Christi, TX, USA	Storm damage
7110	PB2Y-5	3/11/45	Salton Sea, CA, USA	Landed in desert
7063	PB2Y-5	3/13/45	Ulithi Atoll, Caroline Islands, FSM	Fire at mooring
7056	PB2Y-5	3/30/45	Ulithi Atoll, Caroline Islands, FSM	Sunk at mooring by barge
7225	PB2Y-5R	4/21/45	Alameda, CA, USA	Crashed at takeoff practice
7145	PB2Y-5	4/26/45	Kerama Islands, Okinawa, Japan	Hit by another plane on water
7226	PB2Y-5R	5/9/45	Honolulu, HI, USA	Hit reef

The ambiguity in records was further confounded by cross-checking these tables against a secondary source compilation of WWII aircraft losses (Campbell 2011). This compilation contradicted the AAR crash location of two aircraft (BuNos 7063 and 7056, both listed as lost in Saipan) as well as introduced several new aircraft reported lost. This brought the total number of Coronados reported lost in Saipan to 12 aircraft (Table 3).

Table 3. PB2Y Coronado losses reported in Saipan

BuNo	Type	Date Lost
7070	PB2Y-5R	9/15/45
7160	PB2Y-5	5/10/45
7044	PB2Y-5R	6/22/45
7186	PB2Y-3	9/10/44
7152	PB2Y-5	3/31/45
7076	PB2Y-5	3/15/45
7063	PB2Y-5	3/13/45
7056	PB2Y-5	3/30/45
7055	PB2Y-5	7/17/45
7053	PB2Y-5	8/11/45
7074	PB2Y-5	8/11/45
7103	PB2Y-5	8/11/45

Ultimately, after crosschecking against Aircraft Accident Reports, Aircraft History Cards, Squadron Histories, and Squadron War Diaries, the aircraft determined not to have crashed in Tanapag Lagoon, Saipan, were:

- 7160: AAR lists location of loss as Saipan; squadron history details the account of loss near Kerama Rhetto seadrome, which is located in Okinawa, Japan (Patrol Bombing Squadron Thirteen 1945b).
- 7044: Five hours after takeoff, 7044 made a forced landing at sea between Saipan and Ebeye. USS *Polaris* rescued crew and cargo, and attempted to tow aircraft to port; efforts failed, and aircraft sank (Air Transport Squadron Two War Diary, June 1945).
- 7152: Squadron war diary records VPB-13 was assigned to Ulithi Atoll, Caroline Islands, FSM, during March 1945. War diary reports 7152 crashed on 31 March during takeoff in rough water (Patrol Bombing Squadron Thirteen 1945a). Argument is bolstered by memoir of pilot, Donald Frentz, lamenting his loss of Japanese guns and other keepsakes to Ulithi Lagoon (Bracho 2005:112–113).
- 7076: Squadron war diary reports 7076 was damaged on 10 January 1945 and recommended for striking in March because of inability to obtain structural parts required for repairs (Patrol Bombing Squadron Thirteen 1945a).
- 7063: Squadron war diary records VPB-13 was assigned to Ulithi Atoll, Caroline Islands, FSM, during March 1945. War diary reports 7063 was destroyed by fire at its mooring on 13 March (Patrol Bombing Squadron Thirteen 1945a).
- 7056: Squadron war diary records VPB-13 was assigned to Ulithi Atoll, Caroline Islands, FSM, during March 1945. War diary reports 7056 was damaged and sunk by a barge that

drifted through mooring area at night during a violent storm on 30 March (Patrol Bombing Squadron Thirteen 1945a).

- 7055, 7053, 7074, and 7103: All four aircraft are listed in Campbell (2011) as assigned to CASU(F)-48 at time of loss. CASU were Combat Air Service Units, responsible for maintenance of aircraft. BuNo 7055 was transferred to CASU(F)-48 and stricken on 10 July because of its age and seriously damaged hull (Patrol Bombing Squadron Thirteen 1945a). Aircraft history cards for the other three aircraft indicate they were assigned to CASU(F)-48 when they were stricken; it is likely that these were transferred and stricken similar to 7055.

Discounting these ten aircraft for the reasons listed above, historical and archival research suggests that only two PB2Y Coronados were lost in Tanapag Lagoon: BuNos 7186 and 7070.

BuNo 7186 was assigned to Rescue Squadron One (VH-1). Its Aircraft History Card lists the model as a PB2Y-3, as does the squadron war diary. The squadron war diary lists all Coronados as PB2Y-3, even though they must have been PB2Y-3H variants fitted with stretchers for air ambulance service. By summer 1944, it is likely (though unconfirmed) that the aircraft had been upgraded to the PB2Y-5H model. According to the squadron war diary, 7186 was "boarded by the enemy and sunk with grenades while moored in Saipan Harbor" at 0430 on 10 September 1944 (Rescue Squadron One War Diary, September 1944). It further notes that there were no casualties, though one crewmember "suffered a few abrasions from a grenade which exploded in the bilges beneath him" (Rescue Squadron One War Diary, September 1944). Although there is not an Aircraft Accident Report from this incident, more information comes from a VPB-13 pilot operating out of Saipan at the time, who recalled:

One morning I had just gotten airborne and was about to depart on my patrol when I heard a report from one of the PB2Y's moored to a buoy that they had been boarded by two armed Japs [sic]. The aircraft belonged to Hospital Evacuation Squadron One and was unarmed. The Japanese had swum out under cover of darkness and tossed a hand grenade through the open waist hatch and then boarded the plane...the grenades had ruptured the hull and the Coronado was taking on water...and ultimately sank. (DeLorenzo 1987:24)

The loss of BuNo 7070 was more carefully documented. Air Transport Squadron Two (VR-2) PB2Y-5R BuNo 7070 began life as a combat model PB2Y-3 in December 1942, and served with Patrol Squadron 13 (VP-13). In July 1943, BuNo 7070 transferred to Rohr for upgrades and conversion to a PB2Y-5R model, after which it was transferred to Air Transport Squadron Two. BuNo 7070 crashed on takeoff at 0354K (local time, UTC+10) on 15 September 1945, on a scheduled flight carrying 4 passengers in addition to its 10 crewmembers. The aircraft, although less than three years old, had already logged 2,356.4 hours on its airframe since conversion and required three overhauls in that period. All four engines had over 1,000 hours each since installation, and over 500 hours since last overhaul (US Navy 1945h; US Navy 1945b).

Lt. Baumhover, an experienced pilot with over 1,500 hours flight time in Coronados (155 in the past three months alone), prepared for takeoff assisted by the plane commander, Lt. Lehrkind, as copilot. They began the takeoff run on runway #23, into swells from the southwest and a light 2 kt (3.7 km/h) breeze from the south-southeast. Other conditions were fair, with an unlimited ceiling and 8 miles (12.9 km) of visibility. Upon stepping up onto plane, the aircraft began "porpoising"—skipping across the water, rising off then settling back onto the surface. By

the third porpoise, at an estimated 60 knots (111 km/h), the aircraft struck the water with right wing low and crashed. Of the 14 people on board the aircraft (10 crew, 4 passengers), only 6 crewmembers survived the crash; the remaining 8 passengers and crew suffered "death by drowning" (US Navy 1945h). The status of all personnel, as reported in Aircraft Accident Report Serial No. 9-45, is presented in Table 4. Severity of injury was classified A to D, with A resulting in death and D receiving no injury. Passengers are indicated by (P) before their names. Bodies of the deceased, after recovery, were buried in in the US Army Cemetery, 27th Division, in Saipan (Air Transport Squadron Two War Diary, September 1945).

The crash analysis as given in the report reveals dissonance between lower- and higher-level investigators or reviewers. The breakdown of cause of accident was originally distributed at 20% pilot error (poor reaction), 60% seadrome swells, and 20% darkness. The commanding officer (CO) of VR-2, reviewing the accident report, recommended increasing the pilot error category in light of the pilot's experience and familiarity with the area. The CO attributed 60% to pilot error (20% poor reaction, 40% poor judgment), with the remainder split evenly between seadrome swells and darkness (US Navy 1945h). Upon receipt of the accident report, the Deputy Commander of NATS commented, "This command is of the opinion that the accident was the result of 100% pilot error" (Whitney 1946). This insinuates a potential trend for crash investigators at the lowest level to attribute the crash on outside factors, while pilot error tended to increase proportionally with reviewer rank and position.

Table 4. BuNo 7070 personnel during crash.

Name	Rank	Service	Position Occupied	Injury Class	Description
Lehrkind, Paul	Lt	USNR	Flt. deck copilot	C	abrasion forehead and left hand
Baumhover, Denis	Lt	USNR	Flt. deck, pilot seat	C	lacerations right ear, forehead, left arm
Moriarty, Robert	Ens	USNR	Step btwn pilot & copilot	C	laceration left thigh and right leg
Kalbfus, William	LtJg	USNR	Flt. deck, nav. table	A	death by drowning
McCormick, Gerald	LtJg	USNR	Flt. deck, nav. table	A	death by drowning
Eastham, Harrold	AMMF2c	USNR	Flt. deck, engr. panel	A	death by drowning
Oldensmith, Paul	AMMF3c	USNR	Flt. deck, standing near engr table	A	death by drowning
Wiediger, Adolph	ACRM	USN	Compt. D	B	severe comminuted laceration forehead, fracture sesgical [sic] and facb.
Smith, William	ARN2c	USN	Flt. deck radio table	C	necked left homens
McElroy, Thomas	SpV3c	USNR	Compt. K	C	lacerations forehead
(P) Trotter, R.T.	LtJg	USN	Compt. G	A	death by drowning
(P) Causey, J.T.	Ens	?	Compt. G	A	death by drowning
(P) Mottalini, A.J.	S1c	?	Compt. G	A	death by drowning
(P) Thebarga, D.G.	ARM3c	?	Compt. G	A	death by drowning

5.2.2 Geographic Survey

A geographic survey was conducted, to determine both if geospatial analysis could help identify the aircraft wreck, and if the wreck site was in an area that may have been affected by activities such as dredging or harbor clearance. The survey began with the current NOAA chart of Saipan Harbor, chart number 81076 (13th Edition), published in January 2013.

Anachronistically, it still demarcates a seaplane landing area and anchorage, even though "the golden age of civil flying boats came to an end with the beginning of the war... [and] the golden age of military flying boats closed with the end of the war" (Allward 1981:119).

The current chart was compared to an early chart of Saipan Harbor published by the Hydrographic Office (HO) of the US Navy, chart number 6062. The second edition, corrected through December 1948, was consulted. When georectified in ArcGIS and overlaid on the modern NOAA chart, the result demonstrates that neither the seaplane runways nor anchorage were moved; it appears their positions were copied directly onto the NOAA chart. The HO chart exhibits buoys at the ends and intersections of the seaplane runways. They were still marked at their extremities by yellow seadrome buoys during a survey in 1950 (US Navy 1950:24–25). Even though a record of their removal was not found, the buoys were not present during fieldwork. Although the post-war HO chart shows many more shipwrecks (some labeled as aircraft), neither the period nor the modern charts indicate a wreck or obstruction at the location of the Coronado site (Figure 38). The closest wreck indicated, some 380 m south, is believed to be *Shoan Maru* (McKinnon and Carrell 2011:38).

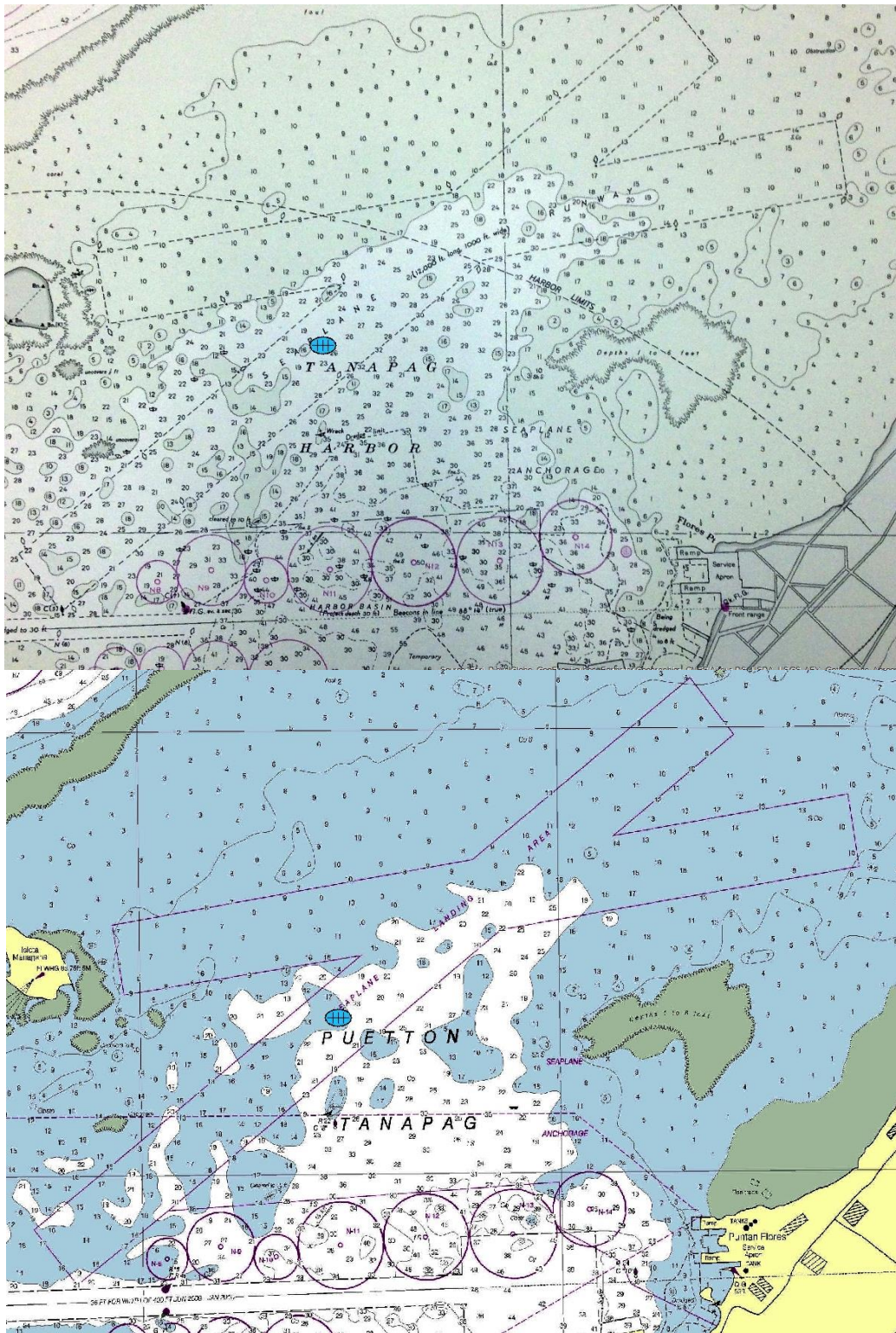


Figure 38. *Top*, Hydrographic Office chart 6062 (1948) and *bottom*, NOAA chart 81076 (2013). Both illustrate the location of seaplane runways (center), seaplane anchorage (lower right between reef and mooring circles), and overlaid site location of the Tanapag Lagoon PB2Y Coronado (blue symbol).

As seen in Figure 38, the Tanapag Coronado site is situated squarely in the center of one of the two seaplane runways. The seaplane anchorage, though its boundaries are not clearly delineated, lies 1 km to the east of the site. It is also 1 km north of the main channel, and over 400 m northwest of the nearest dredge limit shown on HO chart 6062. Further research into the seaplane runways referred to the runways as 8-26 and 5-23 (US Navy 1950:25). Runway naming convention labels runways as reciprocal pairs of compass headings, rounded to the nearest 10 then divided by 10. Thus, a runway with an east-west orientation ($90^{\circ}/270^{\circ}$) would be named 9-27. Runway 9 is the westerly end of the runway (facing due east), while runway 27 is the easterly end (facing due west) (NASA 2014). See Figure 39 for Tanapag Lagoon runway layout.

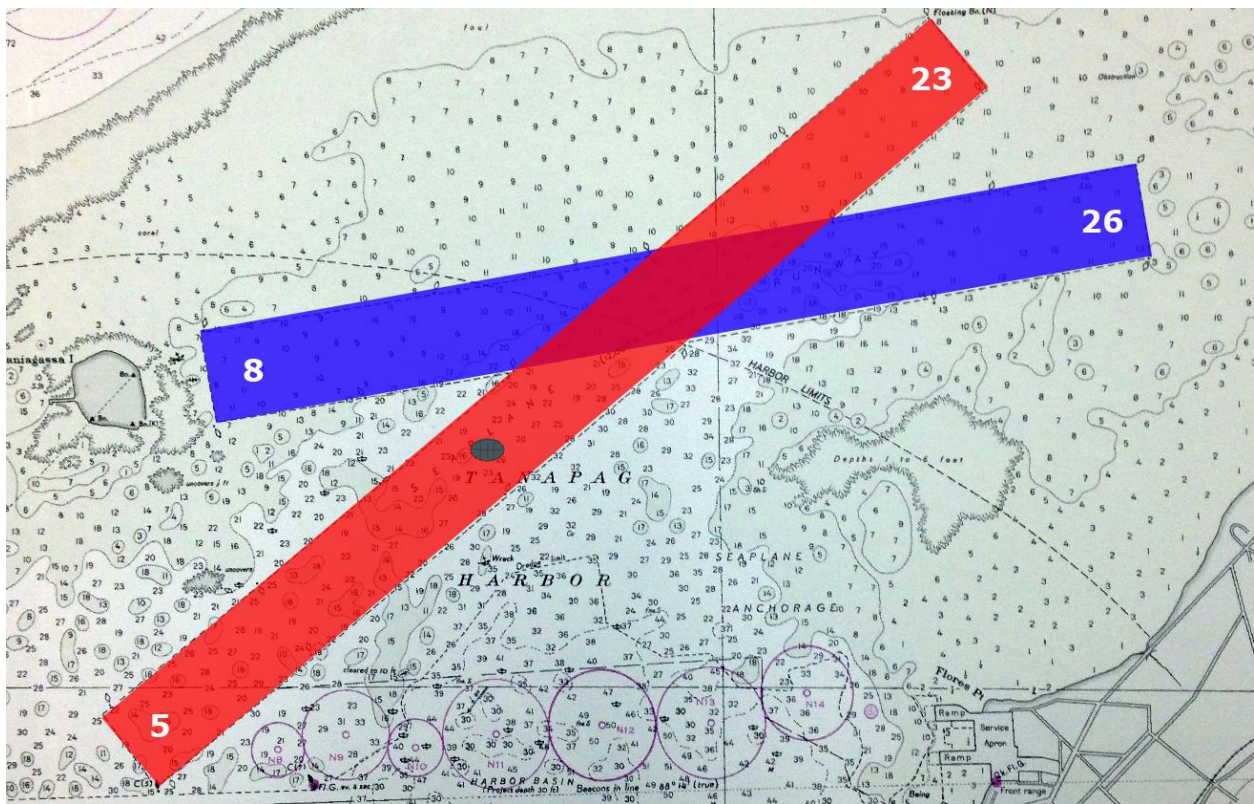


Figure 39. Tanapag seadrome runways, labeled, and overlaid site location of the Tanapag Lagoon PB2Y Coronado (blue symbol). (HO chart 6062, 1948).

5.2.3 Magnetometer Survey Results

In 2008, Southeastern Archaeological Research, Inc. (SEARCH) of Jonesville, Florida, conducted a remote sensing survey and diver identification under contract to the CNMI Department of Community and Cultural Affairs, Division of Historic Preservation (DHP). Out of 778 magnetic anomalies, 54 were sampled through diver investigation, side scan sonar, or were previously identified (Burns 2008:i-1). Although aircraft are primarily constructed of aluminum or aluminum alloys, the Kawanishi H8K3 "Emily" flying boat remains created a magnetic anomaly during the survey (Burns 2008:79). As the PB2Y Coronado was a similarly sized flying boat, it was assumed it would have created a similar magnetic anomaly. Survey results, however, do not show the Coronado site; the nearest recorded magnetic anomaly was 170 m (558 ft.) distant from the Coronado site (Burns 2008:59).

One possible reason is the deficiency of ferrous materials on the Coronado site when compared to the Emily. Four engines, complete with propellers, and a machine gun turret are present on the Emily site. These are the most likely objects to contain a large amount of ferrous materials. In contrast, the Coronado site boasts only one engine, and no propellers or gun turrets. Further exacerbating the situation, the Pratt and Whitney Twin Wasp engine installed in Coronados featured a forged aluminum crankcase and "liberal amounts of magnesium" to reduce weight (Machine Design 2003; Canadian Museum of Flight 2014). This may further explain why the Coronado site did not produce a magnetic anomaly large enough to be recorded during the 2008 survey.

Another hypothesis, though less likely, lies with the proximity of the Coronado site to the mooring and route used by the tourist submarine that operates in Tanapag Lagoon. The site is just over 150 m (492 ft.) north of the mooring used by the tourist submarine between tours and

when embarking or disembarking passengers (Figure 40). The submarine passes by the site on its tour route to visit the Emily, northeast of the Coronado site. While the submarine never approached close enough for visual contact underwater, it was estimated that the submarine passed between 100 and 200 m (328 and 656 ft.) of the site. The 2008 report makes no note of the survey being disrupted by the submarine, but the possibility exists that the Coronado site was either missed while avoiding the submarine, or any magnetic anomaly recorded in the area was attributed to the submarine and discounted.



Figure 40. Tourist submarine and tender as seen from Coronado site.

5.3 Faux Site

During the 2012 field season that initially surveyed the Coronado, the research team visited another unidentified “aircraft wreck” site close to the Coronado. The site, located 275 m (902 ft.) south-southeast of the Coronado site, is composed of two propellers (four-bladed), hatch covers, multiple aircraft seats, a machine gun and mount, ammunition, and other large pieces of wreckage. Samantha Bell (2010:88), studying site formation processes of several aircraft sites in

the lagoon, mirrored a local dive operator in her belief that the submarine company created the site by moving the components from other sites in the lagoon. The 2012 Flinders University/Ships of Discovery survey team visited this site, and concluded it to be a "faux site," created by the tourist submarine company (McKinnon and Carrell 2014:46).

This author, upon surveying the site in November 2014, drew the same conclusion. The site contains a relatively small number of artifacts compared to the other aircraft wreck sites. More importantly, the site contains only easily identifiable artifacts, such as propellers, guns, seats, and hatches. Even the unknown section of fuselage has a window, which is a recognizable feature. Thus, this site contains only moveable objects that tourists, unfamiliar with aircraft, can understand when viewing from a distance through a viewport. Further, the entire site is in a location that is accessible by the submarine; no features are hidden, buried, or require maneuvering to be seen (Figure 42 and Figure 42).



Figure 41. Faux wreck site overview, with two propellers (top left and center), two seats (center), a machine gun (center), various hatch covers, and ammunition scatter (center to bottom right). (Photograph J. Carpenter, 24 February 2012).



Figure 42. *Left*, faux site in 2012 (photograph J. Carpenter, 24 February 2012). *Right*, Similar view in 2014 with submarine in background. Note positions of seats, hatch covers, and machine gun have changed since 2012.

Both Bell (2010:113–114) and McKinnon and Carrell (2014:46) hypothesized that components of the faux site were removed from the Martin PBM Mariner site. Bell suggested that the seats came from the Mariner, as opposed to the Kawanishi H8K "Emily," because the seat is larger than those typically found on Japanese craft, and at that time the Coronado had not been known. McKinnon and Carrell proposed that the two four-blade propellers were also moved from the Mariner site, as that aircraft was equipped with four-blade propellers and its wreck site is devoid of engines and propellers. Both opinions were conjecture, however, and were made without the knowledge of the nearby Coronado site. Both reports also recommended further research on the faux site to determine the origin of its artifacts.

This author suggests, based on brief surveys performed on 22 November 2014, and again on 30 November 2014, that the majority of artifacts belong to a PB2Y Coronado. Of the two seats on the faux site, one (Figure 43, top left) is identical to the seat found on the Coronado site and proven to match the type used in that aircraft (Figure 29). This type of seat was not installed in PBM Mariners, disproving that theory (Ginter 2013:52). The second seat (Figure 43, top right)

resembles the type of seat installed at the flight controls. These seats had two distinctive features when viewed from behind: a high, arched headpiece extruding back the top rail, and tubular top, mid, and lower rails supporting the seatback (Figure 43, bottom left). Although the headpiece has been crushed, the second seat on the faux site does exhibit the tubular rails supporting the seatback (Figure 43, bottom right), leading to the conclusion that this seat, too, came from a Coronado.

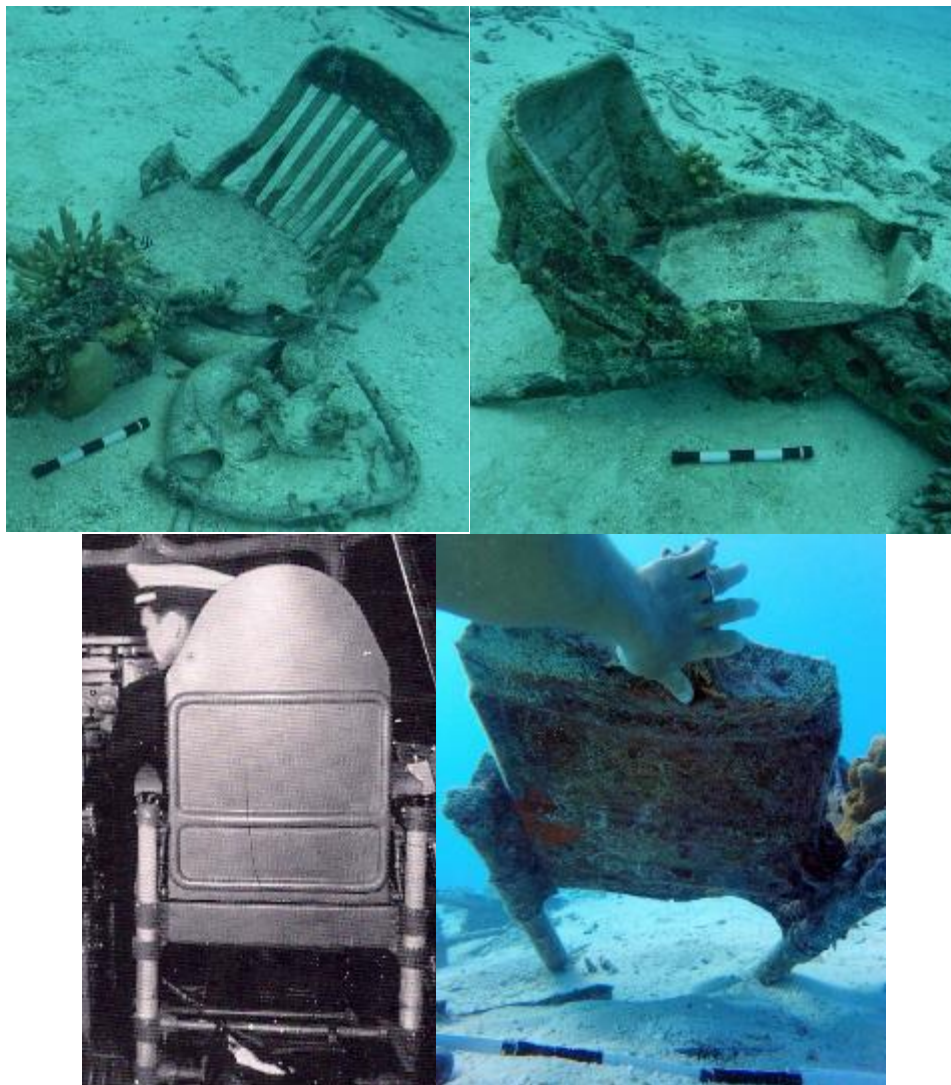


Figure 43. *Top left*, Coronado seat on faux site, as placed by the machine gun in 2012. Oblique view, 25 cm scale. (Photograph J. Carpenter, 24 February 2012). *Top right*, suspected Coronado pilot or copilot seat, oblique profile view, 25 cm scale. (Photograph J. Carpenter, 24 February

2012). *Bottom left*, back of copilot's seat (Hoffman 2009:163). *Bottom right*, seat back of suspected pilot or copilot seat. Oblique view, 10 cm scale increments.

A second group of artifacts that can be attributed to a Coronado is a collection of four hatch covers (see Figure 44 for examples). Two hatch covers are oblong, and appear to have been installed on interior spaces (see (Hoffman 2009:150). A third (Figure 44, right) is the remains of a cockpit escape hatch cover (see Figure 22 for in situ example). The fourth, a semi-oblong cover (seen partially obscured by propeller, Figure 42 right), is of a type also installed in Coronados (Hoffman 2009:172). Of the four, only the escape hatch cover can be determined with absolute certainty to have originated from a Coronado. The remaining three, while proven to be of a type installed in Coronados, require further research to establish whether they were installed in only Coronados, or whether they were also installed in other types of aircraft.

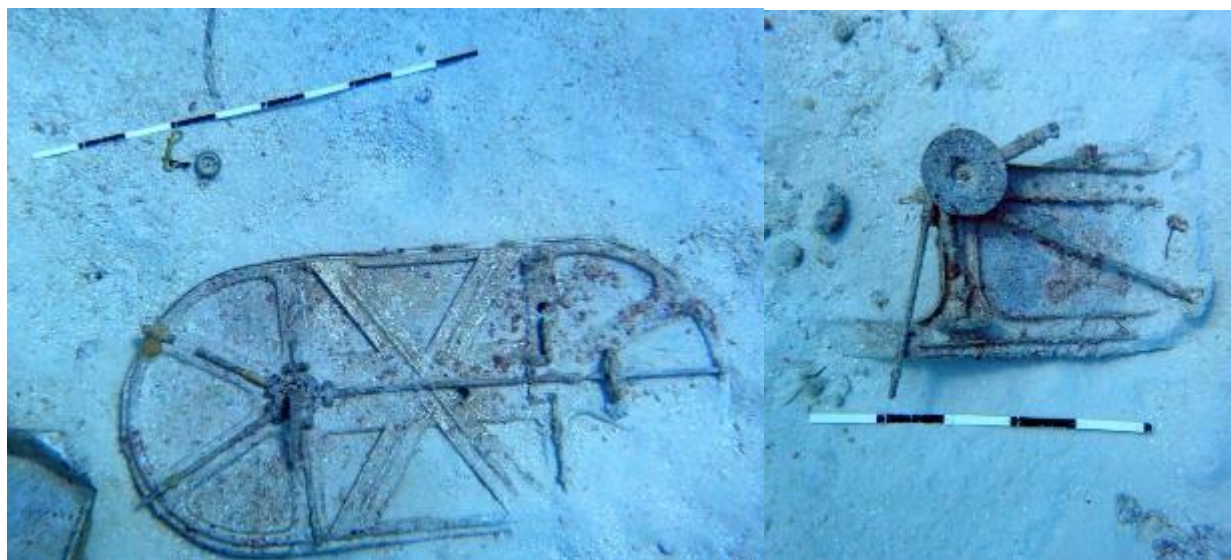


Figure 44. Examples of hatch covers on faux site. *Left*, oblong interior hatch, plan view, 1 m scale. *Right*, damaged escape hatch, plan view, 50 cm scale.

Just to the north of the faux site, across a patch reef, lies a large beaching gear wheel (Figure 45). Coronados were not amphibious aircraft, like the later PBY-5A Catalina that had

retractable landing gear. Before beaching a Coronado on a seaplane ramp, heavy beaching gear had to be brought out to the aircraft and attached (Bracho 2005:51–52). Only the wheel and tire are visible; the rest of the gear, if present, is buried. A strand of twisted steel cable, probably for the brake, extrudes from the hub. Unlike other artifacts located on the faux site, this appears to not be staged for tourist viewing; it is partially buried, and cannot be seen from the faux site because of the reef. Its purpose here is unclear.

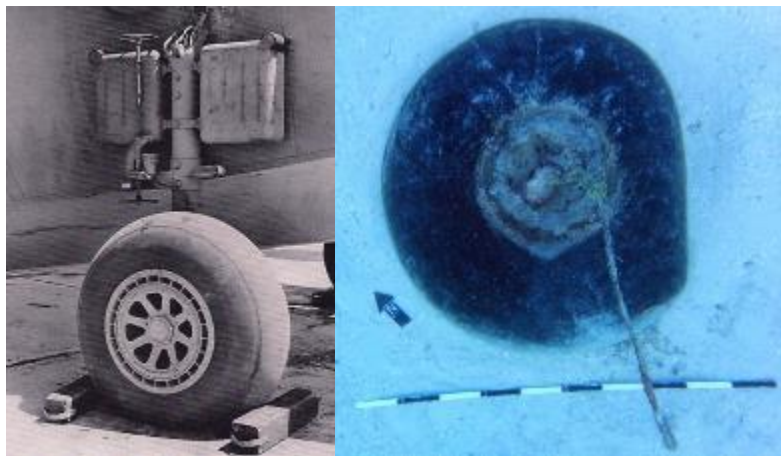


Figure 45. *Left*, front beaching gear attached to Coronado (Hoffman 2009:183). *Right*, beaching gear tire to north of faux site. Plan view, 1 m scale.

Identifying the two propellers on the faux site is a difficult venture. Four-bladed propellers were not uncommon on large aircraft during WWII (the PB2Y Coronado, PBM Mariner, and Kawanishi H8K "Emily" represent examples located within Tanapag Lagoon). It would be difficult, if not impossible, to determine by examination of only these ex situ propellers from which aircraft they originated. A 2012 photograph (Figure 46) reveals a serial number on an external component attached to the propeller hub. The function of this component is unknown; it was detached and partially buried by the 2014 survey.



Figure 46. Unknown propeller hub component with serial number. Oblique view, 25 cm scale. (Photograph J. Carpenter, 24 February 2012).

Research of the serial number, 29G3015-L, produced no information concerning the nature of the component. It did uncover evidence demonstrating that it came from a Coronado. In an email to Jennifer McKinnon soon after the field season concluded in March 2012, Peter Harvey, manager of Maritime Heritage Victoria, revealed that the "29" of the serial number indicates it was installed on a Coronado. This corroborates with the two numbers found on the Tanapag Lagoon site: the radio panel (29EF2044-29), and float strut (29L5300-2), which also bore the Consolidated Aircraft "CA" stamp. An internet search returned a post on an online forum that substantiated the claim that Coronado parts were marked with serial numbers beginning with "29" (WaltW, post to "unidentified wing section Roi-Namur," January 14, 2013). Research into the Coronado's history reveals that before acceptance by the Navy, the Coronado was known as Model 29, which is likely the origin of the serial number (Pescador et al. 2008:42).

In 2014, one of the tourist submarine captains confided that rumor within the tourist submarine company was that they created the site, over 20 years ago. Unfortunately, through employee turnover, company reorganization, and a number of other causes, none of the people

involved in the endeavor were still with the company or even on the island of Saipan. One long-term employee, not directly involved with that project but employed by the company at the time, recalled the propellers being moved, and asserted that all components were removed from one site. This wreck, he claimed, lay roughly halfway between the seaplane ramps and the current submarine mooring.

If this information is true, then there was another Coronado wreck, much further inshore than the Coronado site studied for this thesis. As the endeavor to move the propellers would have required a considerable amount of equipment and effort, it is likely that it was remembered correctly. Smaller items on the faux site, however, might have been gradually brought to the site over a period of years. If so, then it is likely that their true origin was forgotten, especially if they were taken from two or more sites. All components thus far, then, can be identified as belonging to a PB2Y Coronado. Moreover, there is testimony that part if not all of the components were removed from a second Coronado site.

None of this evidence can explain the machine gun or ammunition, though. Historical documentation recorded the loss of two Coronados in Tanapag Lagoon (discussed in 5.2.1). Both of these losses were unarmed: one was a (likely passenger) transport, and the other was an air ambulance. During the conversion process from combat to transport configuration, all armament was removed to reduce weight and increase internal space. If historical records are accurate, then the machine gun could not have originated from a Coronado. This fact erodes the validity of the claim that all components of the faux site came from the inshore Coronado site; at least the machine gun and ammunition came from elsewhere. Further confusing matters, the machine gun is not mounted—its barrel is propped on a piece of unrelated wreckage (Figure 47).



Figure 47. Unscaled view of machine gun from rear. Note that barrel of gun is resting on wreckage; the gun is not mounted.

The faux site, then, raises more questions than provides answers. It may account for the loss of some components from the Coronado site studied in this thesis, but at least the machine gun and ammunition did not come from that site. It is also unlikely that the propellers came from the thesis site—the Coronado site shows signs of a catastrophic loss, while the propellers on the faux site are undamaged. Most auspiciously, though, study of the faux site led to the information that there might be another Coronado wreck site in Tanapag Lagoon, located further inshore and closer to the seaplane ramps.

5.4 Identity and Justification

Muckelroy (1978:157) claimed that if site formation processes could be tested and demonstrated on sites with both extensive archaeological and documentary evidence existed, then they can be later applied to situations in which that evidence is more fragmentary. If a site can be identified, and records exist that describe the wrecking event or subsequent salvage efforts, then site formation processes can be better understood and accurate models created that

can then be applied to other sites. For this reason, identifying the Tanapag Lagoon Coronado site was an important part of this research.

There are several methods through which a wrecked WWII-era aircraft can be identified. The most conclusive, and perhaps the most elusive, method is to find a component marked with the aircraft's bureau number (see (Rodgers et al. 1998:15) for example). As Brown (2014:278) observes, the bureau number was usually located in two areas: painted on the vertical stabilizer, and stamped onto a metal data plate (normally secured inside the cockpit). This is also the case for the PB2Y Coronado, although the number increases to three locations when considering its twin vertical stabilizer design. On aircraft configured with a single vertical stabilizer, the number is painted on both sides. On the Coronado, photographs indicate that the number was always painted on the outside surfaces of the twin stabilizers, but only sometimes painted on the insides. Photographs also show the number painted on the nose of some, but not all, Coronados. This means that a Coronado wreck site might contain between three and six airframe components marked with its bureau number.

This method failed to identify the Tanapag Lagoon Coronado site. Only one vertical stabilizer (port side) was present on site; it was lying with the inside surface facing up. Although a thin layer of marine growth sparsely covered its surface, coverage was not great enough to preserve the paint beneath; only bare metal remained (Figure 48). Even if the bureau number had been originally painted on the inside surface of the vertical stabilizer, it no longer exists. The stabilizer rested on another piece of wreckage, creating a gap of approximately 10 cm between the outer surface and the seabed. This allowed assessment of the outer surface, facing the seabed. As it was not buried in the sand, conditions were similar: thin growth over bare aluminum. Consequently, it was not possible to identify the aircraft by its vertical stabilizer.



Figure 48. Detail of vertical stabilizer surface, showing sparse marine growth over bare aluminum; no paint remains. 50 cm scale.

Identifying the aircraft by the manufacturer's data plate was also not possible. The original location of the data plate was known prior to conducting fieldwork: approximately 50 cm below the top of the starboard side main cockpit window (Figure 49, top). Assuming that area of the Tanapag Lagoon Coronado's cockpit is attached, undamaged, and merely buried under the sand, the manufacturer's data plate would be buried at least 50–60 cm (20–24 in.) deep, as the top of the starboard side main cockpit window is not even visible above the sand at this site (Figure 49, bottom). Consequently, the manufacturer's data plate could not be used to identify the aircraft, either.

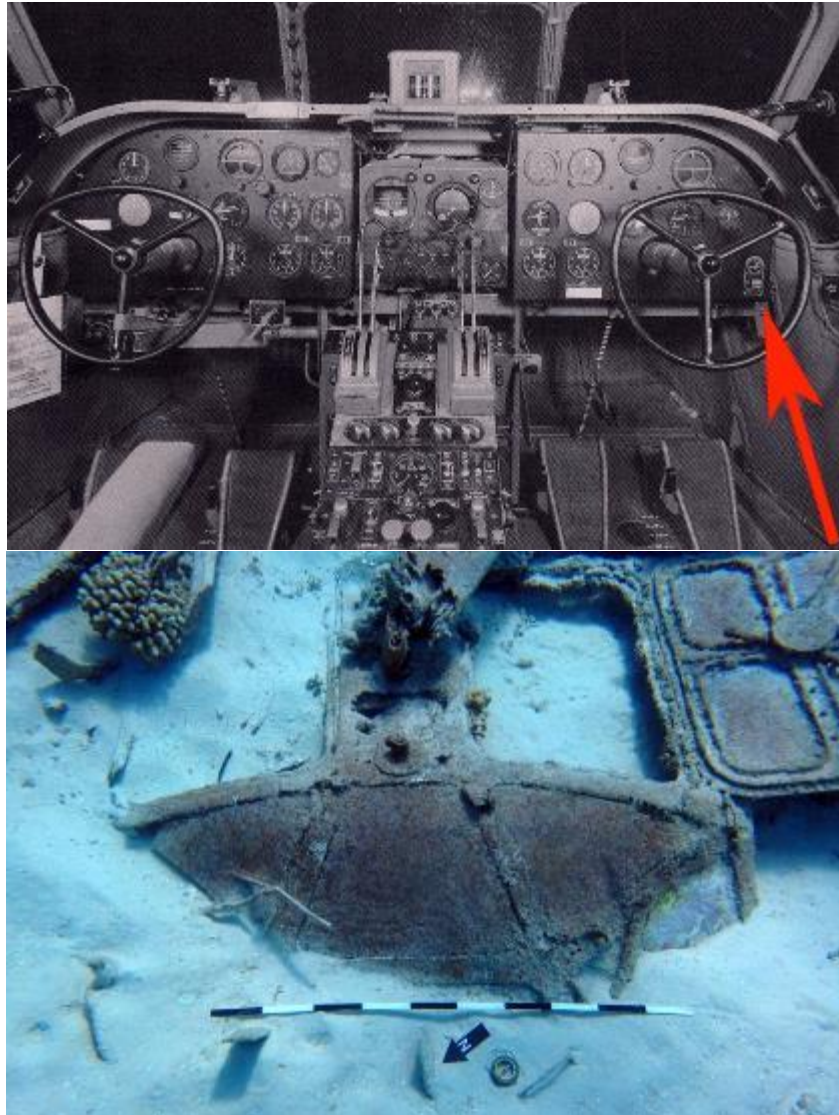


Figure 49. *Top*, location of manufacturer's data plate (Consolidated). *Bottom*, buried cockpit at Tanapag Lagoon Coronado site. Note top edge of starboard main cockpit window is not visible above sand. 1 m scale, oblique view facing southeast.

A second method, and one used successfully by Jung (1996; 2007b; 2013) to identify PBY Catalina flying boats in Darwin Harbor and Roebuck Bay, and by Rodgers, Coble, and Tillburg (1998) to argue that the PBY Catalina observed in Kaneohe Bay was sunk as a result of the Japanese air strike, is to determine the aircraft's model. Both of the above examples dealt with PBY Catalina flying boats, which underwent significant changes between models. Jung

(1996:28) created a set of line drawings illustrating the differences for reference. Unfortunately for this thesis, the changes between PB2Y Coronado models were not as easily distinguished visually.

The first and second models, XPB2Y-1 and PB2Y-2 (see 4.1.1 and 4.1.2), were significantly different than later models in shape and layout. The XPB2Y-1 was equipped with perfectly circular vertical stabilizers as opposed to the elongated circle shape used on later models. PB2Y-2 models had different machine gun configurations, a top turret shaped like a teardrop instead of a dome, and circular rear waist hatches. More importantly they can be discounted as only one XPB2Y-1 and six PB2Y-2 models were built, and all were accounted for—the XPB2Y-1 was retired and scrapped in August 1945, while the PB2Y-2s were either lost in stateside training accidents (3/6), transferred to United Airlines Training School (2/6), or used for prototyping future models (1/6) (Hoffman 2009:10; Air Transport Squadron Two War Diary, 1942-1945) Likewise, the PB2Y-4 and PB2Y-6 models (see 4.1.4 and 4.1.6) never advanced past the prototype stage, and thus cannot be the Tanapag Lagoon Coronado.

The remaining 210 Coronados were built as PB2Y-3 or PB2Y-5 models (Swanborough and Bowers 1976:85–86). As noted in section 4.1.3, the PB2Y-3 model suffered major problems with fuel leaks and underpowered engines. Affected aircraft were recalled, fuel tanks repaired and engines upgraded, then rechristened as PB2Y-5 models. Therefore, the PB2Y-5 was not a new and different model as such, but rather a repaired PB2Y-3 with upgraded engines. This is evidenced by a letter from the Chief of Naval Operations to "clarify the distinctions between the various modifications of PB2Y aircraft," defining PB2Y-3s as those powered by R-1830-88 engines and PB2Y-5s as those powered by R-1830-92 engines (Cornwell 1944). The only visual changes were the installation of four-bladed propellers on the inboard engines, and the presence

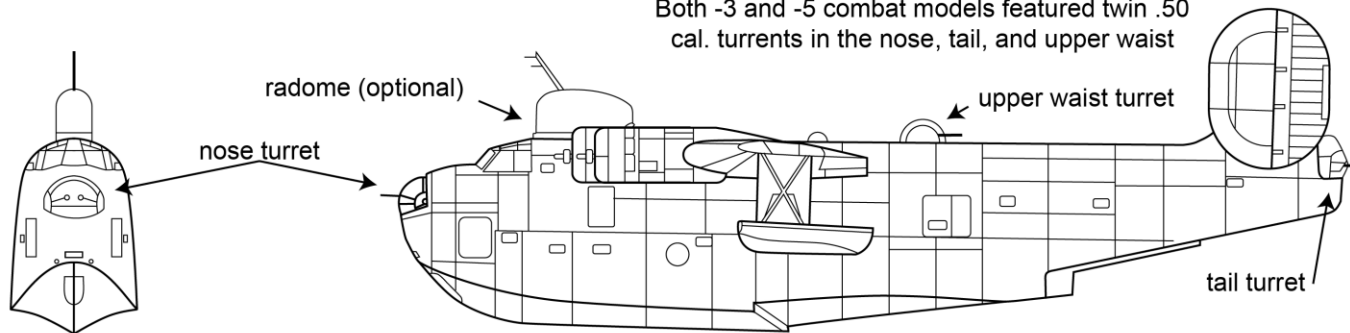
of external oil coolers on the PB2Y-5's engines. Further, as the main diagnostic feature between the two is the engine and propeller, the presence of one engine or another is hardly a "smoking gun." Jung stated "it may be too tenuous to assert that the different engines can actually indicate which model aircraft they were mounted on," using an example of an early-model Catalina in Darwin harbor fitted with later-model engines (Jung 1996:29).

The PB2Y-3 and -5 models came in two versions: combat and transport conversions (see 4.1.3 and 4.1.5). The main diagnostic feature between the two is the presence or absence of offensive weapons. Combat versions of both PB2Y-3 and -5 models were equipped with twin .50 caliber machine gun turrets in the nose, upper waist, and tail, as well as deployable single machine guns in the waist hatches. The transport conversion process removed these weapons, and faired over the holes left by removing the turrets. See Figure 50 for a visual representation of these diagnostic features. Transport conversions were further modified depending upon use: they were set up to transport cargo, passengers, or medical patients. As these modifications affected only the internal spaces, they do not provide external diagnostic features. The transport variant can only be confirmed archaeologically by the presence of stretchers, passenger seats, or cargo platforms.

PB2Y Coronado External Diagnostic Features

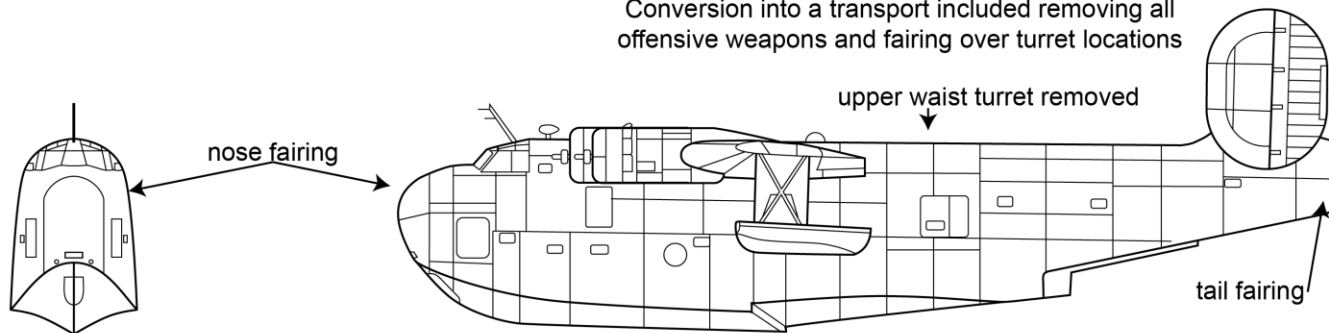
Combat Version

Both -3 and -5 combat models featured twin .50 cal. turrets in the nose, tail, and upper waist

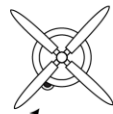


Transport Version

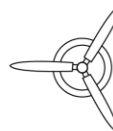
Conversion into a transport included removing all offensive weapons and fairing over turret locations



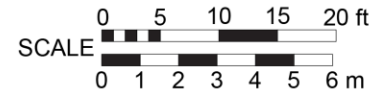
Four-bladed props installed only on inboard PB2Y-5 engines



Three-bladed props installed on all PB2Y-3 engines, only on outboard PB2Y-5 engines



External oil cooler (only PB2Y-5)



J. Pruitt after Hoffman 2009:192-193

Figure 50. Line drawing showing Coronado diagnostic features.

Application of this method to the Tanapag Lagoon Coronado site proved only marginally successful. Neither the nose, tail, nor upper waist is present on site; it is thus impossible to confirm version through the presence of either turret or fairing. As a large, heavy object, a machine gun turret is likely to survive a catastrophic wrecking event, sink quickly, and remain on site. Three other aircraft wreck sites in Tanapag Lagoon, those of the Kawanishi H8K, Martin PBM Mariner, and TBM Avenger, still contain turrets or turret rings (McKinnon and Carrell 2011:65, 76, 89). This indicates, albeit not conclusively, that turrets were likely to remain on the Coronado site if it were a combat version. The lack of turrets suggests a transport conversion, which agrees with historical records for both Coronados recorded lost in Tanapag Lagoon.

The single engine on-site, although missing its propeller, can be identified as a Pratt and Whitney R-1830-92 Twin Wasp engine based on the external oil cooler (Figure 51). Upgrading to this engine model signified the change from a PB2Y-3 to a PB2Y-5. As argued earlier, however, it was not uncommon for aircraft to require engine overhauls or complete replacements. As the invasion of Saipan took place over two and a half years after the United States formally entered the war, it is not surprising that the engine found on this site is a later model.



Figure 51. Engine with external oil cooler (circled). Profile view, facing north, 1 m scale.

Consequently, utilization of this method to determine a specific model proved inconclusive. As aforementioned, the lack of turrets or other armament implies a transport conversion, which concurs with historical accounts of Coronados lost in the lagoon. However, while a turret is likely to remain on-site, as on other aircraft wrecks in the lagoon, it is important to note that those sites also contain all engines. As three engines are unaccounted for on the Coronado site, it must also be considered that any armament may have become removed from the site in the same manner as the missing engines. Further, no archaeological evidence was identified that might suggest a transport variant. Assuming the site is either BuNo 7186 or 7070 (the only two recorded candidates), either stretchers or passenger seats mounted on cargo platforms should be contained among the wreckage. As fieldwork did not reveal either, this method could not identify the model or configuration. Thus, this method was only successful in not disproving historical records that suggest no combat models crashed in Tanapag Lagoon.

The geographic survey, coupled with interpretation of wreckage condition and distribution, provided the most conclusive evidence. Records show that BuNo 7070 crashed on takeoff in the runway area, and BuNo 7186 sank while moored. Plotting the Tanapag Lagoon site places it in the runway area, quite some distance away from the seaplane anchorage (Figure 52). The AAR states that 7070 started its takeoff on runway 23. Wind direction was recorded as south-southeast. Since the preferred method is to take off into the wind, it can be concluded that 7070 started at the northeast end of runway 23 and headed towards the southwest end when it crashed. The location of the Tanapag Lagoon Coronado site is consistent with the crash scenario of BuNo 7070.

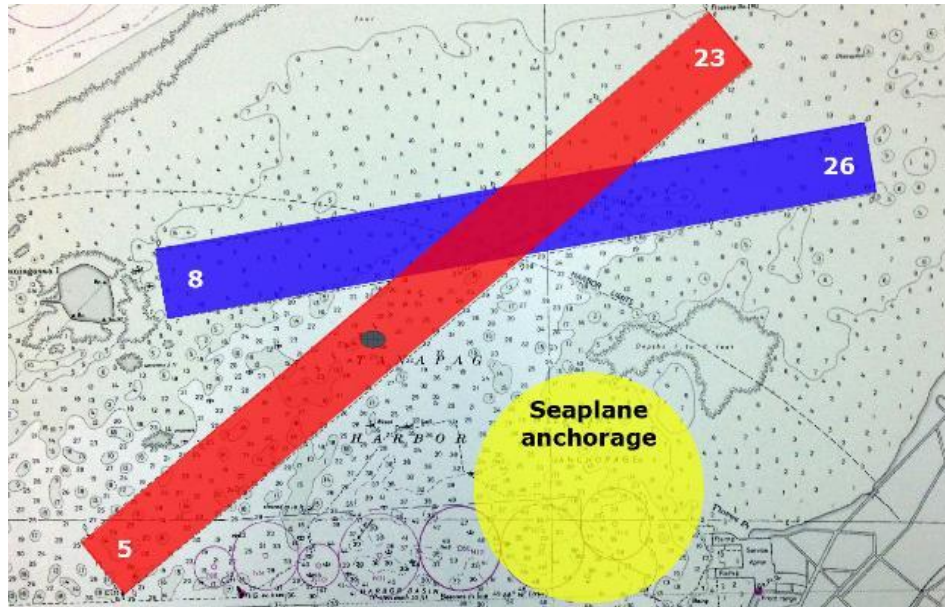


Figure 52. Positions of site (oval), runway (red), and anchorage (yellow) (HO chart 6062, 1948).

If there is indeed another Coronado site, located inshore, that "donated" parts for the faux wreck site, then that site would be situated within the anchorage area. This matches the documentary evidence surrounding the loss of BuNo 7186. Taking this into consideration, then both recorded Coronado losses could be accounted for—the site studied for this thesis is BuNo 7070, and the unidentified inshore site stripped for the faux site is BuNo 7186.

Site distribution is also consistent with a catastrophic wrecking event. Pieces of the aircraft were scattered throughout a 200 m (656 ft.) diameter circle (see Figure 53). The hatch cover and navigator's astrodome, originally mounted to the same hatch, are now separated by 92 m (302 ft.). Fuselage sections are crumpled and torn; the largest section of fuselage is only 10 m (33 ft.), representing only 42% of the original length. Even if the site distribution is attributed to post-depositional events, damage to the large sections of fuselage and wing conforms to that of high-speed impact. Neither site distribution nor damage fit DeLorenzo's (1987:24) description of the loss of BuNo 7186, which "ultimately sank" due to a ruptured hull.

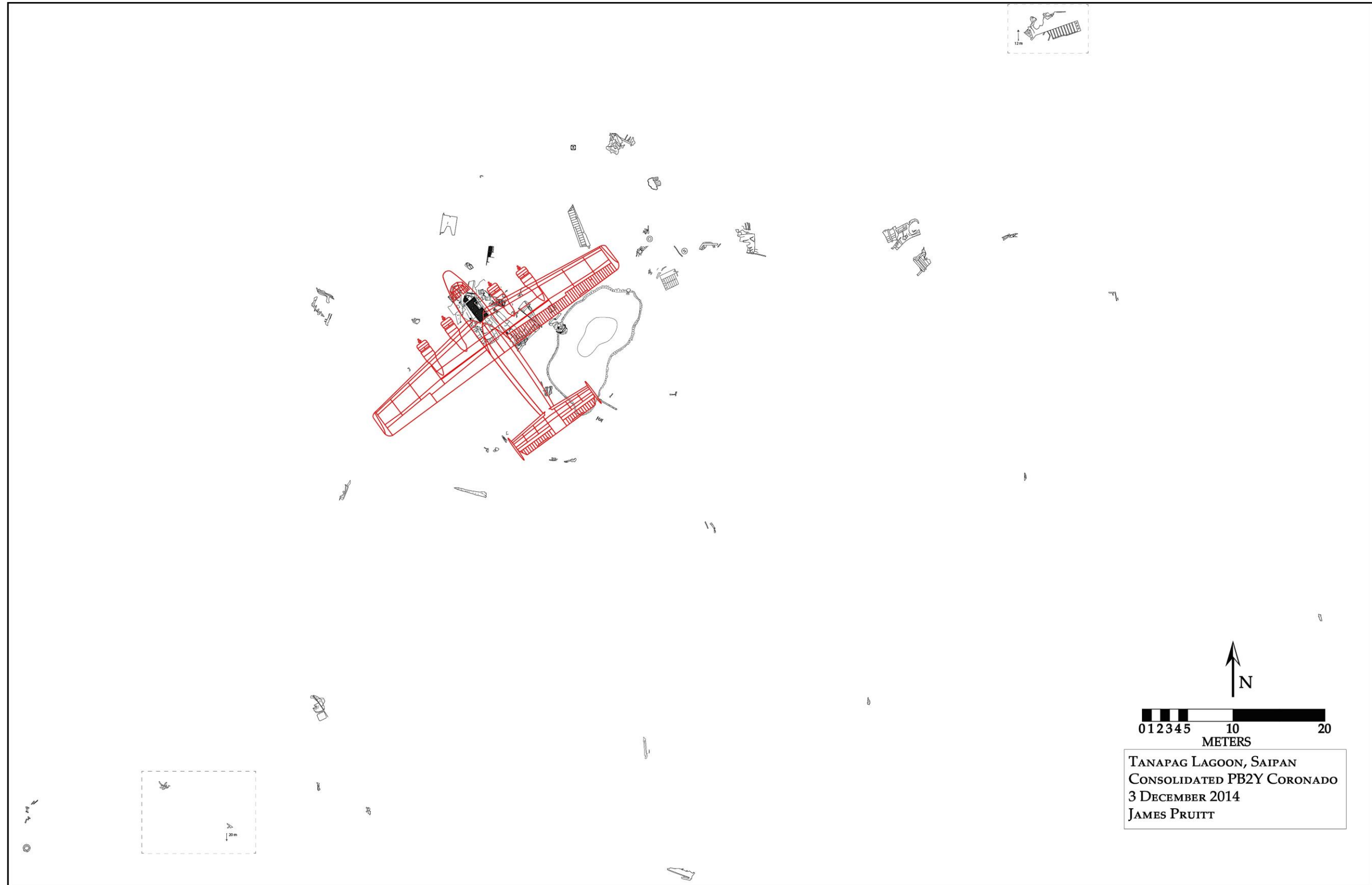


Figure 53. Comparison of site distribution (black) to scaled PB2Y Coronado line drawing (red overlay)

Finally, the site location and distribution differs from that expected from those disposed of by VPB-15 after disestablishment in November 1945. Records were not located indicating how many aircraft they disposed of, where, or exactly how. The squadron war diary's last entry in October 1945 stated the squadron operated 12 aircraft (Patrol Bombing Squadron Fifteen 1945). According to Hoffman (2009:81), the aircraft were scuttled or used as targets for P-51 fighters. Procedures for disposal by scuttling are unknown, but an officer of one of the RAF squadrons that received Coronados through Lend-Lease recalled that their aircraft were removed of engines, rudders, and other items, towed "a couple of miles" east of St. George (Bermuda) and sunk (Hoffman 2009:111). It is likely that US Navy practices were similar, in that aircraft were probably scuttled well away from shore, and any valuable items (possibly radios) would have been removed. The aircraft would also likely have been scuttled as a group; the presence of only one Coronado at this site in the lagoon contradicts that idea.

The site distribution also does not match that of an aircraft sunk as a target for fighter planes. P-51 Mustangs were fighter planes; they would have conceivably sunk the target Coronados by strafing them with their machine guns. The Tanapag Coronado showed no evidence of strafing, such as bullet holes. Strafing damage also cannot explain the catastrophic damage to the Coronado, revealed by the large area over which its remains were scattered. A Coronado sunk by strafing as target practice for fighter planes would likely resemble the Catalina sites examined by Jung (2007a; 2009a): mostly intact, with major damage only to structural support areas. Lastly, it is difficult to imagine that the Navy would conduct target practice in the seadrome, less than 2 km (1.2 mi.) from their seaplane base.

Although this survey did not uncover irrefutable evidence, such as a manufacturer's data plate, a legible bureau number painted on the vertical stabilizer, or conclusive diagnostic features

indicating the aircraft was configured either as a passenger transport or air ambulance, a preponderance of circumstantial evidence suggest that the Tanapag Lagoon PB2Y Coronado site is Bureau Number 7070. The most compelling evidence is the wreck site's location within the runway, where BuNo 7070 crashed on takeoff on 15 September 1945. This argument is bolstered by the knowledge that the only other confirmed Coronado loss in the lagoon occurred further inshore in the anchorage area. A wreck supposedly still exists in the area, which all current indications suggest is the second lost Coronado. Although locating and identifying that site, recovering indisputable evidence from the site under investigation through excavation (such as the manufacturer's data plate), or uncovering installation records for either of the two components marked with serial numbers, would confirm the identity beyond doubt, it can be concluded with a high degree of certainty that the site under investigation is BuNo 7070.

5.5 Site Formation Processes

With the identity of the aircraft established as BuNo 7070, the following section will examine depositional and post-depositional processes that formed and then altered the site. Potential natural impacts to the site formation, Schiffer and Rathje's (1973:170) N-transforms, were studied through personal observations during fieldwork, local knowledge of weather and its effects on the lagoon, and a historical survey of storms on Saipan. Cultural impacts (C-transforms) will be inspected as Muckelroy's (1978) scrambling devices and extraction filters, noting what is missing and what is out of place that cannot be explained by the depositional event itself. Finally, a wrecking model will present a hypothesis of how this site was created, as well as what elements are required to create a more accurate predictive model.

5.5.1 Natural Impacts

Early accident investigators attributed 60% of the blame for the crash to natural causes. Those familiar with the area believed that seadrome swells (40%), coupled with darkness (20%), caused the pilot to lose control (see page 112 for details). Even though the Deputy Commander of VR-2 later placed 100% of the blame on pilot error, the initial assessment attributing natural causes to the depositional event remains on record.

As a main theme for this thesis was understanding site deposition and post-deposition distribution, potential N-transforms were studied through a survey of the weather and environment. Potential factors affecting deposition included wind, waves, and current. According to the crash report, weather conditions at the time of the crash were: unlimited ceiling, 8 mi. (12.9 km) visibility, 2 knot (3.7 km/h) light breeze from south-southeast, and swells from the southwest. No information regarding current speed and direction or tidal conditions was recorded. Historical data for both tides and current was unavailable from other sources, as well. Regarding the possibility of current, a local captain, submarine pilot, and diver who has operated in the lagoon for over 10 years said that in September, current, if any, is usually light (Scott Eck, 10 November 2014, pers. comm.).

In these conditions, then, it is likely that upon crashing, any floating matter was carried to the northeast direction by the breeze. Further, as the aircraft was traveling in a southeast direction at high speed when it crashed, any pieces that broke off during the crash are likely to be located along a northwest-southeast line. This pattern is exhibited by the site distribution—the largest pieces of wing and fuselage are to the north and east of the main assemblage. Wreckage to the south and west is comprised of mostly smaller pieces, with the only exception being the bow section and anchor hatch (see page 105).

Potential factors for post-depositional impact included wind, waves, and current along with storm-related waves and surge. As the site lies within the protected waters of a lagoon, most of these factors are likely to have little impact on the wreckage. Current, induced by wind, waves, and tidal changes, can cause movement of small objects, as well as transfer sediment causing burial or scouring. The initial survey team recorded in February 2012 that "a steady and generally light current affecting the site did not visibly move sediment," while another team recorded that "there was a slight current (<0.5 knots) running in a NNE direction" (McKinnon and Carrell 2014:39; Richards and Carpenter 2012:77).

This was not the case during fieldwork conducted in November 2014. Current strength varied widely, based on tidal state and wind/wave strength and direction, while direction was consistently southwest. Tidal fluctuation in Tanapag Lagoon is mixed semidiurnal: two high and two low tides of unequal value (e.g. high high, low low, low high, and high low) that cycled every approximately 25 hours (Bird 2008:25). Although fieldwork operations lasted three weeks, meaning that dive operations were conducted in a variety of tidal conditions (rising, slack, and falling for high and low tides), the only perceptible difference experienced by the divers was that current was strongest during rising or falling, and weakest during slack tides.

Wind and swell direction also perceptibly affected current strength. Wind was generally forecast east (83.2%) throughout fieldwork, with the remainder of days evenly forecast north (5.6%), northeast (5.6%), and southeast (5.6%). The observed data agrees with a report by the Water and Environmental Research Institute of the Western Pacific, that states "for most of the year, the winds on Saipan are from the east, but during the summer and early autumn, the winds can become west to southwest for periods lasting up to one month" (Lander 2004:6). Swell direction was forecast east (50%), mixed east and north (33.3%), and mixed east and northwest

(16.7%). East swells did not perceptibly affect current; swells coming from the north or northwest caused an increase in strength (as they push water over the north edge of the lagoon, which can then only exit through the channel to the southwest). Based on observations throughout fieldwork, current was generally lightest during slack tide on days with no or low swells coming from the north or northwest. During tidal shifts on days with more than 2 m (7 ft.) swells from the north or northwest, the current became quite strong, estimated at almost one knot at times. Divers aborted one dive because they could not make forward progress into the current.

The current, although strong at times, did not visibly affect the site. Current did not move undisturbed sediment, although once disturbed, it was quickly carried away. Signs of damage from scouring were not present. Light deposition of sediment on the site by current was observed; a fine layer of sediment covered items cleared for photographing by the next day. There was no perceptible increase of artifact burial between 2012 and 2014 photographs, however. The original survey team observed that although the site may be affected by heavy seas caused by storms, total burial "seems unlikely to occur" (McKinnon and Carrell 2014:39).

Whilst further burial is unlikely to occur, a modified probing survey was conducted to determine if wreckage might already be buried. Since this thesis was based on a principle of non-disturbance survey, probing was conducted not to locate wreckage but rather to determine depth of sediment over the underlying substrate. The results of this survey are displayed in Table 5.

Table 5. Probe survey results.

Direction	5 m	10 m	15 m	Notes
314°	100+ cm	100+ cm	100+ cm	sand
44°	40 cm	50 cm	15 cm	rock, coral
112°	reef	30 cm	100+ cm	reef to sand
200°	100+ cm	100+ cm	50 cm	sand, coral hash

Based on these results, complete burial of wreckage is possible in the sandy areas to the north, west, and southwest of the main assemblage. Although it is unlikely that large components, such as engines, are buried, burial may partially account for missing wing and fuselage sections.

In this case, burial is unlikely to occur because of current, but rather because of storms. Since the site is located centrally within a lagoon, it is protected from the effects from all but the worst storms, unless there is a typhoon that passes directly over the lagoon. Plotting typhoon tracking data from JTWC for the years 1959–2013 produced the data in Table 6. As the table shows, only five typhoons passed directly over the lagoon during those years. Only two Category 4 (113–136 kt, 209–251 km/h) typhoons passed within 50 km (31.1 mi.) of the island, and that number only increased to two Category 4 and one Category 5 (over 137 kt, 252 km/h) when the range is expanded to 100 km (62.1 mi.). Further, an independent source noted that "Saipan has not had a direct strike by a major typhoon (100 kt sustained wind or higher) since Super Typhoon Kim in 1986" (Lander 2004:35).

Table 6. Historical typhoon data for Tanapag Lagoon, 1959-2013

Distance from Tanapag Lagoon	Number of typhoons	Average maximum windspeed in range	Single maximum windspeed in range
0 (direct hit)	5	50 kt	100 kt
10 km (6.2 mi.)	12	56.8 kt	110 kt
50 km (31.1 mi.)	70	50.4 kt	135 kt
100 km (62.1 mi.)	189	53.2 kt	140 kt

Moreover, it is unlikely that even with a direct pass over the lagoon, waves within the lagoon could reach the necessary height to affect the Coronado remains. Since the movement of water in a wave becomes almost immeasurable by a depth equal to half its wavelength, the protected waters of the lagoon prevent the necessary space for wave buildup (Bird 2008:13). While storms are capable of creating tremendous current (for example, Hurricane Dennis righted

USS *Spiegel Grove* off Key Largo, FL, in 2005), the barrier reef would also diminish current moving into the lagoon. Thus, even though typhoons may produce stronger current and higher waves in the lagoon, they are unlikely to reach the intensity required to significantly impact the Coronado site. This opinion was seconded by Scott Eck, a submarine pilot who operates in the lagoon, who said, "the worst effects of typhoons are stronger currents in the lagoon that can produce scouring," concluding that he had not seen movement of wreckage in the lagoon due to storms during 10 years of operating the tourist submarine (Scott Eck, 10 November 2014, pers. comm.).

A final natural impact, physical deterioration due to submersion in a marine environment, was considered. Research design for this thesis did not include detailed analysis of physical, chemical, or biological processes as demonstrated by Ward, Larcombe, and Veth (1999:565–566). Richards and Carpenter (2012:77–81) conducted a detailed conservation survey on the Coronado, including corrosion parameter measurements, in 2012. While collecting the same data for 2014 would represent a step towards creating a comprehensive corrosion potential model for the Coronado, such research was beyond the scope of this research. Instead, photographs from both studies were examined for major physical change due to deterioration. No such changes were visibly evident (Figure 54).

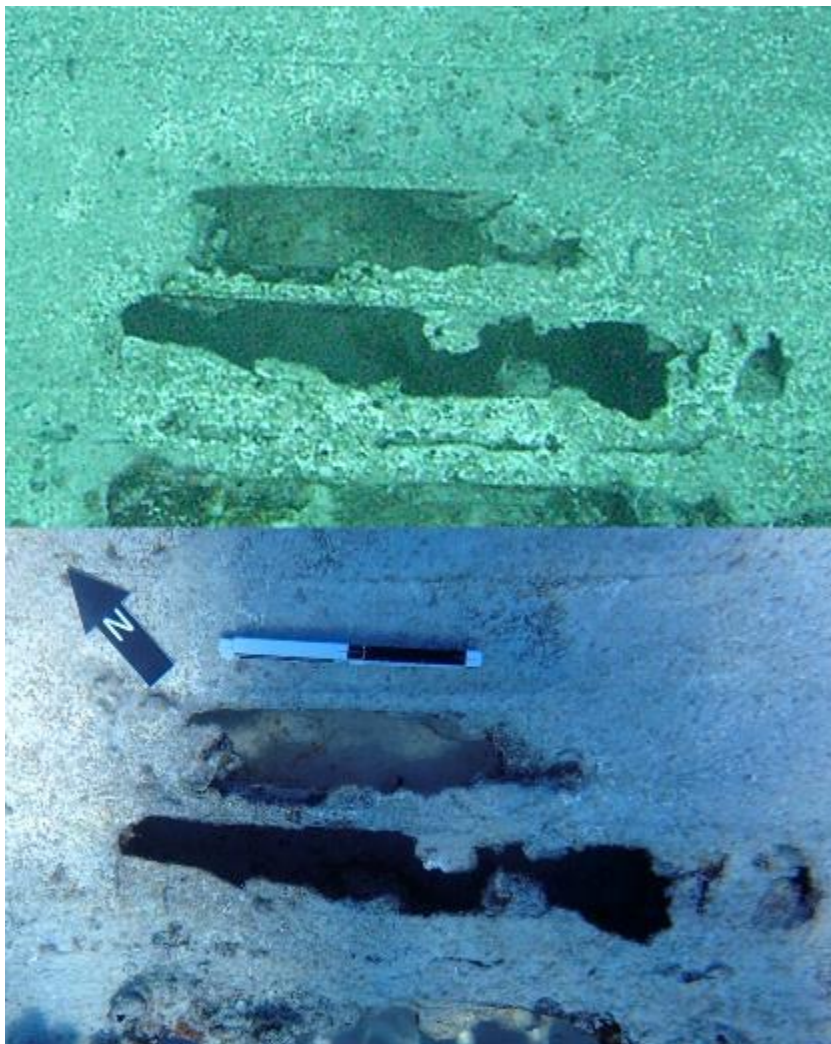


Figure 54. Deteriorated aluminum skin on suspected horizontal stabilizer. *Top*, 23 February 2012. (Photograph J. Carpenter). *Bottom*, 11 November 2014, 20 cm scale.

5.5.2 Cultural Transforms

Regarding the state of the Coronado site, the initial survey team concluded their report with "the presence of smaller artifacts (e.g. seat, forks, etc.) in situ supports the fact that this site is not visited frequently and human interference has been minimal to date" (McKinnon and Carrell 2011:39). Taken in the intended context of visitor or diver impact, this author wholeheartedly agrees with that statement: the presence of smaller artifacts does support the fact that the site is not visited frequently. The absence of three engines, four propellers, and a large

majority of wing (94%) and fuselage (72%), though, suggests a different type of human interference (salvage) has not been minimal, and has severely affected the site. This salvage has acted as both a scrambling device and an extracting filter.

As postulated earlier, a portion of this missing material may be buried on site, however, it is not likely that burial can account for more than a small portion of material remains. Muckelroy (1978:165) offers three processes that lead to the loss of material from a site: the process of wrecking, disintegration of perishables, and salvage operations. While some material may be scattered outside the 200 m zone surveyed during fieldwork (floated away during the process of wrecking), larger pieces would have been discovered during a wider-radius circle snorkel survey, and would also likely be known to the submarine pilots. Likewise, disintegration of perishables is improbable, considering the wing and fuselage were constructed of an aluminum alloy, the engines were a combination of aluminum, magnesium, and steel, and the propellers were steel. The only available explanation for the loss of this quantity of material from the site is salvage.

Salvage operations capable of removing three engines, weighing 667 kg (1,467 lb.) each, and four propellers, can be categorized as systematic salvage (Gibbs 2006:14). No conclusive records of salvage, by either the US Navy or other parties, were found. Official correspondence among navy officials shortly after the crash offered tantalizing clues, but no details. The telegram from VR-2 notifying other naval officials of the crash soon thereafter, also informed that the plane was demolished and "salvage operations [are] being conducted, further information when available" (Telegram #150141 to SecNAV from ComAirTransron Two, 15 September 1945). The promised follow-up, on 18 September, clarified the status of 7070's crew and passengers: six injured, eight missing (Telegram #150141 to SecNAV from ComAirTransron Two, 18 September 1945). The final telegram updated the status of missing crewmembers from missing

to "killed," and indicated the bodies were recovered (Telegram #182327 to SecNAV from ComAirTransron Two, 19 September 1945).

No details were given about the "salvage operations" mentioned on 15 September. The telegram chain concerning the crash ended with a report that all bodies were recovered, but did not mention cargo. The War Diary for NAB Tanapag was more enlightening, reporting that "all bodies were recovered as was the bulk of mail and cargo" (US Navy 1945c). The War Diary for VR-2 added that deceased personnel were buried in the US Army Cemetery, 27th Division, in Saipan (Air Transport Squadron Two War Diary, September 1945). Body recovery procedure is unclear, especially for aircraft in shallow locations. The accident report listed that deceased personnel were in two areas: the crew members were on the flight deck, and passengers were in Compartment G. The flight deck is present on-site, albeit split open. Compartment G is the main cargo or passenger area in the tail of the plane, which was not located.

The accident report mentioned the condition of the wrecked aircraft itself in two locations. Under the heading "Material Damage," equipment was reported "total washout, all parts submerged in salt water." Towards the end of the report, which summarizes the effect of the crash on the navy, the "Disposition of Serviceable and Unserviceable Material" was concluded as "No serviceable material. All material unserviceable. Disposed of by sinking at sea" (US Navy 1945h). Again, it is unclear what this means. Was the aircraft considered "disposed of" because it sank? Or was the airframe lifted to the surface, deemed unserviceable, and re-deposited (creating a scrambling device)?

"Common sense" explanations, like that whereby the Navy would not redeposit wreckage in the middle of the runway in shallow water, might not be defensible. Flying boats and seaplanes do not require deep water to takeoff, and the Coronado remains are actually deeper

than the nearby reef upon whose base the engine rests. The remains of an apparently intentionally deposited Aichi E13A in slightly shallower water (7 m versus the Coronado's 8 m) in the lagoon further weakens the argument that disposal of Coronado remains would have taken place outside of the lagoon (Bell 2010:67–70; McKinnon and Carrell 2011:56–57). Additionally, a 1950 report noted "the present controlling depth of the seadrome is eight feet on runway 8-26 and nine feet on runway 5-23" (US Navy 1950). Intentional deposition of material onto a seabed two to three times that depth would not have affected the controlling depth of the runway, and thus might have been allowable.

Further research into body recovery practices, and post-accident assessment and management of aircraft, may help clarify the meaning of "salvage operations" mentioned in the initial telegram. Research may also offer insight into the site formation processes as exhibited by the damaged flight deck and the missing tail section. Was body recovery, and accident investigation, conducted in situ by divers? Some evidence exists that suggests that this may have been the preferred method. A salvage report from 2 April 1945 described the removal of secret radar and navigational instruments from a sunken Coronado in Ulithi Atoll. In that case, divers determined that the plane was damaged beyond salvage value, removed the cockpit escape hatch cover, and removed the secret equipment (US Navy 1945d). If this was the method used for the Tanapag Coronado, then further extraction and scrambling of the Coronado site must have happened afterwards.

Alternatively, if the Navy did raise sections of the wreckage for body recovery and accident investigation, then later discarded or scrapped it, this may account for the areas of the aircraft that are missing from the site. The accident report tangentially supports this theory, as it recommended that "the passenger's seats be fastened more securely to the plane structure than to

the plywood deck as is now the case" (US Navy 1945h). As all four passengers perished in the crash, it is possible that the cargo/passenger section of the aircraft was recovered for investigation and body removal. This could possibly explain both how the accident investigators made the above recommendation regarding seat fastening practices, as well as why that section of the aircraft is now absent from the site.

If the Navy did not recover material from an aircraft they deemed a complete loss and properly disposed of, then who did and why? Removing three engines and four propellers would take considerable equipment. The tourist submarine company had the potential to salvage or move the Coronado wreckage, but the faux site has no engines. Only two propellers are located on the faux site, and they are conspicuously not damaged; propellers bend upon impact with the water, especially if they are spinning. Whether the submarine company, or another entity with capable equipment, salvaged the engines, propeller, and large amounts of wing and fuselage is unknown. If they were salvaged for scrap, then why salvage only part of the wreckage while leaving the fourth engine and main assemblage?

Salvage of WWII material for scrap metal continues on Saipan. An internal report from the Historic Preservation Office outlines a site visit to a scrap metal company in Tanapag, to view propellers bought by the company (Figure 55). The scrap operator told HPO officials that CNMI Customs informed them they would be allowed to ship the propellers if they obtained a letter from HPO, which they requested.



Figure 55. Propellers purchased by scrap company. (Photograph Saipan HPO, 15 January 2008).

HPO officials then visited the dump site from which the propellers were allegedly removed. Apparently military trucks drove to the top of a bluff and dumped scrap material over the side, into a valley. At the time of the visit, in January 2008, there were still "several people actively working the area, mining through the drums and rusty scrap looking for copper, brass, aluminum, etc." Recommendations proffered by the report included creating a permit system to allow people to collect and sell the scrap, and to deliver a letter to the scrap company allowing them to sell the propellers (as they are "not suitable for interpretive exhibit, etc., not significant because of secondary deposit, etc."). While this incident is unrelated to the Tanapag Lagoon Coronado site, it does prove that WWII materials are still collected for their scrap value (Saipan Historic Preservation Office 2008).

Barring systematic salvage of large components, the site does appear to not be visited frequently, and disturbance by divers appears minimal. The presence of small, easily removed artifacts like the forks and spoons (Figure 36) attests to this. Radio equipment, especially dials and gauges from the panels or the assorted broken radio components strewn throughout the area,

are also likely to have been removed by divers. In fact, the only clue that the site has been visited at all by divers is the seat's position, propped against a rock (Figure 29). Its position appears staged, leaning upright against a rock at the very edge of the reef. Bell (2010:83–84) observed this during her work on the Emily and Mariner sites. Although that was usually limited to smaller artifacts, like ammunition, being moved into larger piles, Bell did note a ladder-like object moved into position against the wing on the Emily site. The seat on the Coronado site bears the impression of similar movement.

6 Discussion

The previous chapter presented data collected from both fieldwork, as well as historical and archival research of the Tanapag Lagoon PB2Y Coronado site. This chapter will apply the knowledge gained from the study of the Coronado to the primary research question, as well as summarize conclusions pertaining to the secondary questions. It will then offer suggestions for the management of this site, founded on other management programs in place in Saipan and for submerged aircraft. Finally, questions for future research raised during this thesis will be presented.

6.1 Primary Research Question

The primary research question this thesis attempted to address involved the degree to which site formation process studies contribute to our understanding of submerged WWII aircraft and their subsequent management. Based on this research, the understanding of site formation processes for submerged WWII aircraft is essential. It provides the foundation for study and interpretation of such sites. Understanding site formation processes, both depositional and post-depositional, is fundamental for any research conducted on submerged aircraft, whether it is as specific as aircraft identification or as broad as examining how the development of a lagoon into a seaplane base affected the interpreted seascape and postwar usage of the area by native islanders. A thorough understanding of site formation processes that affect these submerged aircraft sites is also crucial for proper and effective management of the sites. With diligent consideration of post-depositional impacts, especially cultural impacts, cultural resource managers can determine whether sites remain in situ, measure the degree of human interference,

understand the threats posed specifically to submerged aircraft, and finally decide how best to preserve sites meriting protection.

In the case of the Tanapag Lagoon PB2Y Coronado, which the present research has postulated represent the remains of BuNo 7070, although historical records successfully constrained possible choices, aircraft identification was ultimately founded upon an interpretation of material remains. Study of the location and condition of the remains allowed various scenarios for both deposition-related and post-depositional disturbance to be examined and understood. Evaluation of these scenarios, compared to the disposition of wreckage on the site, ultimately allowed the identity of the aircraft to be determined. Through study of site formation processes active on this site, the aircraft was identified to a high degree of certainty, even without finding artifacts bearing its Bureau Number.

This site further confutes Muckelroy's (1980:10) opinion that modern sites do not deserve archaeological study (see page 4). Muckelroy believed that if historical data was available, then nothing could be learned from archaeology. Study of this site proved that historical records are not infallible; research proved that 10 of the 12 Coronados reported lost in Saipan were actually lost somewhere else (see pages 109 to 111). In addition, archaeological research of the Tanapag Coronado site disclosed details of depositional and post-depositional events that were not recorded in historical documents, including location, damage, and salvage. Further, archaeological research of this site and its surroundings revealed the phenomenon of the faux site and its relationship to another Coronado crash site. These findings show that even where historical data exists, there is much that can be learned from archaeological study.

This case study compared favorably with other site formation studies of submerged aircraft. Although the depositional event vastly differed from those in other studies (Jung 2007a;

Jung 2009a; Rodgers et al. 1998; Bell 2010; Dagneau 2014; Brown 2014), the methods for research, identification, and interpretation were similar. All studies consulted wartime documentation of the loss event, which was found to be incomplete or even wrong in some cases. Line drawings outlining the diagnostic differences between an aircraft's models and variants were constructed to aid in identification. Researchers sought manufacturer's data plates and painted aircraft identification numbers that were usually missing, illegible, or buried. In the end, aircraft were identified by a combination of location, wreckage condition, and site distribution. Likewise, although the site distribution of this site was dissimilar to other studies, post-depositional impacts were demonstrably consistent with those found on other submerged WWII aircraft sites.

Comparing the Tanapag Lagoon site with the four sites studied by Bell (2010) (Aichi A13A Jake, Kawanishi H8K Type 2 Emily, Martin PBM Mariner, and TBM Avenger), all sites indicated certain similar environmental impacts. Even though the Avenger was in a dissimilar, high hydrodynamic environment, it too displayed common characteristics. Chief amongst these was the presence of a thin mucilaginous layer covering aluminum surfaces, and coral growth on objects containing iron (Bell 2010:108). The Aichi E13A, Kawanishi H8K, and Martin PBM Mariner are all located centrally in the lagoon, and thus are protected from waves, currents, and scouring, much like the Coronado. All aircraft studied by Bell were similar to the Coronado in that they also displayed some degree of disintegration of the aircraft's aluminum skin (Bell 2010:65,79,91,104). Corrosion parameter measurements of these five aircraft placed the Coronado towards the lower end of the group (containing less concentrations of incorporated copper), yet only slightly lower than the PBM Mariner (Richards and Carpenter 2012:84).

In terms of cultural impacts, the Coronado site shares characteristics with some, but not all, of the other four sites examined. Most significantly, all displayed evidence of possible salvage. Bell claimed that evidence of possible systematic salvage was evident on three of the sites: the TBM Avenger, Aichi A13A, and PBM Mariner (Bell 2010:68–69,91,102). Salvage of the Avenger and Mariner most closely resembled the Coronado, as all sites were missing engines and propellers. The Kawanishi site did not show direct evidence of systematic salvage, but it did suggest that wreckage might have been moved for aesthetic purposes. Movement of smaller objects by divers was confirmed. In one instance, a ladder-like object was propped against the wing (Bell 2010:83). This is potentially similar to the chair on the Coronado site, propped against the edge of the reef (see Figure 29). Bell also questioned whether at least one of the Kawanishi engines was moved to a more aesthetically pleasing position (Bell 2010:88). If so, that impact would resemble the creation of the faux site, which further research might still show affected the Tanapag Coronado site. Most notably absent from the Coronado site, yet present on the others, was the evidence of heavy diver impact. The other sites contained monuments, graffiti, mooring damage, and exhibited diver-based movement of wreckage and artifacts. None of these were present on the Coronado site; in fact, only the seat propped against the reef indicated that divers might have affected the site at all.

6.2 Secondary Research Questions

In addition to the primary research question, this thesis set forth four secondary questions, intended to help direct broader research paths. This section will reiterate those questions, provide a brief summary, and direct the reader to the relevant section for more detailed answers.

- How can the site be identified? Which particular aircraft is it? Can the crash cause or wrecking type be identified?

This series of questions set the basis for identification of the site. As that endeavor required both archaeological and historical study, these questions were approached with an interdisciplinary mindset. The identification of this site, as discussed in detail in section 5.4, was a three-pronged procedure. First, artifacts or features bearing the aircraft's Bureau Number were identified through historical research, and then sought among the wreckage. No such features were uncovered. The next method called for identification of the aircraft's model and variant, for comparison to historical records of Coronado loss in the lagoon. This also proved inconclusive, as no external diagnostic features were present on site. While a single engine suggested that it was a later model Coronado, aircraft were of modular construction and frequently required the fitting of new engines. Thus, determining model or variant by external diagnostic features was also inconclusive. The final method for site identification required a spatial analysis of the site. The geographic location of the site within the lagoon was compared to historical accounts of lost Coronados, suggesting one aircraft over the other prominent candidate suggested by archival research. The wreckage contained within the site was also spatially analyzed and compared to historical records. The combination of these two analyses culminated in the identification of the aircraft, as both its location and site distribution matched the expected results from historical records.

Using the above methods, the aircraft was determined to be PB2Y-5R Coronado BuNo 7070. This aircraft crashed on takeoff on 15 September 1945, resulting in the death of 8 of the 14 crew and passengers aboard. Wreckage indicated that this was a catastrophic event, as objects installed next to each other were located 100 m away from each other on the seabed.

Unfortunately, the wreckage was only able to confirm that the aircraft suffered a catastrophic event; because of post-depositional extraction and possible scrambling of material, there was no distinguishable pattern that suggested, "crash on takeoff." In this case, had only archaeological evidence been available, it would have been impossible to determine the cause of crash. Because of this, it was also not possible to create a predictive model of site formation processes, as was originally hoped.

- What cultural or natural events have taken place that may have affected the site? How can these be identified?

Natural events were examined through study of historical crash records, GIS analysis of typhoon data between the years 1959–2013, observations during fieldwork, and local interview. The post-accident investigation originally attributed 60% blame for the crash to natural causes (see 5.5.1). This would have affected the depositional process of the site, scattering wreckage along a northwest-southeast line. Study of potential post-depositional natural impacts revealed that all natural phenomena studied likely did not affect the site. Probing revealed that while burial was possible in the loose sands to the north, west, and southwest of the center of the site, observation of artifacts within those areas proved complete burial of wreckage was unlikely. Impact from typhoons was also ruled out; only 5 typhoons passed directly over Saipan in the 54 years for which downloadable typhoon tracking data was available (see Table 6), and their impact on the area of the site is expected to have been minimal. The last major typhoon was in 1986, suggesting that typhoons, especially powerful ones, do not frequently strike Saipan. Further, as the site is centrally located in a protected lagoon, even the wind, waves, and current of typhoons are unlikely to affect the site. A submarine pilot who regularly operated in the

lagoon confirmed this final point—he stated that in the last ten years he had never seen movement of wreckage in the lagoon due to storms (Scott Eck, 10 November 2014, pers. comm.).

Cultural transforms were studied in a number of ways. Historical records were searched for any evidence of salvage. Unfortunately, detailed records were not uncovered; the few mentions of any activities referenced that bodies were recovered along with most of the mail and cargo. Results of the presence/absence test revealed that 75% engines, 100% propellers, 94% of the wing structures, and 72% of the fuselage were absent from the site. This demonstrated that salvage did take place on the site, and on a large scale. The full details of who performed what salvage, when, and why, could not be answered based on the available historical records and archaeological evidence. The US Navy conducted body recovery efforts, but it is unclear what methods were used and how much material was removed from the site during this process. Although a contemporary salvage report from a different location proved that the US Navy did use divers to recover equipment from a sunken Coronado, the combination of the absence of the cargo/passenger area from the Tanapag site, and the recommendation in the accident report to more securely fasten the passenger seats to the frame of the aircraft, points to the possibility that the entire section was raised for inspection. If the Navy was not responsible for the extensive salvage of other materials missing from the Tanapag Coronado site, then it is possible that another entity was. Practiced since the end of the war, the salvage of WWII material for scrap metal still continues on Saipan.

Cultural impacts from divers were largely absent from the site. Small, easily removed artifacts like forks and spoons are still present on site. Other equipment likely to have been removed, including components from the radio panels or even the hatch covers, also bears no evidence of diver impact. Graffiti and the mass movement of artifacts, both diver impacts noted

on the Kawanishi H8K, are completely absent from the Coronado site. The only evidence that divers may have visited and affected the site in the past is the position of the seat, propped against the reef. It appears to have been placed against the reef for aesthetics, but there is no evidence available to prove this supposition.

- What management programs for submerged United States WWII aircraft are currently available for the world, the Pacific, and Saipan?

Literature review (section 2.5) revealed precious few "programs" set in place for management of US WWII aircraft. The most prominent statute, and only one with a worldwide scope, is the SMCA. This law and its resulting regulations prescribe legal protection to sunken US Naval aircraft, including protection from disturbance without a permit. It is not, however, a comprehensive management program for those aircraft sites. Neither the law nor its regulations provide recommendations for providing (or prohibiting) public access and interpretation, intervals for initial and follow-up surveying, or suggestions for *how* to protect those sites—they only reiterate ownership and prohibit disturbance without a permit.

Wessex Archaeology's (2008) report did offer recommendations towards the management and protection of submerged aircraft sites, albeit for those in United Kingdom's waters. Key recommendations included greater priority in research and management for aircraft crash sites at sea, the creation of a comprehensive database of those locations, and the development of policy and guidance specific to submerged aircraft sites. Although the study was based on the United Kingdom's sites and needs, the suggestions contained in this report could be applied to US WWII aircraft policy, as well.

Regionally, the topic of submerged aircraft site management programs in the Pacific is one that has seen little development. Articles like those authored by Coble (2001), Jeffery (2006), and Spennemann (1992) studied the problems that authorities face in the management of submerged US WWII aircraft sites, especially in foreign countries. These articles outlined those problems specific to the Pacific region, including lack of government funding, warbird hunters, and pressure from divers and dive boats. They offered suggestions toward the resolution of these individual problems, but for the most part fail to describe a management program.

McKinnon and Carrell's (2011; 2014) reports, however, do offer both a comprehensive management plan and the description of the creation of an underwater heritage trail in Saipan. Although the management plan was tailored to address the management laws, sites, and needs of Saipan, it could be used as a model for locations throughout the Pacific. With modification, it could form the basis of a management plan for other, less similar, areas throughout the world.

- Who are the stakeholders of this site, both inside and outside Saipan?

Before a comprehensive management plan can be written, all stakeholders with an interest in the site must be identified. Both the US Navy and Saipan's Historic Preservation Office are clearly stakeholders. The CNMI Division of Fish and Wildlife, which manages the Managaha Marine Conservation Area, is another stakeholder as the site lies within its boundaries. Within the local business community, dive shops and Saipan Submarine may be considered stakeholders. Other stakeholders might include any local or tribal groups that claim a connection to or some form of ownership of the lagoon (currently unknown). Jeffery (2004:117–118) stated that ownership issues are a stumbling block in Chuuk, especially as different villages claim ownership to different parts of the island.

6.3 Management Considerations

Shipwreck sites generally require management for site monitoring and protection from looters and salvors, diver and fishing impacts, and marine infrastructure developments. Submerged aircraft sites like the PB2Y Coronado site studied in this thesis pose many challenges to cultural resources managers. Some, like targeted salvage by warbird hunters and differing corrosion properties for the materials used in aircraft, are specific to aircraft sites and require creative management solutions. While the creation of a complete management plan is beyond the scope of this thesis, this section seeks to highlight those issues most relevant to the management of the PB2Y Coronado site, and offer suggestions for use in implementation of a management plan. For a more complete overview of issues, as well as a comprehensive chapter on broad-based protection of underwater cultural heritage in Saipan, see McKinnon and Carrell's (2014) report "Management Plan and Public Outreach for WWII Submerged Resources in Saipan."

6.3.1 Relevant Issues

One issue specific to aircraft wreck sites is a special kind of treasure hunter: the “warbird” hunter. Warbird is a term given to World War II aircraft, especially fighting planes. These enthusiasts hunt for intact parts such as the control column, either as souvenirs, or for the restoration of museum models or working replicas (Wessex 2002:2). Some of the adventures and exploits of “warbird hunters” are captured, in detail, in popular books like *Hidden Warbirds* (Veronico 2013) and *Hunting Warbirds* (Hoffman 2002). Stories in these books show not only the measures warbird hunters will take in recovering aircraft or parts, but also the financial motivation driving them—a flyable B-17, for example, might sell in the \$2 million to \$3.5 million dollar range (Veronico 2013:88).

Another important issue surrounds the "war grave" status of this site. Cooper (1994:134) alluded to the fact that many aircraft wreck sites are war graves, while Jeffery (2006:150) discussed the issues faced by Japanese war graves in high-visitation areas in Chuuk Lagoon. Dagneau (2014) demonstrated the importance to the military of recovering human remains. This potentially affects the management of this site, as eight servicemen perished in the crash that created the Tanapag Lagoon Coronado site. Clarification is necessary, especially in this case. Research has not produced any official policy or codification regarding the "war grave" designation. Thus, there is no guidance as to the management of these sites. The SMCA prohibits disturbance of the wreck site of any naval vessel or aircraft, but does not specify if war graves should be managed using a different set of rules more stringent than the general non-disturbance ideals set forth therein. The situation becomes more muddled when considering sites like the Tanapag Coronado site: service members perished during that crash, but their remains were reportedly recovered and buried. Further, the crash occurred one month after Japan's surrender, and nearly two weeks after the official signing of surrender documents. Does it remain a "war grave", or would it be better classified a "maritime grave"? If remains were reportedly removed, should it still be considered a grave at all?

6.3.2 Protection

How can the Tanapag Lagoon Coronado site best be protected? Entering the aircraft into the National Register of Historic Places establishes a base level of protection, and while uncommon, is not unprecedented for aircraft (Diebold 1993; Conlin and Ho 2014). Completing National Register Nominations is one of many suggested actions in the "Management Plan and Public Outreach for WWII Submerged Resources in Saipan" report (McKinnon and Carrell

2014:70). See Appendix A for a completed National Register application that can be submitted if deemed appropriate by the site's stakeholders.

Although salvage almost certainly accounts for most if not all of the missing material, the site bears no signs of recent disturbance; salvage likely happened decades ago. This produces somewhat of a quandary as to how to best protect the site from this point forward—keep the site's existence, or at least location, unpublished and hopefully hidden from the public eye, or add the site to the already existing underwater heritage trail and promote it? If the site remains relatively unknown, as it is now, then it may be protected from the diver impacts inevitably imparted on a frequently visited dive sites. It could also serve as a control, to gauge the impact of divers on heavily visited sites that are on the underwater heritage trail. This, *de facto*, is its current use, since the site was not included on the underwater heritage trail because it was not known at the time of the trail's creation (Jennifer McKinnon, 31 January 2015, pers. comm.).

On the other hand, if the site is added to the underwater heritage trail, it might be protected by the local community through a developing sense of heritage ownership. Dive shops might discourage souvenir collecting and salvage in order to protect their dive site intact for future visitation. The increased publicity, however, also means that the site will inevitably be damaged through diver impact, accidental as it may be, and through mooring damage if a proper mooring system is not put in place. Accordingly, increased visitation to the site, which is tantamount to Spennemann's "fourth horseman of the apocalypse," poses a potentially serious threat (Spennemann 1992:285). While this is somewhat inevitable, the following is a short study of each problem, and proposed solutions for mitigation or reduction.

Accidental diver impact can result from either divers with poor skills bumping into the site, or from unintentional causes such as exhalation bubbles prompting increased rates of

corrosion on affected surfaces (Jeffery 2006:151). Damage from divers who are unaware of proper wreck diving practices can be mitigated through education. One step in this solution is to ensure that diving instructors, not just in locations where there are many shipwrecks but everywhere, teach the importance of protecting cultural heritage in their basic scuba courses (Scott-Ireton 2008). Another step is to develop a public outreach program within the diving community, to ensure that both divers and dive shops are indoctrinated with the importance of promoting appropriate behavior and buoyancy on wrecks (McKinnon and Carrell 2014:76). Further, divers can be educated about the fragility of their nature and discouraged from entering delicate wrecks in large volumes.

Divers also affect sites through the deliberate looting or moving of artifacts. World War II sites in particular have a large amount of small, recognizable, and moveable artifacts. Divers can easily take these artifacts as souvenirs, or rearrange them on the archaeological site. This has been recorded in detail in Saipan; “of the nine sites on the [underwater heritage] trail, four have had some form of looting or movement of artifacts” (McKinnon and Carrell 2014:43).

The PB2Y Coronado site is in particular danger of this, as there are a number of susceptible artifacts, including concreted forks, seats, and instruments. Should these artifacts be moved or removed, the historical and archaeological context of the site will be negatively affected (McKinnon and Carrell 2014:43). Once again, proper education for divers, dive shops, and boat operators, coupled with a strong sense of community ownership, is the best way in mitigating this risk. McKinnon and Carrell (2014:71) also recommend the creation of a database to record at-risk artifacts as a means to manage the sites on Saipan. They further suggest taking photographic documentation of these artifacts at a minimum, and removal from the sites if risks are posed (McKinnon and Carrell 2014:71).

Finally, increased visitation puts the site at risk from anchor damage. Aircraft are particularly vulnerable to anchor damage, as the materials used in boat anchors is made from stronger materials than the aluminum skin found on most aircraft exteriors. Even when the public knows the location of the site, visitors unintentionally dropping their anchors directly on or dragging across sites can cause accidental damage to remains. The Coronado site is at high risk for this, as the wreckage is scattered across such a large area. During fieldwork for this project, the ideal location (for diving) to anchor would have been to the northeast of the main assemblage. This is the area of highest concentration of debris. The area of lowest wreckage concentration, to the northwest, would have required a long swim across the current to get to the site and to return to the boat. Installing permanent mooring buoys, similar to those on the Kawanishi H8K Emily site, would prevent anchoring damage. This is a costly solution, however, and is only justifiable if the PB2Y Coronado site is included on the underwater heritage trail.

6.3.3 Management Suggestions

This author believes that the Tanapag Lagoon Coronado site should continue to serve as a control site to study diver impact on the underwater heritage sites. While the site would make an excellent addition to the underwater heritage trail, it is more valuable as a means of measuring effectiveness of the current protective measures set in place on the other sites. Without the luxury of constant monitoring on those sites, it is impossible to judge the effectiveness of the program in actually protecting them through diver education and public involvement. The Coronado site, remaining relatively unknown, need not be monitored as often to determine whether divers have rearranged or removed artifacts, damaged the site with anchors, or vandalized the wreckage (all actions that have occurred on sites protected by the trail) (McKinnon and Carrell 2014:41–47). While corrosion parameter measurements may not be comparable to other sites, because of the

damaged and disarticulated nature of the Coronado remains, the site has the potential to offer other valuable insight into environmental impacts (Richards and Carpenter 2012:81). One such example is the comparison of post-typhoon damage and movement. If both the Coronado and Emily sites exhibit movement of artifacts after a storm, then it is likely that the movement was storm-related. If only the Emily site shows movement, then the cause is likely diver-related.

This use of the site as a control can assist resource managers in generating new policy for the lagoon as a whole through improved understanding of the continuing site formation processes at work on the sites both included and excluded from the underwater heritage trail. If comparison shows that diver impact on the underwater heritage trail sites is minimal, then that information may be the impetus to add more sites to the trail. Conversely, if the data shows heavy diver impact on those sites, then management policy may need to be reconsidered, and relations with stakeholders and community involvement improved.

Eventually, the Coronado site will be re-discovered, and will begin to exhibit the diver impact seen on the more well-known sites. The site is not completely unknown—an internet search for “Saipan PB2Y Coronado” returned posts in two online forums (specializing in wreck and warbird hunting) that affirmed the existence of a PB2Y Coronado in the lagoon, near Managaha Island (jdvoss 2015a; jdvoss 2015b). Additionally, the posters mention that this information was published in the Lonely Planet travel book for Saipan. This was not verified, as a Lonely Planet travel guide specific to Saipan could not be located; no reference was found in the Lonely Planet travel guide to Micronesia (fourth edition, published in 2000), which included a section on Saipan. When the Coronado site begins to show signs of diver disturbance, then its management plan should be re-evaluated. At that time, when the site is no longer useful as a

control to measure diver impact on publicized sites, it may better serve the public through direct access and interpretation.

The Coronado site may then be protected through education. As Secci (2011:120) noted, "public informal education is ... extremely necessary for [underwater cultural heritage] widespread protection and conservation." Since there is already a program in place in pursuit of this goal (the WWII Maritime Heritage Trail - Battle of Saipan), protection through education should be gained through addition to the underwater heritage trail. The PB2Y Coronado would be an excellent addition, as the site is located between two other sites already on the trail. It has great tourism potential, as well, since this will be the only publicly documented Coronado known to be accessible to divers. This site also is unique within the trail because it is the only aircraft whose identity and history are known. Further, as BuNo 7070 was an unarmed transport that crashed after the cessation of hostilities, the Coronado site represents a transition of the lagoon to peacetime activities and therefore highlights a separate era of the lagoon's history.

6.4 Suggestions for Future Research

Throughout this thesis, numerous topics emerged that offer the potential to yield greater knowledge of topics as specific as this site to as broad as naval aviation. Described below, they are arranged in ascending order from specific (to this site) to broad.

To more accurately understand the site formation processes for the Tanapag Coronado site, records pertaining to salvage performed on this aircraft, if extant, should be uncovered. These might further elucidate what processes occurred on the site, specifically if the main assemblage remains in situ as deposited, or if it was raised to the deck of a boat for salvage then re-deposited. No records were identified at NARA II in record groups 24 (casualties), 38

(squadron, ship, and base war diaries), 72 (Bureau of Aeronautics), or 313 (Trust Territory of the Pacific Islands). Likewise, the Naval Archives' squadron histories and general ship histories for salvage vessels known to be stationed at Saipan (USS *Preserver*, *Valve*, *Anchor*, *Vestal*, *Deliver*, *Vent*, and *Gear*) returned no information. The subject matter specialist at NARA II advised that the only place to find such records would probably be in the daily deck logs for each ship. This would be an extensive project that would involve going through daily deck logs for every salvage vessel, seaplane tender, and harbor craft capable of lifting an aircraft, as well as any nearby vessel housing a salvage diving unit.

Research into this site suggested that another PB2Y Coronado site (believed to be BuNo 7186) is located in the lagoon. Another future task is to locate and survey that inshore Coronado wreck site. Since this is allegedly the "donor" for the parts on the faux site, a survey of this site could better elucidate both the faux site and this thesis site.

To create a predictive model for Coronado crashes, and other large flying boats, research should be conducted into other Coronados that crashed at takeoff or landing. At least two other Coronados are known to have crashed at takeoff and landing (BuNos 7152 and 7160). The remains of these, if still intact, as well as historical records or eyewitness accounts, could provide further insight into the depositional process for Coronado crashes. As both of the above Coronados were assigned to VPB-13, it is likely that more detailed information may exist (see, for example, Mary Bracho's (2005) book of memoirs, or Frank DeLorenzo's (1987) article). This topic could also be expanded by including depositional analysis of other large flying boats, such as the Kawanishi H8K Type 2 "Emily", Blohm & Voss 222 Viking, and Short S-25 Sunderland.

For a greater understanding of post-depositional impacts on this site, one could pursue a study of contemporary naval practices involving body recovery from aircraft. Why did they

recover bodies from this aircraft? Did they attempt this for all aircraft, or just this site because it was shallow and accessible? Did they use divers to recover bodies only, or did they recover entire sections of aircraft (to be later disposed)? A better understanding of this topic affects our interpretation of not only the Tanapag Coronado site, but also any submerged aircraft crash site from which human remains were recovered during or immediately following the war.

Additional depositional information might be gathered by locating and surveying the PB2Y Coronados of VPB-15, which reportedly "scrapped" their aircraft in the Marianas by scuttling or as targets for fighters. Hoffman (2009:81) reports that VPB-15 personnel returned to the United States aboard carrier USS *Boxer* (CV-21). If these aircraft can be located, then it is possible that a predictive model can be created from them, similar to Jung's (2009a) model created from a group of PBY Catalinas all sunk in a similar fashion.

Covering even broader topics, a further proposal would involve examining how the development of Tanapag Lagoon into a seaplane base altered the seascape and use of the lagoon by native islanders. This process could be studied in two phases, as the original development by the Japanese may differ from its subsequent use by the United States. Later abandonment of the base could possibly constitute a third phase, as the lagoon, base, and seaplane ramps are currently utilized for different purposes.

Finally, and the broadest topic of all, is a study of the liminal nature of naval aircrew. Did operating in the skies yet being based on the seas alter their self-identity as sailors? Compare this to differences (if any) with flying boat aircrew, who operated their machines as both aircraft and boats. A further avenue of research would be to examine how (if at all) that changed through time; does the current specialization of jobs within the Navy change that self-identity?

6.5 Conclusions

This thesis has demonstrated the importance of site formation studies in the interpretation of the PB2Y Coronado located in Tanapag Lagoon. Even though the site was created relatively recently, with abundant historical documentation available, its identification and interpretation would not have been possible without an understanding of the processes that affected its creation and later altered its makeup and distribution. The diagnosis of the importance of site formation studies to the interpretation of submerged WWII aircraft has been mirrored in countless other reports (Jung 2007a; Jung 2009a; Rodgers et al. 1998; Bell 2010; Dagneau 2014; Brown 2014). This attests to the importance of continued studies of site formation processes that affect submerged WWII aircraft. This should be continued following Muckelroy's (1978:157) advice to test and document site formation process theories on sites with extensive archaeological and documentary evidence, so that they can be later applied to more fragmentary sites. Only in this manner can archaeologists understand the fundamental makeup of these sites and move on to broader cultural and socio-historical questions.

This thesis has also demonstrated the value of site formation process studies of submerged WWII aircraft in making management decisions about submerged heritage sites. Understanding the past and present factors affecting a site can inform cultural resource managers what risks, if any, a site currently faces and assist in the development of site management plans. Such lessons can also enable managers to better inform the public about their underwater cultural heritage through interpretation and education.

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Appendix A: National Register of Historic Places

Registration Form

National Register of Historic Places Registration Form

This form is for use in nominating or requesting determinations for individual properties and districts. See instructions in National Register Bulletin, *How to Complete the National Register of Historic Places Registration Form*. If any item does not apply to the property being documented, enter "N/A" for "not applicable." For functions, architectural classification, materials, and areas of significance, enter only categories and subcategories from the instructions.

1. Name of Property

Historic name: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Other names/site number:

Name of related multiple property listing:

N/A

(Enter "N/A" if property is not part of a multiple property listing)

2. Location

Street & number: Tanapag Lagoon

City or town: Tanapag State: MP County: Saipan

Not For Publication: Vicinity:

3. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act, as amended,

I hereby certify that this nomination request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60.

In my opinion, the property meets does not meet the National Register Criteria. I recommend that this property be considered significant at the following level(s) of significance:

 national statewide local

Applicable National Register Criteria:

 A B C D

<hr/>	
Signature of certifying official/Title:	Date
<hr/>	
State or Federal agency/bureau or Tribal Government	

In my opinion, the property <u> </u> meets <u> </u> does not meet the National Register criteria.	
<hr/>	
Signature of commenting official:	Date
<hr/>	
Title :	State or Federal agency/bureau or Tribal Government

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070
Name of Property

Saipan, MP
County and State

4. National Park Service Certification

I hereby certify that this property is:

- entered in the National Register
- determined eligible for the National Register
- determined not eligible for the National Register
- removed from the National Register
- other (explain:) _____

Signature of the Keeper

Date of Action

5. Classification

Ownership of Property

(Check as many boxes as apply.)

- Private:
- Public – Local
- Public – State
- Public – Federal

Category of Property

(Check only **one** box.)

- Building(s)
- District
- Site
- Structure
- Object

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070
Name of Property

Saipan, MP
County and State

Number of Resources within Property

(Do not include previously listed resources in the count)

Contributing	Noncontributing	
<u>N/A</u>	<u>N/A</u>	buildings
<u>1</u>	<u>N/A</u>	sites
<u>N/A</u>	<u>N/A</u>	structures
<u>N/A</u>	<u>N/A</u>	objects
<u>1</u>	<u>N/A</u>	Total

Number of contributing resources previously listed in the National Register NONE

6. Function or Use

Historic Functions

(Enter categories from instructions.)

DEFENSE/air facility=aircraft
TRANSPORTATION/air-related=aircraft

Current Functions

(Enter categories from instructions.)

NONE

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070
Name of Property

Saipan, MP
County and State

7. Description

Architectural Classification

(Enter categories from instructions.)

Materials: (enter categories from instructions.)

Principal exterior materials of the property: See narrative

Narrative Description

(Describe the historic and current physical appearance and condition of the property. Describe contributing and noncontributing resources if applicable. Begin with a **summary paragraph** that briefly describes the general characteristics of the property, such as its location, type, style, method of construction, setting, size, and significant features. Indicate whether the property has historic integrity.)

Summary Paragraph

The Consolidated PB2Y Coronado was a four-engine, long-range patrol flying boat. Prototyped in 1936, the U.S. Navy placed their first order for the PB2Y Coronado in 1939, and they would continue to use them throughout World War II for long-range patrols, long-range bombers, antisubmarine duties, cargo transport, air ambulance, and Dumbo missions throughout the Pacific Theatre. 24.14 m long with a wingspan of 35.05 m, the Coronado was crewed by 9 to 11, could carry a load of 10,000 kg, and had a range of 4,000 to 6,400 km depending upon configuration (Hoffman 2009:1–2; Creed 1985:43; Polmar 2013:14–15; Hoffman 2009:1–2; Andrews 1989:22).

Based on a preponderance of circumstantial evidence, this particular aircraft has been identified as Bureau Number 7070, a transport conversion that crashed on 15 September 1985. The aircraft now lies broken and scattered inside Tanapag Lagoon in approximately 8 m of water on a flat, undulating seabed comprising primarily of calcareous sediment. A main assemblage, measuring 10 m long by 6 m wide, rests at the center of the site. It constitutes the largest continuous piece of wreckage, and contains the cockpit canopy, port and starboard flight deck walls, radio equipment, a horizontal and vertical stabilizer, and a single detached engine. The remaining

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Saipan, MP

Name of Property

County and State

wreckage is scattered within a 100 m radius circle. The site is missing three engines and all four propellers, in addition to a large amount of wing (94%) and fuselage (72%), which is likely the result of salvage.

Narrative Description

PB2Y Coronado Construction and Use:

The Consolidated PB2Y Coronado (PB stands for Patrol Bomber, 2 means 2nd model, and Y is the manufacturer code for Consolidated Aircraft [Creed 1985:15]) was as a result of the U.S. Navy's interest in the 1930s in developing a four-engine, long-range patrol aircraft to support fleet operations. Consolidated, which was already producing the highly successful PB4Y Catalina, began development on the Model 29 on 23 July 1936 to compete with Sikorsky's XPBS-1, which started a year before on 29 June 1935 (Hoffman 2009:1-2; Creed 1985:43; Polmar 2013:14-15). Both were similar in design: high-wing, cantilever monoplanes, single tails and wing tip floats, nose and tail gun turrets, and bomb bays in the wings. Both used 1050-hp Pratt and Whitney R-1830 Twin Wasp engines. Consolidated's aircraft used the retractable wing-tip floats as were on its PB4Y Catalina, while Sikorsky's used fixed floats (Andrews 1989:22).

Consolidated's Model 29, rechristened the XPB2Y-1 ("X" for experimental, "-1" for first model), first flew on 17 December 1937 (Creed 1985:15, 43). Despite beginning development over a year earlier, the competing Sikorsky XPBS-1, did not fly until 9 September 1937 (Hoffman 2009:1). Consolidated's XPB2Y-1 suffered from control and directional stability problems. The tail assembly was overhauled, resulting in twin circular tail fins attached to a dihedral horizontal mounted to a stub fin (Andrews 1989:22). The under-hull was also redesigned (Polmar 2013: 14-15). These changes solved the stability problems, and the Navy Board of Inspection and Survey trials began in August 1938. The XPB2Y-1 made a cross-country round trip to Naval Air Station (NAS) Anacostia, D.C., in late October. There President Roosevelt inspected it; simultaneously, the uniqueness of a large flying boat making transcontinental flights gained considerable media attention. When the design was finalized, the Navy accepted the prototype and selected Consolidated for the production contract in March 1939. The contract called for six to be delivered (Andrews 1989:22). The prototype XPB2Y-1 became a flag transport, shuttling around important figures such as Admiral Nimitz throughout the war (Hoffman 2009:10).

The production model, PB2Y-2, was a greatly modified version of the prototype XPB2Y-1. It featured improved engines (Pratt and Whitney R-1830-78, 1020-hp), a modified hull, and both bomb-carrying capacities and machine-gun turrets were increased. Between December 1940 and summer 1941, five PB2Y-2s were delivered to Patrol Squadron (VP) 13 in San Diego. The sixth was modified to serve as prototype for the next generation Coronado, the PB2Y-3. While only five PB2Y-2s existed, VP-13 Coronados played a key role in the early Pacific Theatre, serving as VIP transports from the west coast to Hawaii to Australia. These duties were taken over by Naval Air Transport Service (NATS), which continued to use PB2Ys (Andrews 1989:22).

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Saipan, MP

Name of Property

County and State

VP-13 began to receive the new PB2Y-3 in June 1942. They featured increased armament, pilot armor, and self-sealing fuel tanks. Unfortunately, these improvements were not accompanied by an increase in engine power, and mission performance suffered. Further, heavy spray from the bow damaged the inboard propellers during take-offs. Four-bladed steel propellers were the solution, but shortages led to many PB2Y-3s being equipped with four-bladed propellers only on the inboard engine, with three-bladed propellers on the outboard (Polmar 2013:14–15). The PB2Y-3s were also plagued with leaking internal fuel tanks and inadequate range with self-sealing tanks. Ultimately, 210 PB2Y-3 models were produced. Of the first 60 produced, 29 were stripped of combat features and flew as transports (designated PB2Y-3R). VP-13 received 12 as the first combat squadron, while one was used in conjunction with XPB2Y-1 as a flag transport. NATS received 98, and 35 went to the British under the Lend-Lease Act (Andrews 1989:22–23).

Although three of the four planned squadrons were flying Coronados, the problems with the aircraft became intolerable by late summer in 1943. Both Consolidated and Rohr Aircraft performed the rework. Different blocs of aircraft received different solutions. For example, to solve the fuel tank leakage problem, some aircraft were fitted with synthetic rubber cells installed in the tanks, while others were coated with new sealing compounds. Combat planes received self-sealing tanks, while extra tanks were added to the hull to compensate for lost volume (Andrews 1989:23).

Further, the still-underpowered engines were again upgraded; they were refitted with Pratt and Whitney R-1830-92 1200-hp, single-stage supercharged engines. These were redesignated as PB2Y-5. Some were stripped of combat equipment, and operated as transports (suffix -5R), evacuation aircraft (-5H), and flagships (-5F). The transports could carry 44 passengers or up to 6800 kg (15,000 lbs), while the evacuation aircraft were equipped to carry 25 stretchers (Figure 2) (Niderost 2012; Polmar 2013:14–15). These specialized aircraft proved their worth in noncombat roles, just as the standard models proved themselves in combat (Polmar 2013:14–15).

PB2Y-3s and -5s, operating in VP-13 and VP-102, had outstanding combat records in the Pacific. Normal duties included long-range bombing and minelaying missions (they were capable of flying 6400 km round trip bombing runs), which were often flown at night (Polmar 2013:14–15). These aircraft participated in raids on Wake Island, the longest over-water bombing mission yet attempted by the Navy, and mining runs on Chuuk Lagoon (Bracho 2005:73, 87). PBY-5Hs were instrumental in evacuating many of the seriously wounded during the battles in the Pacific islands (Andrews 1989:23). The transports and flagships also served an important role in the Navy, as many tactical planners needed to visit newly-conquered islands that either did not have runways, or the runways were too damaged from recent battle to safely operate. In these circumstances, flying boats like the Coronado were the only way to conduct air travel.

By the end of the war, the PB2Y Coronado had become obsolete. The B-24 Liberator and PB4Y-2 Privateer replaced the Coronado as long-range bombers, while the C-54 Skymaster took over long-range transport duties and the Martin P5M Marlins assumed the seaplane VP role (Polmar 2013:14–15). By 1946, the Navy had completely retired the PB2Y Coronado (Andrews 1989:23). With many aircraft reaching upwards of 4,000 hours in their flight logs, most were

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Saipan, MP

Name of Property

County and State

salvaged for spare parts and scrapped. Only one extant aircraft still exists, restored and on display at the National Naval Aviation Museum at Pensacola, Florida (Andrews 1989:23; Naval Aviation Museum).

PB2Y-5R Coronado BuNo 7070 History and Crash

PB2Y-5R BuNo 7070 began life as a combat model PB2Y-3 in December 1942, and served with Patrol Squadron 13 (VP-13). In July 1943, BuNo 7070 transferred to Rohr for upgrades and conversion to a PB2Y-5R model, after which it was transferred to Air Transport Squadron Two (VR-2) of the Naval Air Transport Service (NATS) (US Navy 1945c). Responsible for establishing scheduled air transport operations and developing an organization capable of engaging in and supporting tactical operations, NATS established VR-2 as its Pacific Division on 1 April 1942. By the end of the war, VR-2 conducted regular flights throughout the Pacific, operating from terminals at Johnston Island, Kwajalein, Guam, Saipan, and Manila (Hoffman 2009:86–90; Air Transport Squadron Two 1945).

BuNo 7070 crashed on takeoff at 0354K (local time, UTC+10) on 15 September 1945, on a scheduled flight carrying 4 passengers in addition to its 10 crewmembers. Lt. Baumhover, an experienced pilot with over 1,500 hours flight time in Coronados (155 in the past three months alone), sat in the pilot's seat while the plane commander, Lt. Lehrkind, sat in the copilot's seat. The aircraft, although less than three years old, had already logged 2,356.4 hours on its airframe since conversion and required three overhauls in that period. All four engines had over 1,000 hours each since installation, and over 500 hours since last overhaul (US Navy 1945b).

The Coronado started its takeoff run on runway #23, into swells from the southwest and a light 2 kt (3.7 km/h) breeze from the south-southeast. Other conditions were fair, with an unlimited ceiling and 8 miles (12.9 km) of visibility. Upon stepping up onto plane, the aircraft began "porpoising"—skipping across the water, rising off then settling back onto the surface. By the third porpoise, at an estimated 60 knots (111 km/h), the aircraft struck the water with right wing low and crashed. Of the 14 people on board the aircraft (10 crew, 4 passengers), only 6 crewmembers survived the crash; the remaining 8 passengers and crew suffered "death by drowning" (US Navy 1945b). The status of all personnel, as reported in Aircraft Accident Report Serial No. 9-45, is presented in Table 1. Severity of injury was classified A to D, with A resulting in death and D receiving no injury. Passengers are indicated by (P) before their names. Bodies of the deceased, after recovery, were buried in the US Army Cemetery, 27th Division, in Saipan (Air Transport Squadron Two War Diary, September 1945).

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Saipan, MP

Name of Property

County and State

Table 1. BuNo 7070 Personnel during crash.

Name	Rank	Service	Position Occupied	Injury Class	Description
Lehrkind, Paul	Lt	USNR	Flt. deck copilot	C	abrasion forehead and left hand
Baumhover, Denis	Lt	USNR	Flt. deck, pilot seat	C	lacerations right ear, forehead, left arm
Moriarty, Robert	Ens	USNR	Step btwn pilot & copilot	C	laceration left thigh and right leg
Kalbfus, William	LtJg	USNR	Flt. deck, nav. table	A	death by drowning
McCormick, Gerald	LtJg	USNR	Flt. deck, nav. table	A	death by drowning
Eastham, Harrold	AMMF2c	USNR	Flt. deck, engr. panel	A	death by drowning
Oldensmith, Paul	AMMF3c	USNR	Flt. deck, standing near engr table	A	death by drowning
Wiediger, Adolph	ACRM	USN	Compt. D	B	severe comminuted laceration forehead, fracture sesgical [sic] and facb.
Smith, William	ARN2c	USN	Flt. deck radio table	C	necked left homens
McElroy, Thomas	SpV3c	USNR	Compt. K	C	lacerations forehead
(P) Trotter, R.T.	LtJg	USN	Compt. G	A	death by drowning
(P) Causey, J.T.	Ens	?	Compt. G	A	death by drowning
(P) Mottalini, A.J.	S1c	?	Compt. G	A	death by drowning
(P) Thebarga, D.G.	ARM3c	?	Compt. G	A	death by drowning

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070
Name of Property

Saipan, MP
County and State

Archaeological Site Condition:

Overview:

The remains are located approximately 8 m deep on a generally flat, undulating seabed comprising primarily of fine calcareous sediment. Most of the remains are exposed; the site averages 50 cm profile above the seabed, with maximum relief occurring at the engine (1.5 m). A layer of fine sediment covers the lower areas, while a mucilaginous layer covers the aluminum surfaces (McKinnon and Carrell 2014:39). As the site lies in a lagoon, it is generally protected from wave action and rough seas. McKinnon and Carrell (2014:39) noted “a steady and generally light current [that] did not visibly move sediment” in February 2012, although researchers experienced heavy (nearing 1 knot) current on most days in November 2014.

The site is generally disarticulated and scattered around a main wreckage assemblage. The main assemblage measures approximately 10 m long by 6 m wide, and contains the most identifiable parts of the aircraft, including the cockpit canopy, radio equipment, and a tail fin, with one detached engine lying nearby (Figure 3). The main assemblage also contains the largest continuous piece of wreckage: the cockpit canopy, flight deck ceiling, and flight deck walls. Scattered about the main assemblage in a 100 m radius are approximately 40 large pieces of wreckage (larger than 1 m on one axis) and countless smaller pieces, including hatch covers, a float support, a seat, and a cluster of concreted forks and spoons (Figure 4). The site is missing three engines and all four propellers, in addition to a large amount of wing (94%) and fuselage (72%), which is likely the result of salvage.

The following is a description of the identifiable wreckage and significant features of this site:

Cockpit canopy: The main feature of the site is the cockpit canopy (Figure 5). Situated directly above the pilot and copilot seats, the top three windscreen windows are exposed, while the very tops of the port and center main windscreen windows are visible above the sand. A windscreen wiper, with rubber blade still attached, emerges from the sand on the starboard side. Directly aft of the upper windows, the escape hatches open into sand 40 cm below. The port (pilot's) hatch cover is present and in the open position, while the starboard (copilot's) hatch sill is buried and the cover is missing.

Between the escape hatches, the aerial mast lies twisted and bent to the port side. Since the mast is connected directly to the cockpit canopy, this aircraft was not fitted with a radome (radar dome) as many later model aircraft were. The aerial mast served as the forward fixation point for many of the Coronado's antennae, including the sense, G.F. Voice, V Type, and High Frequency V type antennae (Hoffman 2009:39). Aft of the aerial mast, the cockpit canopy continues until it is buried under the sand. The port side canopy window is present, as is the mount for the D.Z. Type loop antenna (mount only, antenna is missing). Both are hidden from plan view by the overlying section of fuselage wall, which is supported by the D.Z. Type antenna mount.

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Saipan, MP

Name of Property

County and State

Flight deck walls: The port side flight deck wall, where the navigator's station would be located, separated from the deck below it and bent upwards at the turn of the fuselage. The port side wall is still attached to the cockpit canopy, albeit bent upwards and level with the cockpit canopy. The starboard side wall, the radio operator's compartment, separated completely from the cockpit canopy. The wall now rests with the inside surface facing upwards.

Radio equipment: East of the starboard flight deck wall, a variety of radio equipment lies scattered across a roughly 2 m by 2 m area (Figure 6). Whole components include a panel containing two ART-13B transmitters and one unknown unit, two unknown units connected to each other with a third stacked on top, and an unknown unit lying on its side. Cable connects all units to the panel. Broken sections of radio equipment and individual electrical components such as large capacitors are strewn throughout the area. Markings in several areas on the ART-13B transmitters are still legible, and a serial number is present at the bottom of the panel.

Vertical stabilizer: The forward section of the port vertical stabilizer (Figure 7) lies to the south of the cockpit canopy. The stabilizer is damaged, with tears in both the bottom and top leading edge. The connection to the horizontal stabilizer has been torn off, and only a small forward section of the rudder is present. The rear edge of the rudder bears evidence of being violently ripped apart. Slightly east of the vertical stabilizer is a section believed to come from the horizontal stabilizer, torn at one end, crumpled on the other, and lying atop at least two different layers of wreckage.

Engine: A single detached engine is located 11.80 m east of the cockpit. The engine rests on its forward surface, at an angle against a reef (Figure 8). The nacelle is present, although some sections are missing (the access panel in the photograph is missing) and it is heavily overgrown. The propeller is unaccounted for, as are the other three engines.

Seat: A seat rests (Figure 9) propped up against the northern edge of the same patch reef as the engine, 18 m east of the cockpit canopy. Coral growth permanently attaching it to the reef indicates that the seat has been undisturbed for quite some time, yet it remains questionable whether the seat's position is a result of deposition, or a post-depositional event. This type of seat was installed at non-flying crew member stations, such as the radio operator, navigator, and flight engineer's stations.

Float Strut: A disarticulated float strut, a structural component that connected the wingtip float to the wing, is located 6 m north of the cockpit window (Figure 10). The Coronado featured retractable floats that folded up into the wingtip while in flight. The strut, lying with its outer surface facing up, shows evidence of being violently torn from both the wingtip and the float. This strut shows traces of green and black paint towards the top end, with heavy white paint along the extreme top edge. A serial number is located along the side near the top. The serial number "29L5300-2" is readable, with a possible final digit or digits obscured by a rivet head. Below the serial number, the upside-down Consolidated Aircraft "CA" is stamped into the metal.

Wing: A large section of wing rests partially buried 65 m to the northeast of the cockpit canopy (Figure 11). This represents the largest section of wing present on the site; other pieces are

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Saipan, MP

Name of Property

County and State

smaller and constitute control surfaces. The piece is 5.5 m long, and undulates across the seabed, badly damaged. The west end appears to have been violently torn off, and only a structural support remains, bent straight upward at a right angle. The other end of the wing disappears into the sand, but likely does not continue as its exposed trailing edge stops. The leading edge is missing, also torn asunder.

Hatch Cover and Astrodome: The PB2Y Coronado featured an interchangeable hatch cover and an astrodome for its top hatch, aft of the flight deck. These were installed on opposite sites of the hatch, and either could be used to cover the opening. The 70 cm diameter circular hatch cover, with two semi-circular windows and a handle, rests 24 m east-northeast of the cockpit canopy. The accompanying astrodome was found 73 m southwest of the cockpit canopy and 92 m southwest of the hatch cover discussed above. The base is intact, complete with hinges and sealing gasket, while the dome itself is shattered (Figure 12).

Eating utensils: A group of nine forks and four spoons are located 19 m northeast of the cockpit canopy (Figure 13). Two single forks and four single spoons are mixed amongst broken coral and rocks in a 100 cm by 50 cm area. A concreted cluster of seven forks is also present. Notably, the base of the handle of at least one fork is inscribed "USN". Based on the small number present, the artifacts here likely represent those from the Coronado's galley, rather than a cargo of eating utensils.

Port anchor hatch: Originally located beneath and forward of the cockpit, a section of fuselage containing the port anchor hatch (Figure 14) is located 45 m southwest of the cockpit canopy. This section of hull is warped and damaged, with at least one panel is missing completely. The hatch and hatch cover are both present.

8. Statement of Significance

Applicable National Register Criteria

(Mark "x" in one or more boxes for the criteria qualifying the property for National Register listing.)

- A. Property is associated with events that have made a significant contribution to the broad patterns of our history.
- B. Property is associated with the lives of persons significant in our past.
- C. Property embodies the distinctive characteristics of a type, period, or method of construction or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.
- D. Property has yielded, or is likely to yield, information important in prehistory or history.

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070
Name of Property

Saipan, MP
County and State

Criteria Considerations

(Mark "x" in all the boxes that apply.)

- A. Owned by a religious institution or used for religious purposes
- B. Removed from its original location
- C. A birthplace or grave
- D. A cemetery
- E. A reconstructed building, object, or structure
- F. A commemorative property
- G. Less than 50 years old or achieving significance within the past 50 years

Areas of Significance

(Enter categories from instructions.)

Criterion A: Military, Maritime History

Criterion C: Military, Maritime History, Engineering, Transportation

Criterion D: Archaeology-Historic-Military

Period of Significance

1937-1945

Significant Dates

1944, 1945

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Name of Property

Saipan, MP

County and State

Significant Person

(Complete only if Criterion B is marked above.)

Cultural Affiliation

American

Architect/Builder

Consolidated Aircraft

Statement of Significance Summary Paragraph (Provide a summary paragraph that includes level of significance, applicable criteria, justification for the period of significance, and any applicable criteria considerations.)

The Consolidated PB2Y-5R Coronado BuNo 7070 located in Tanapag Lagoon is eligible for the National Register as an aviation wreck that qualifies as a significant site, as explained in the Guidelines for Evaluating and Documenting Historic Aviation Properties:

An aviation wreck is any aircraft that has been crashed, ditched, damaged, stranded, or abandoned. The wreck may be intact or scattered, may be on land or in water, may be—in National Register terms—a structure or a site. ...a wreck "site" lacks the structural integrity of an aircraft, although the site may contain the structural elements of the aircraft. (Milbrooke et al. 1998:20)

The wreck site of BuNo 7070 is significant according to Criteria A and C as a vessel that played an important role during World War II, especially during the Pacific island hopping campaign. The Coronado was the largest mass-produced flying boat used by the Navy at the time, and it was specifically developed and modified to support evolving fleet tactics. The versatility of the flying boat, especially the large, four-engined Coronado, enabled the Navy to make use of aircraft in transport, scouting, bombing, and rescue missions, in areas that were not completely secured, had no runways, or had runways that were too damaged to operate.

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Saipan, MP

Name of Property

County and State

The period of significance for the Coronado was from the time of first flight, 1937, to the conclusion of World War II, after which they were quickly salvaged or scrapped. Throughout this time period, the Coronado contributed greatly to the war effort, especially in the Pacific. The year 1944 was significant for the Coronado lying in Tanapag Lagoon because of its ties to the Battle of Saipan. Not only were Coronados used during the battle, but Saipan became a major base for further operations, remaining so until nearly the conclusion of the war. Thus, the Tanapag Lagoon Coronado represents not only the role of Saipan to U.S. operations, but it also represents the effects that the Battle of Saipan, and later U.S. occupation, had on Saipan.

Narrative Statement of Significance (Provide at least **one** paragraph for each area of significance.)

Criterion A: The BuNo 7070 wreck site is historically significant due to its direct association with World War II in general, and the Pacific campaign, island-hopping, and the Battle of Saipan in particular. The Coronado was developed specifically to support fleet operations, which played a pivotal role in the Pacific theatre. The PB2Y Coronado was employed in long-rang patrols, anti-submarine activities, Dumbo missions (the rescuing of downed aircrew, either by landing in the open sea to rescue them or by directing submarines to the aircrew's position), long-range bombing and minelaying runs, both VIP and regular transport, and as air ambulances. The Coronado served with distinction, despite constant modification and upgrades, and many aircraft had upwards of 4,000 hours of flight by the time they were retired.

The Tanapag Lagoon Consolidated Coronado symbolizes not only these functions in the greater theatre of war, but it serves as a reminder of the impact of war to Saipan. Captured during World War I and quickly colonized, Saipan was seen as part of the last ring of defenses before the Japanese homeland (Goldberg 2009:vii; Morison 1953:339). By 1944, the Japanese outnumbered the native Chamorro and Carolinian population by almost 15:1 (Sheeks 1945:109–110). After a 25-day battle, less than 1,000 of the original 30,000 Japanese soldiers were taken prisoner; the rest were killed. A further 20,000 civilians were killed or committed suicide. Of the 70,000 American troops that participated in the battle, 3,225 were killed, 13,061 wounded, and 326 missing—a 25% casualty rate (Rottman 2004:9; Brooks 2005:229). During this intense fighting, the native peoples could only hide in caves. After the war, those who were left had to try to pick up their lives again, this time under American occupation.

Tanapag Lagoon was developed by the Japanese as a seadrome, complete with seaplane ramps. After Saipan was secured, the US Navy used it for the same functions. PB2Y-5R BuNo 7070 represents both a wartime and post-war use of the lagoon; VR-2 performed key organic airlift functions out of Tanapag Lagoon from 1944 to 1947 (Air Transport Squadron Two 1945b; Air Transport Squadron Two 1953). This use of the lagoon by both colonizers before, during, and after the war permanently altered the seascape of the area, which is further symbolized in the BuNo 7070 lying in the bottom of the lagoon.

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Saipan, MP

Name of Property

County and State

Criterion C: The Consolidated PB2Y Coronado represents a key type of flying boat in U.S. Navy history, one that saw its heyday during the World War II period. Although the Navy already had successful flying boats in the Consolidated PBY Catalina and Martin PBM Mariner, these were both two-engined aircraft. The Navy began to show interest in long-range patrol flying boats with four engines. Consolidated won the contract with its PB2Y Coronado, and it became a workhorse for the Navy.

The Coronado went through many modifications and upgrades, and served both combat and non-combat roles. The versatility is shown by the many missions it flew, from long-range bombing and patrols, to VIP transport, to air ambulance. The Coronado was used to fly the first successful bombing run on Wake, after Army Air Corps B-24 bombers failed to make it to Wake, find the target, and return. Only two or three of the B-24s made it back. Coronados made four successful attacks, showing the feasibility of using heavy seaplanes in long range advance base operations. It was particularly suited for these operations, as it had four engines; the Coronado could still limp back to a friendly base with the loss of an engine, while two-engined seaplanes like the PBY Catalina or PBM Mariner could not. The flying boat design was also suited for these missions in that damaged aircraft had more places they could safely land; they were not limited to bases with long runways, like traditional bombers.

Coronados were also suited for non-combat roles. With the aforementioned ability to safely land in almost any lagoon, the Coronado was regularly used to transport high-priority goods. They regularly carried mail as well as passengers to islands without runways. The Coronado was especially useful during the island hopping campaign, as many captured islands either had no runway, or the runway was heavily damaged by the time it was captured. This would mean a delay while Seabees brought runways back to operable status; Coronados were used during the interim period. Coronados were regularly used to ferry Admiral Nimitz and his staff during the Pacific campaign. A Coronado carried the staff of Fleet Admiral Nimitz to Tokyo bay for Japan's surrender ceremonies aboard *USS Missouri*.

BuNo 7070, although broken and scattered, is still recognizable as a Coronado. Its large size can be seen in the scatter of the site. Key features, such as the cockpit canopy and float strut, are still present. Although a large percentage of missing material indicates salvage, the integrity of the main site is shown in the presence of small, easily removed artifacts like the concreted forks and chair, as well as high-importance artifacts like the radio panel.

This site is further significant to Criterion C as this is the only known in situ Consolidated PB2Y Coronado. After the war, the model was quickly retired, salvaged and scrapped. From a total of 217 made, only one other Coronado is known to exist—that at the National Naval Aviation Museum at Pensacola, Florida (Naval Aviation Museum).

Criterion D: The BuNo 7070 wreck site has potential to provide important information now and in the future. Integrity of the main site is evidenced by the presence of small, easily taken artifacts. The site can potentially yield information on the PB2Y Coronado and its modifications throughout war, as well as its postwar role as a transport. It can also potentially add to our

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Saipan, MP

Name of Property

County and State

understanding of the role of flying boats, not only in the greater war, but also during the Battle of Saipan and subsequent occupation.

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Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Saipan, MP

Name of Property

County and State

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Archives Branch, Naval History & Heritage Command, Washington, DC.

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Saipan, MP

Name of Property

County and State

Previous documentation on file (NPS):

- preliminary determination of individual listing (36 CFR 67) has been requested
- previously listed in the National Register
- previously determined eligible by the National Register
- designated a National Historic Landmark
- recorded by Historic American Buildings Survey # _____
- recorded by Historic American Engineering Record # _____
- recorded by Historic American Landscape Survey # _____

Primary location of additional data:

- State Historic Preservation Office
 - Other State agency
 - Federal agency
 - Local government
 - University
 - Other
- Name of repository: Flinders University, Adelaide, South Australia; East Carolina University, Greenville, North Carolina

Historic Resources Survey Number (if assigned): _____

10. Geographical Data

Acreeage of Property 100 m radius circle = 7.76 acres

Use either the UTM system or latitude/longitude coordinates

Latitude/Longitude Coordinates

Datum if other than WGS84: _____

(enter coordinates to 6 decimal places)

- | | |
|--------------|------------|
| 1. Latitude: | Longitude: |
| 2. Latitude: | Longitude: |
| 3. Latitude: | Longitude: |
| 4. Latitude: | Longitude: |

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070
Name of Property

Saipan, MP
County and State

Or

UTM References

Datum (indicated on USGS map):

NAD 1927 or NAD 1983

- | | | |
|--------------|-----------------|-------------------|
| 1. Zone: 55P | Easting: 363014 | Northing: 1685191 |
| 2. Zone: | Easting: | Northing: |
| 3. Zone: | Easting: | Northing: |
| 4. Zone: | Easting : | Northing: |

Verbal Boundary Description (Describe the boundaries of the property.)

Verbal Location: BuNo 7070 is located in Tanapag Lagoon, roughly halfway between Managaha Island and the Flores Point seaplane ramps and an equal distance from the jetty east of Muchot Point.

Chart Description: The Coronado is 1.2 km from the flashing light in the center of Managaha Island on a true heading of 100 degrees and 1.5 km from the red lighted buoy at the tip of the jetty east of Muchot Point, as shown on NOAA Chart 81076 (Figure 1). The site can be reached by entering Tanapag Lagoon by the boat channel, and turning northeast just before the lighted red buoy #6. Head towards the unlighted red buoy #22 in the center of the lagoon (avoiding the shipwreck it marks), almost directly between the Managaha Island light and the Flores Point seaplane ramp light. The aircraft is 450 m north of red buoy #22.

Area Definition: The area included in the site is a circle of radius 100 m; the geographical center is the cockpit and fuselage section, UTM 55P 363014 1685191.

Boundary Justification (Explain why the boundaries were selected.)

The BuNo 7070 site features a broken and scattered aircraft that is partially buried. The geographic center of the boundary is the main feature, the cockpit and fuselage. The

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

Saipan, MP

Name of Property

County and State

boundary of this site was determined by snorkeler and diver survey; no artifacts were found outside this range. A site sketch is attached.

11. Form Prepared By

name/title: James R. Pruitt
organization: East Carolina University, Program in Maritime Studies, Master's Candidate
street & number: 302 E. 9th St.
city or town: Greenville state: NC zip code: 27858
e-mail pruitt.jim@gmail.com
telephone: (252) 375-9445
date: 7 January 2015

Additional Documentation

Submit the following items with the completed form:

- **Maps:** A **USGS map** or equivalent (7.5 or 15 minute series) indicating the property's location.
- **Sketch map** for historic districts and properties having large acreage or numerous resources. Key all photographs to this map.
- **Additional items:** (Check with the SHPO, TPO, or FPO for any additional items.)

Photographs

Submit clear and descriptive photographs. The size of each image must be 1600x1200 pixels (minimum), 3000x2000 preferred, at 300 ppi (pixels per inch) or larger. Key all photographs to the sketch map. Each photograph must be numbered and that number must correspond to the photograph number on the photo log. For simplicity, the name of the photographer, photo date, etc. may be listed once on the photograph log and doesn't need to be labeled on every photograph.

Photo Log

Name of Property:

City or Vicinity:

Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070
Name of Property

Saipan, MP
County and State

County:

State:

Photographer:

Date Photographed:

Description of Photograph(s) and number, include description of view indicating direction of camera:

1 of ____.

Paperwork Reduction Act Statement: This information is being collected for applications to the National Register of Historic Places to nominate properties for listing or determine eligibility for listing, to list properties, and to amend existing listings. Response to this request is required to obtain a benefit in accordance with the National Historic Preservation Act, as amended (16 U.S.C.460 et seq.).

Estimated Burden Statement: Public reporting burden for this form is estimated to average 100 hours per response including time for reviewing instructions, gathering and maintaining data, and completing and reviewing the form. Direct comments regarding this burden estimate or any aspect of this form to the Office of Planning and Performance Management, U.S. Dept. of the Interior, 1849 C. Street, NW, Washington, DC.

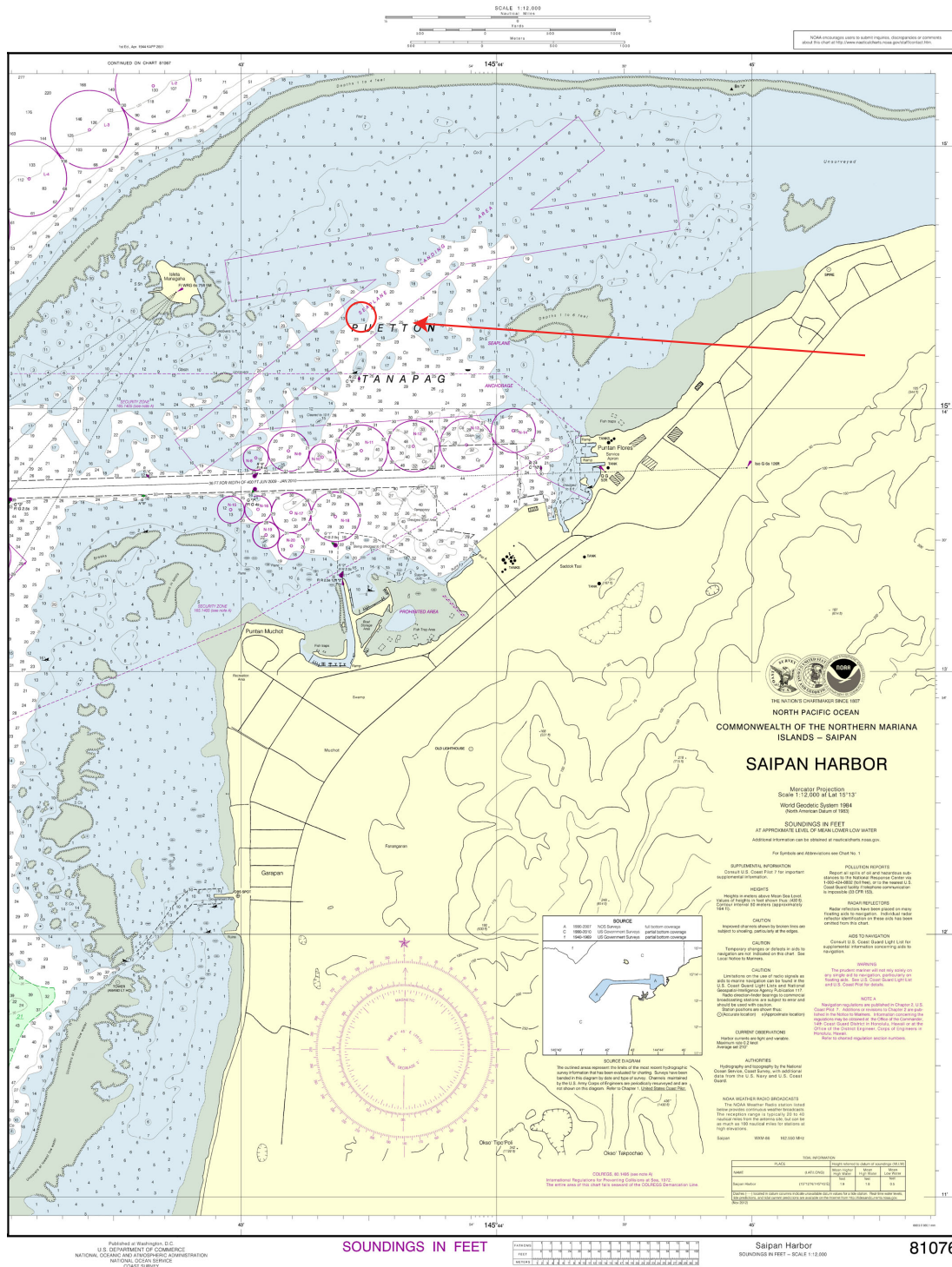
United States Department of the Interior
National Park Service

National Register of Historic Places
Continuation Sheet

Tanapag Lagoon Consolidated PB2Y-5R
Coronado BuNo 7070
Name of Property
Saipan, MP
County and State

Section number Additional Information Page 1

Figure 1: Location of site (circled with arrow). NOAA chart 81076



United States Department of the Interior
National Park Service

National Register of Historic Places
Continuation Sheet

Tanapag Lagoon Consolidated PB2Y-5R

Coronado BuNo 7070

Name of Property

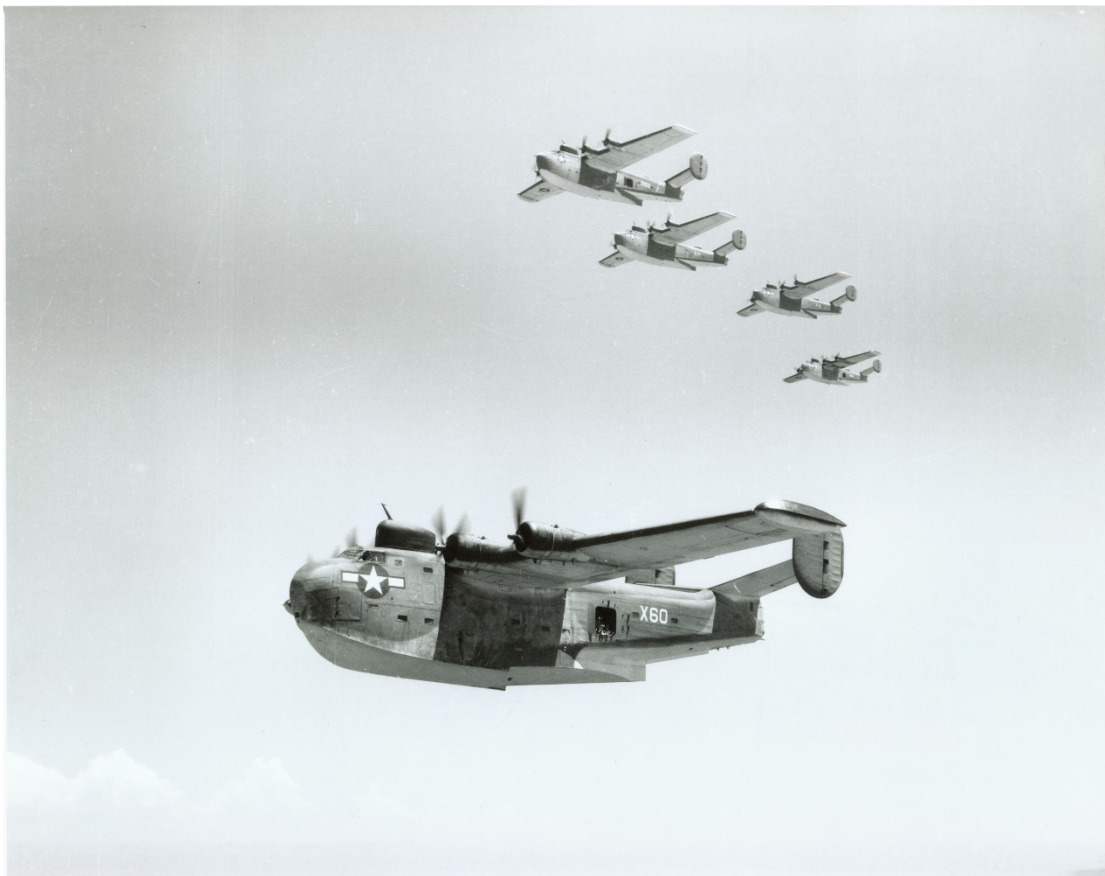
Saipan, MP

County and State

Section number Additional Information

Page 2

Figure 2



Name of Property: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

City or Vicinity: Tanapag

County: Saipan State: MP

Photographer: unknown (Naval Archives)

Date Photographed: unknown

Description of Photograph: Consolidated PB2Y-5R Coronados in flight. PB2Y Coronados played an important role in World War II, especially in the Pacific theatre and island-hopping campaigns.

United States Department of the Interior
National Park Service

National Register of Historic Places
Continuation Sheet

Tanapag Lagoon Consolidated PB2Y-5R

Coronado BuNo 7070

Name of Property

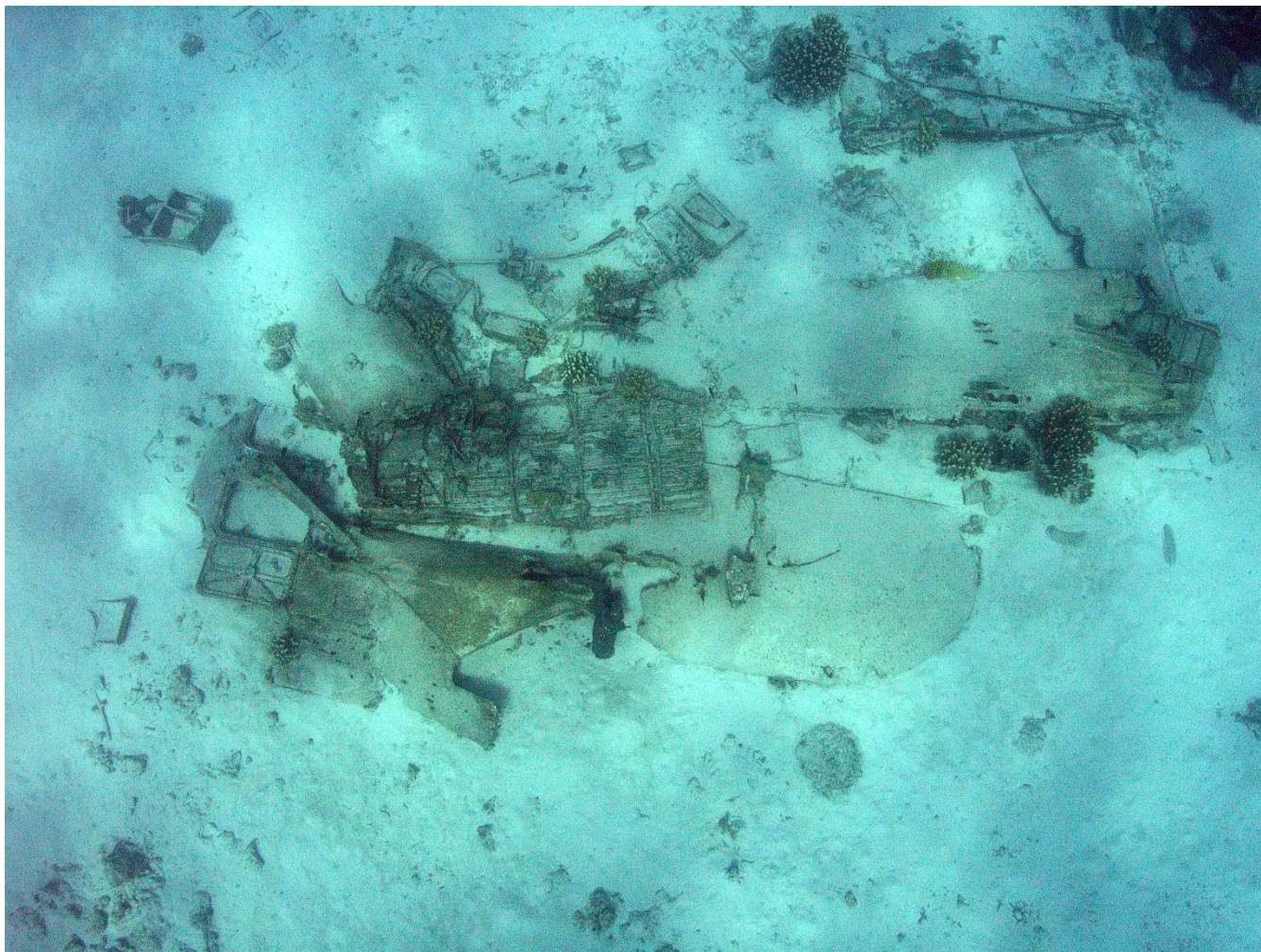
Saipan, MP

County and State

Section number Additional Information

Page 3

Figure 3



Name of Property: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

City or Vicinity: Tanapag

County: Saipan State: MP

Photographer: Jon Carpenter, Ships of Discovery

Date Photographed: 23 February 2012

Description of Photograph: Overview photograph of Tanapag Lagoon Consolidated Coronado site. Cockpit canopy is in center left. Radio equipment is at top center, while engine is at extreme top right.

United States Department of the Interior
National Park Service

National Register of Historic Places
Continuation Sheet

Tanapag Lagoon Consolidated PB2Y-5R
Coronado BuNo 7070
Name of Property
Saipan, MP
County and State

Section number Additional Information Page 4

Figure 4



Name of Property: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

City or Vicinity: Tanapag

County: Saipan State: MP

Photographer: James Pruitt

Date Photographed: 3 December 2014

Description of Photograph: Overview site plan of entire site contained within 100 m radius circle.

Figure 3 is to immediate west of reef (center).

United States Department of the Interior
National Park Service

National Register of Historic Places
Continuation Sheet

Tanapag Lagoon Consolidated PB2Y-5R

Coronado BuNo 7070

Name of Property

Saipan, MP

County and State

Section number Additional Information

Page 5

Figure 5



Name of Property: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

City or Vicinity: Tanapag

County: Saipan State: MP

Photographer: James Pruitt

Date Photographed: 9 November 2014

Description of Photograph: Plan view of cockpit canopy, 1 m scale. Note opened escape hatch at center right, damaged aerial mast at center, and windscreen wiper at lower left.

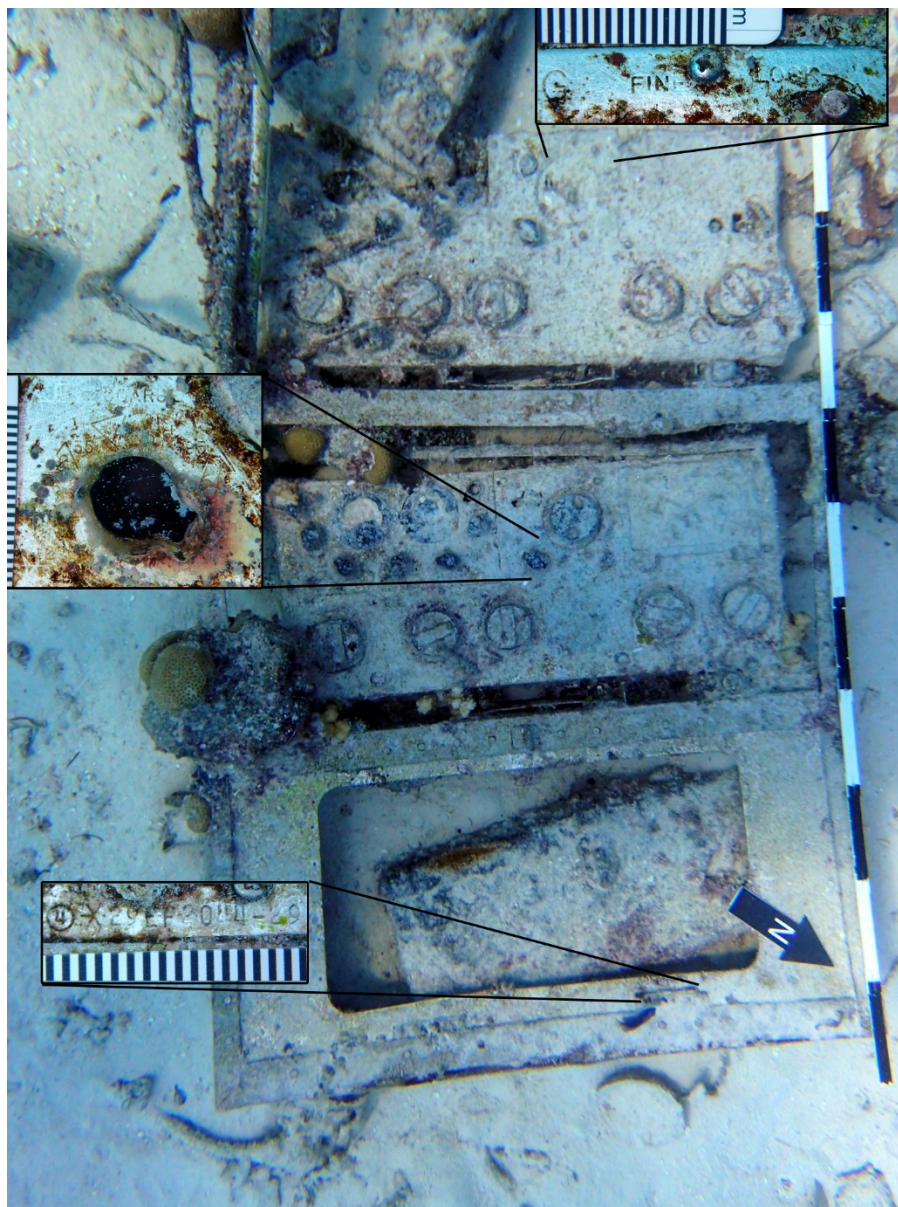
United States Department of the Interior
National Park Service

National Register of Historic Places
Continuation Sheet

Tanapag Lagoon Consolidated PB2Y-5R
Coronado BuNo 7070
Name of Property
Saipan, MP
County and State

Section number Additional Information Page 6

Figure 6



Name of Property: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

City or Vicinity: Tanapag

County: Saipan State: MP

Photographer: James Pruitt

Date Photographed: 13 November 2014

Description of Photograph: Radio panel containing two ART-13B transmitters. 1 m scale, details millimeter scale.

United States Department of the Interior
National Park Service

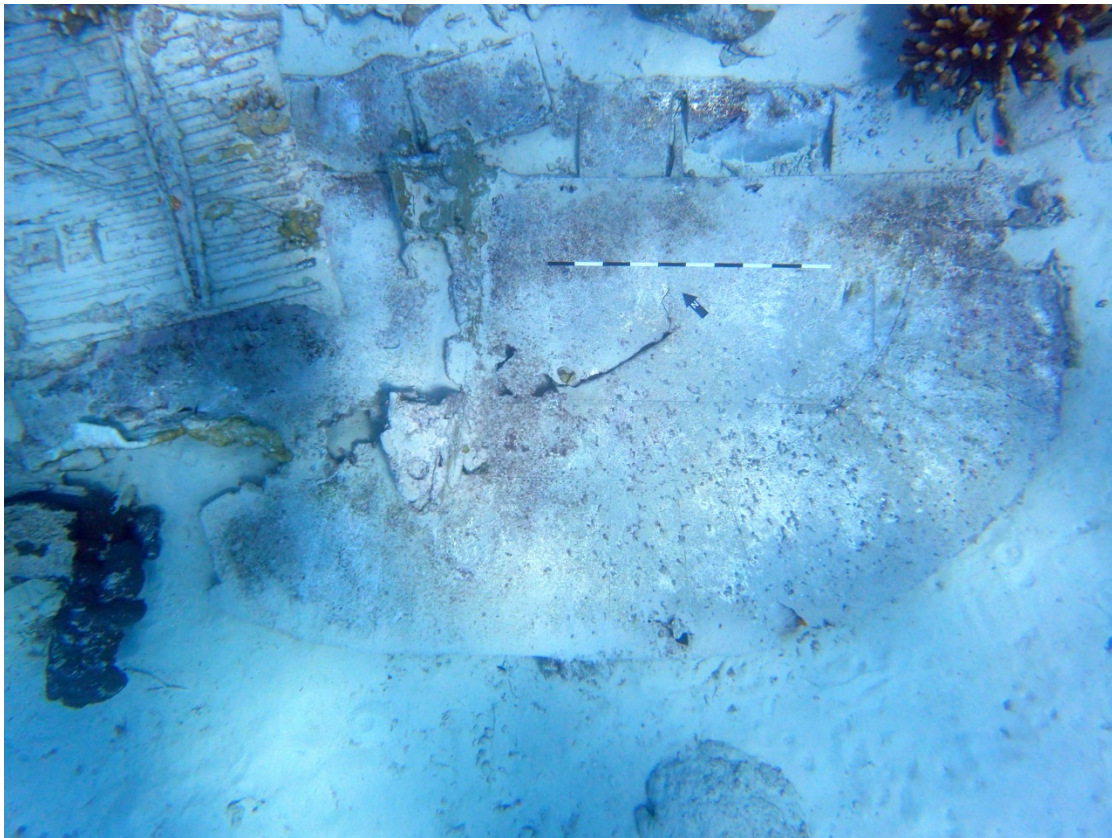
National Register of Historic Places
Continuation Sheet

Tanapag Lagoon Consolidated PB2Y-5R
Coronado BuNo 7070
Name of Property
Saipan, MP

County and State

Section number Additional Information Page 7

Figure 7



Name of Property: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

City or Vicinity: Tanapag

County: Saipan State: MP

Photographer: James Pruitt

Date Photographed: 9 November 2014

Description of Photograph: Port side vertical stabilizer. Plan view, 1 m scale.

United States Department of the Interior
National Park Service

National Register of Historic Places
Continuation Sheet

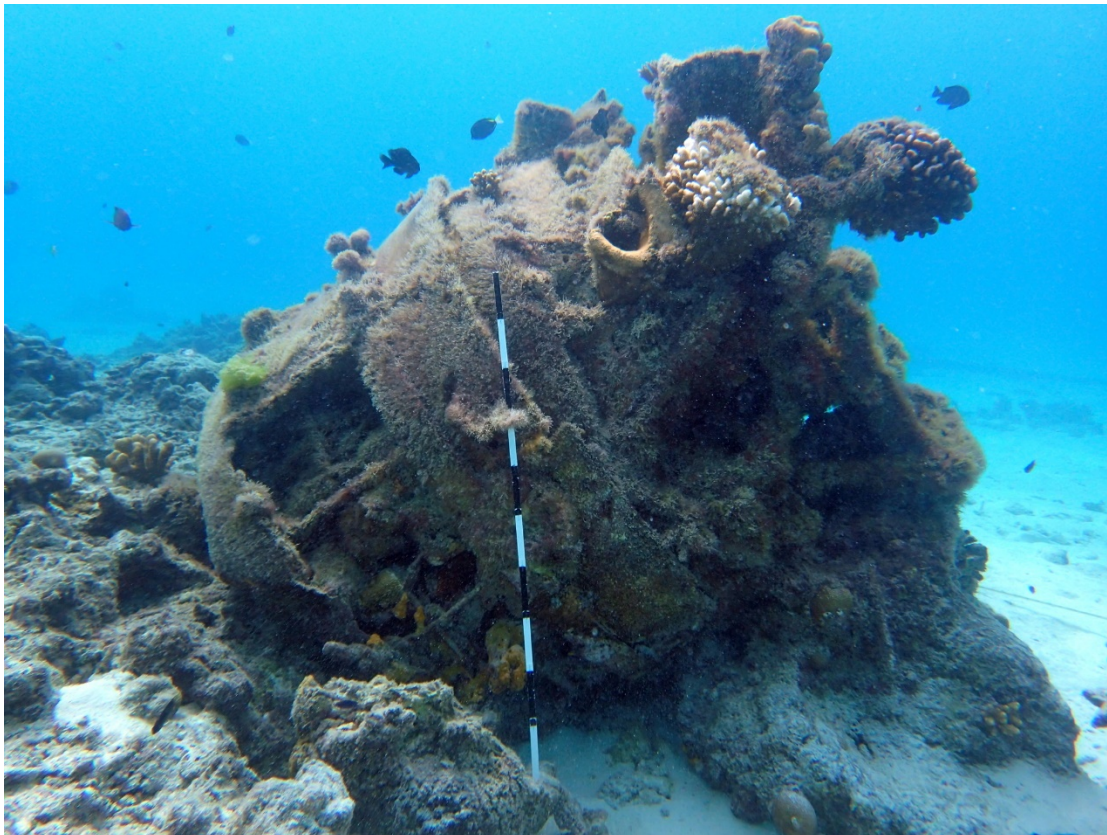
Tanapag Lagoon Consolidated PB2Y-5R
Coronado BuNo 7070
Name of Property
Saipan, MP

County and State

Section number Additional Information

Page 8

Figure 8



Name of Property: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

City or Vicinity: Tanapag

County: Saipan State: MP

Photographer: James Pruitt

Date Photographed: 15 November 2014

Description of Photograph: Engine. Profile view, facing south, 1 m scale.

United States Department of the Interior
National Park Service

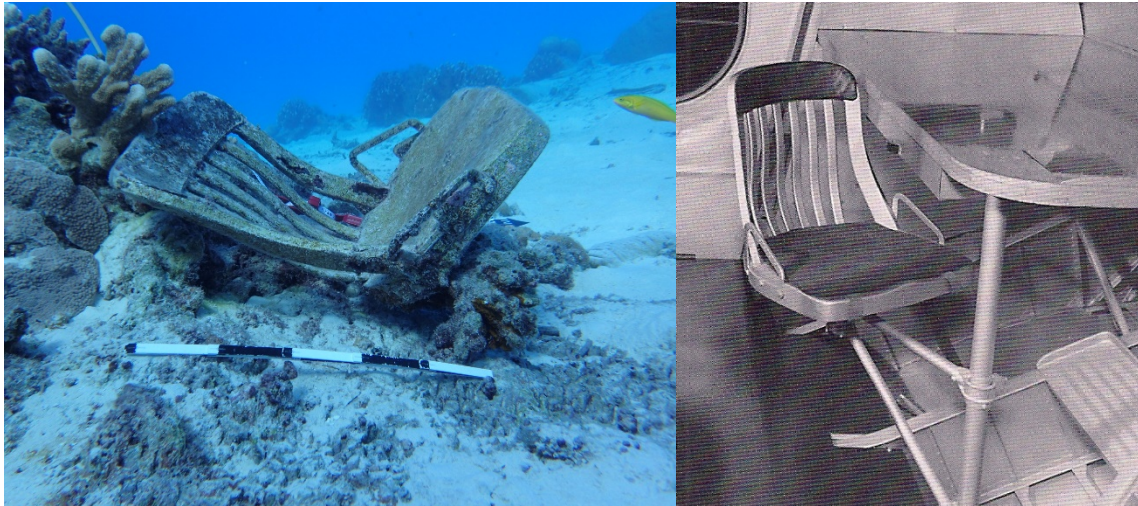
National Register of Historic Places
Continuation Sheet

Tanapag Lagoon Consolidated PB2Y-5R
Coronado BuNo 7070
Name of Property
Saipan, MP
County and State

Section number Additional Information

Page 9

Figure 9



Name of Property: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

City or Vicinity: Tanapag

County: Saipan State: MP

Photographer: James Pruitt

Date Photographed: 15 November 2014

Description of Photograph: *Left*, seat leaning against reef, 50 cm scale. Profile view, facing west.

(Photograph J Pruitt, 18 November 2014). *Right*, seat as installed at navigator's station in XPB2Y-1 (National Archives).

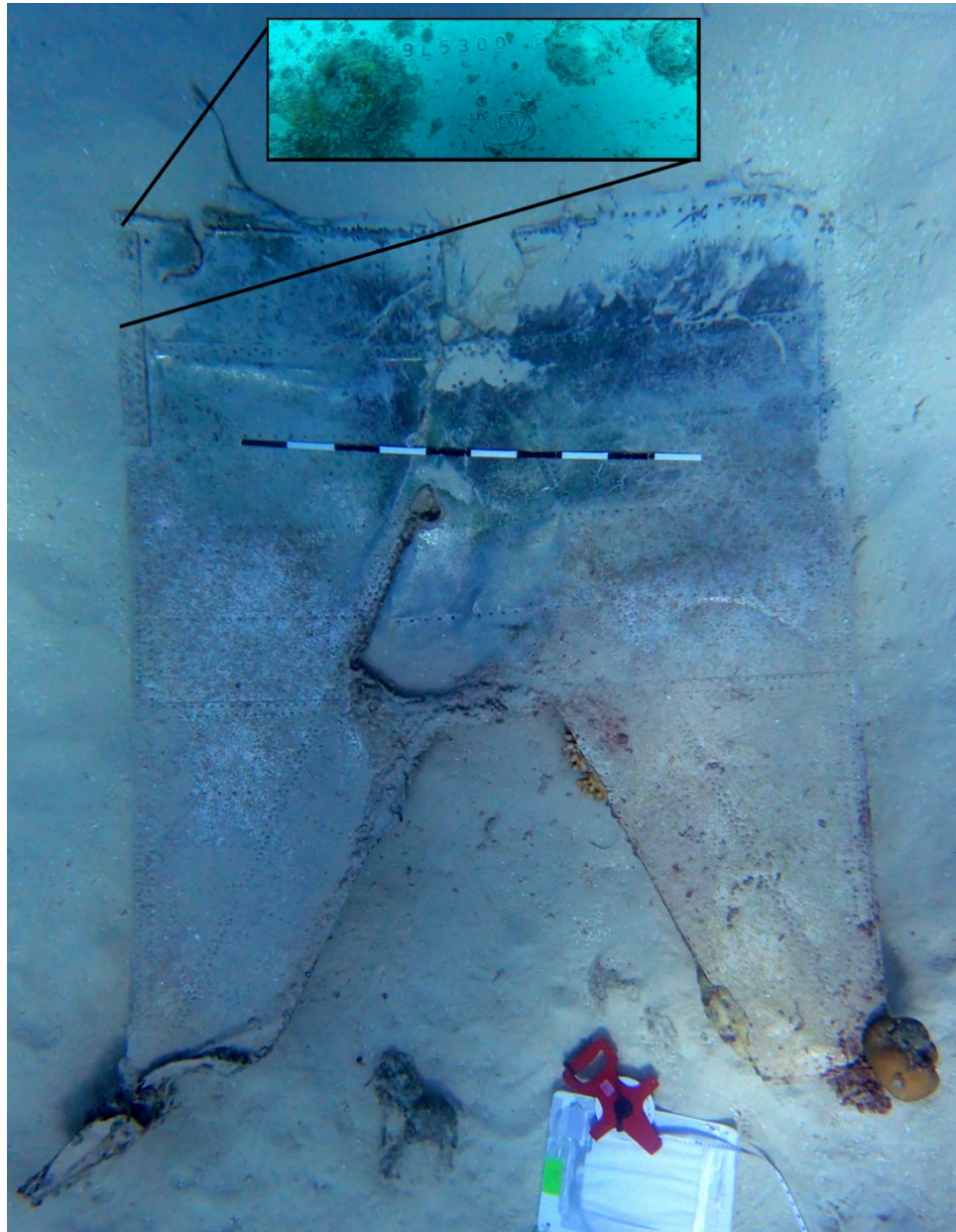
United States Department of the Interior
National Park Service

National Register of Historic Places
Continuation Sheet

Tanapag Lagoon Consolidated PB2Y-5R
Coronado BuNo 7070
Name of Property
Saipan, MP
County and State

Section number Additional Information Page 10

Figure 10



Name of Property: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

City or Vicinity: Tanapag

County: Saipan State: MP

Photographer: James Pruitt and Cos Coroneos

Date Photographed: 15 November 2014 and 24 February 2012

Description of Photograph: Float strut with visible paint. *Inset*, serial number and Consolidated Aircraft Stamp. (Photographs J Pruitt 17 November 2014 and C Coroneos 24 February 2012).

United States Department of the Interior
National Park Service

National Register of Historic Places
Continuation Sheet

Tanapag Lagoon Consolidated PB2Y-5R
Coronado BuNo 7070
Name of Property
Saipan, MP

County and State

Section number Additional Information

Page 11

Figure 11



Name of Property: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

City or Vicinity: Tanapag

County: Saipan State: MP

Photographer: James Pruitt

Date Photographed: 19 November 2014

Description of Photograph: Wing. Plan view, 1 m scale.

United States Department of the Interior
National Park Service

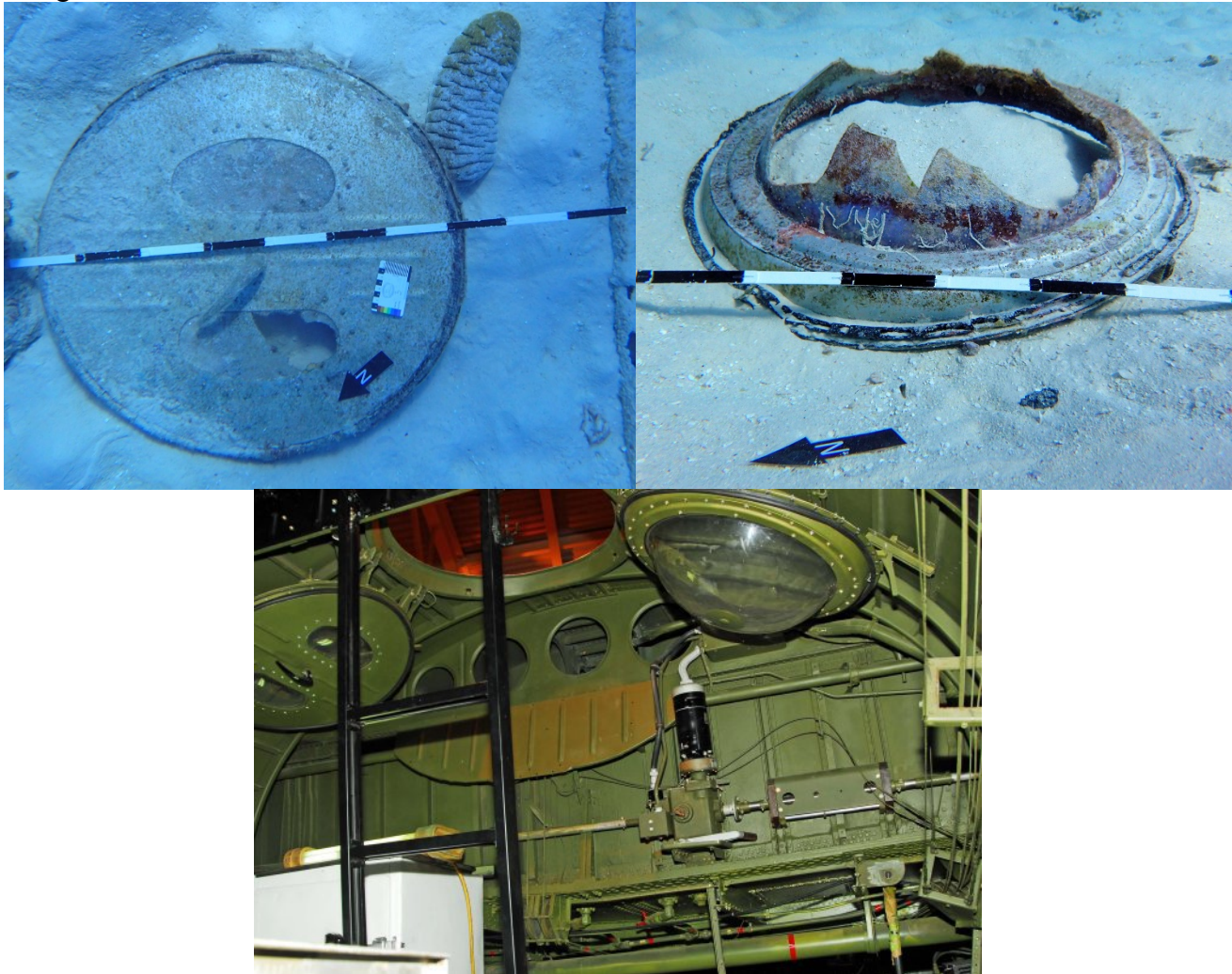
National Register of Historic Places
Continuation Sheet

Tanapag Lagoon Consolidated PB2Y-5R
Coronado BuNo 7070
Name of Property
Saipan, MP
County and State

Section number Additional Information

Page 12

Figure 12



Name of Property: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

City or Vicinity: Tanapag

County: Saipan State: MP

Photographer: James Pruitt

Date Photographed: 18 November 2014 (*top left*), 14 November 2014 (*top right*), accessed 30 December 2014 (*bottom*)

Description of Photograph: *Top left*, Hatch cover, plan view. 1 m scale. (Photograph J Pruitt, 18 November 2014). *Top right*, navigator's astrodome. Oblique view, facing southeast. 60 cm scale. (Photograph J Pruitt, 14 November 2014). *Bottom*, both as installed inside restored PB2Y-5F BuNo 7099. (National Naval Aviation Museum Facebook page, accessed 30 December 2014).

United States Department of the Interior
National Park Service

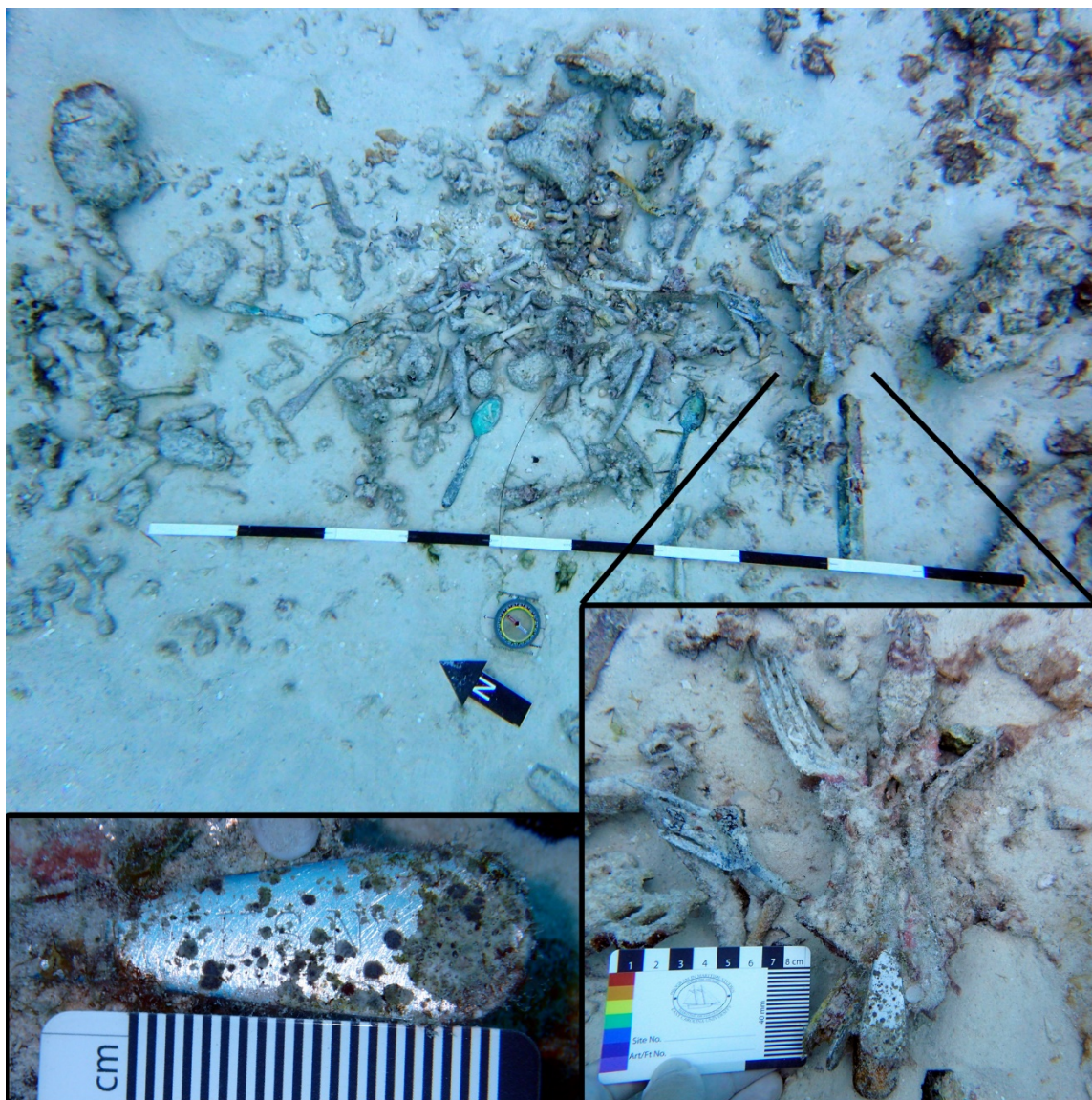
National Register of Historic Places
Continuation Sheet

Tanapag Lagoon Consolidated PB2Y-5R
Coronado BuNo 7070
Name of Property
Saipan, MP
County and State

Section number Additional Information

Page 13

Figure 13



Name of Property: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

City or Vicinity: Tanapag

County: Saipan State: MP

Photographer: James Pruitt

Date Photographed: 8 November 2014

Description of Photograph: Forks and spoons. *Top*, entire scatter, 1 m scale. *Bottom right*, concreted forks, centimeter scale (top) and millimeter scale (right). *Bottom left*, detail of handle inscription, millimeter scale.

United States Department of the Interior
National Park Service

National Register of Historic Places
Continuation Sheet

Tanapag Lagoon Consolidated PB2Y-5R

Coronado BuNo 7070

Name of Property

Saipan, MP

County and State

Section number Additional Information

Page 14

Figure 14



Name of Property: Tanapag Lagoon Consolidated PB2Y-5R Coronado BuNo 7070

City or Vicinity: Tanapag

County: Saipan State: MP

Photographer: James Pruitt

Date Photographed: 20 November 2014

Description of Photograph: Hull section with port anchor hatch, closed, on right side. Hull panels missing on left. Plan view, 1 m scale.