Five Days in June:
The Archaeological and Historical
Legacy of Saipan's Open Ocean Seadrome

By
Geoffrey M. Anthony
May, 2025
Director of Thesis: Dr. Jennifer F. McKinnon, Ph.D.
Major Department: Department of History

ABSTRACT

Saipan's open ocean seadrome was an unconventional and expedient solution to an emergent operational challenge. Operation FORAGER, the invasion of the Northern Marianas, was unexpectedly contested by the Japanese First Mobile Fleet. The United States Fifth Fleet immediately implemented an expedient non-traditional seadrome in the open ocean for emergent long-range searches. It accepted and managed significant operational risk by establishing and operating this atypical seadrome outside a sheltered anchorage — and in harm's way — to support vital PBM-3D Mariner seaplane night Radio Direction and Ranging search operations.

Previous archaeological efforts have yielded a commanding knowledge of the traditional seadrome in Saipan's Tanapag Harbor. Surveys of the captured Japanese seaplane base with existing infrastructure have contributed markedly to the archaeological record. A more thorough effort devoted explicitly to the innovative, high-risk, high-reward implementation of the initial open ocean seadrome and its contribution to the archaeological record has yet to be undertaken.

This open ocean seadrome, established in the opening days of the battle, provided the initial long-range search crucially required for the security of the United States Fifth Fleet. Assessing the impact these patrol planes had on the conduct and outcome of the battle informs an underreported, yet critical, aspect of the Battle of the Philippine Sea. This facility also served as a proof of concept that informed future Pacific seadrome requirements.

Although the exact location of this seadrome remains speculative, archival resources provide the level of geographic fidelity needed to conduct an appropriate archaeological site survey. A PBM-3D maritime patrol seaplane accidentally sank at this anchorage, but without the catastrophic damage and dislocation generally associated with traditional aircraft crashes. Locating, surveying, and recording this aircraft *in situ* would theoretically provide consequential site formation and cultural and environmental impact data.

Other archaeologically significant artifacts may also be present. These artifacts would further contribute to and validate the archaeological record and inform open ocean seadrome operational practices and seaplane tender support activities. The open ocean seadrome was established upon the Saipan Shelf, the invasion's primary amphibious force staging area. The potential for opportunistic incidental artifact discovery should not be underestimated.

This area is approximately 100 feet (31 meters) deep. Search efforts included traditional methods and sought to inform the viability and reliability of leveraging various detection technologies, such as Light Detection and Ranging, adapted for maritime archaeological surveys. Geographic Information Systems software and data were utilized to establish search areas and parameters based on historical records and to assist in mapping the locations of any cultural material associated with the open ocean seadrome. Experimentation with these technologies contributes to their continued development and integration into existing archaeological methods, improving their future effectiveness.

Key Words: Saipan, Battle of the Philippine Sea, seadrome, seaplane anchor, seaplane tender, bowser boat, patrol aircraft, Martin PBM Mariner, Operation FORAGER, VP-16, Pacific Theater, Second World War.

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A Thesis

Presented to the Faculty of the Department of History

East Carolina University

In Partial Fulfillment of the Requirements of the Degree

Masters of the Arts in Maritime Studies

By

Geoffrey Matthew Anthony

Colonel, United States Marine Corps, Retired

May 2025

Director of Thesis: Dr. Jennifer F. McKinnon, Ph.D.
Thesis Committee Members:
Dr. M. Todd Bennett, Ph.D.
Dr. Jason T. Raupp, Ph.D.

DEDICATION

Operation FORAGER was the largest operation of the Pacific War at the time it was executed. The tyranny of geography squarely favored the Japanese with their interior lines of communications and forward bases close to the Marianas. Japanese facilities in the Marianas and at Truk, Yap, and Palau could support Japanese efforts to contest U.S. operations. Consequently, these bases had to be neutralized.

The FORAGER operating area fell squarely in Pacific Fleet Commander Admiral Chester Nimitz's Central Pacific Area of responsibility. Yet, in a display of interservice cooperation, much of the responsibility for neutralizing these bases fell to General Douglass MacArthur's Army Air Forces operating from Southwest Pacific Area bases. The 13th Air Force had recently occupied an advanced base in Los Negros, Admiralty Islands, just north of New Guinea. Four squadrons of heavy bombers from the 307th Bomb Group (Heavy), the fabled Long Rangers, a moniker earned after their extended long-range raids over the open ocean against Wake Island early in the war, began combat operations from there in May 1944.

The 307th participated in attacks on Truk, Yap, Palau, and other Japanese bases to neutralize them in the days and weeks leading up to Operation FORAGER. Their B-24 Liberators were later called upon to fly 1,200 miles (1,931 kilometers) search routes to help locate the recently sortied Japanese First Mobile Fleet to protect the invasion force's southern flank once the Battle of Saipan commenced on 15 June 1944. Following the defeat of the Japanese Navy during the Battle of the Philippine Sea, the Long Rangers returned to attacking targets in the Caroline Islands in continued support of Operation FORAGER and in anticipation of future offensive operations.

On 10 August 1944, the same day the Battle for Guam concluded, ending the Southern Mariana Islands campaign, a B-24J (44-40571) from the 371st Bomb Squadron, 307th Bomb Group (Heavy), 13th Air Force took flight from Mokerang Airdrome, Los Negros, Admiralty Islands to deliver a strike against Colonia, the capitol of Yap Island. Separated from its flight by weather en route, it still pressed the attack after a belated arrival at the target. It did not return. Post-war research and interviews suggest it was destroyed over the target area by anti-aircraft fire. The Japanese plucked two surviving crew members from the island's barrier reef, although they went missing during their captive transit and remain unaccounted for. The other nine members of the crew, including an observer who was also flying that day, are presumed to have gone down with the Liberator, reported by witnesses to have crashed into Colonia Harbor, where they remain.

Although this scene played out in various forms countless times throughout the war, this specific event holds special meaning to the author. The pilot of this Liberator was 24-year-old Don Alpheus Anthony from Punxsutawney, Pennsylvania. This thesis is therefore dedicated in memory of my grandfather, First Lieutenant Anthony, and his crew, killed in action on 10 August 1944 while conducting combat operations in the Caroline Islands (FIGURES i, ii, & iii).

Although you remain far from home, you are not forgotten.

FIGURE i (top): Second Lieutenant Don A. Anthony, United States Army Air Force, (top left) and crew posing in front of the 307th Bomb Group's storied B-24D F*renesi* (42-40323), the first Pacific Theater bomber to reach 100 combat missions. Lieutenant Anthony piloted this bomber on its 98th mission, sustaining battle damage that required landing with a destroyed main mount landing gear. (bottom): Lieutenant Anthony (bottom left), and crew in front of a B-24 bomber (Photos courtesy Anthony family).


FIGURE iii: Aviation Cadet Don. A. Anthony, U.S. Army Air Force. (Photo courtesy Anthony family).

ACKNOWLEDGEMENTS

I want to thank the East Carolina University Department of History and Department of Maritime Studies staff. I welcomed with enthusiasm the level of dedication and professionalism exhibited by the whole of the academic cadre. I must single out for gratitude, first and foremost, Dr. Jennifer McKinnon. My first unknowing exposure to her work was when I purchased a copy of *Underwater Archaeology of a Pacific Battlefield: The WWII Battle of Saipan*. As an interested career Marine and aspiring maritime archaeologist, I remember coming away overwhelmingly impressed, yet wondering who would put this level of Yeoman's work into a relatively obscure battle so central to United States Marine Corps lore. I count myself lucky to have found out firsthand.

As my thesis advisor, Dr. McKinnon has shown unrelenting patience, allowing me extraordinary latitude as a non-traditional student. She permitted me to explore flights of fancy in my research and thesis writing before serving as the needle to the Pole, and gently guided me back to True North. As a mentor and Defense Prisoner of War/Missing in Action Accounting Agency project lead, she exhibited all the leadership traits and management skills that would have made any Marine Corps officer proud. She has my eternal thanks.

Dr. Jason Raupp, a thesis committee member with whom I had too few classes, also provided exceptional guidance in my studies. He was a steady hand, a continuous source of enthusiasm for the community, and a tremendous collaborator as I progressed through the program. Dr. M. Todd Bennett, who graciously offered to serve on my thesis committee despite limited contact with me, is a source of inspiration for his professional accomplishments. His love and command of history and prolific publishing record serve as an inspiration for my future. Finally, Dr Nathan Richards, the Chair of the Department of Maritime Studies and instructor extraordinaire, typifies what it is to be an underwater archaeologist. His sage counsel and eternal availability to his students for all things, big and small, have made him a community pillar. I am grateful to have had the opportunity to receive his tutelage.

I would be remiss if I did not thank others who have made the program the envy of the maritime studies world. Mark Keusenkothen and Ryan Bradley introduced me to a more disciplined, scientific, and safe diving methodology, doing their best and mostly succeeding in breaking my many decades-old habits. The program would not be what it is if not for their efforts.

I am obliged to Aleck Tan. Without her assistance and expertise in Light Detection and Ranging, and Geographic Information Systems, survey efforts in Saipan would not have occurred effectively.

Finally, I would like to express my heartfelt appreciation to my fellow students for tolerating a “peer” thirty years their senior. Their willingness to assist me with my many technical challenges made my progress in the program much more manageable. I am heartened to see their competence and commitment, and I am assured that the community's future is in good hands.

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LIST OF ABBREVIATIONS

AAF	Army Air Force
AK	Cargo Ship
AKA	Attack Cargo Ship
AK	Cargo Ship
AP	Transport Ship
APA	Attack Transport Ship
ASW	Anti-Submarine Warfare
AUV	Autonomous Underwater Vehicle
AV	Large Seaplane Tender
AVD	Destroyer Seaplane Tender
AVP	Small Seaplane Tender
BB	Battleship
CAP	Combat Air Patrol
CIC	Combat Information Center
CNMI	Commonwealth of the Northern Marianas
CTG	Commander, Task Group
CVL	Aircraft Carrier, Light
DD	Destroyer
DE	Destroyer Escort
DPAA	Defense POW/MIA Accounting
DUKW	2.5-ton Six-Wheel Amphibious Truck (Based upon Manufacturing Code)
ECU	East Carolina University

FDC	Fighter Direction Center
FPAN	Florida Public Archaeology Network
GIS	Geographic Information Systems
HF	High Frequency
HPO	Historic Preservation Office
IFF	Identification, Friend or Foe
IJN	Imperial Japanese Navy
JATO	Jet Assisted Take Off
LiDAR	Light Detection and Ranging
LCC	Landing Craft, Control
LCDR	Lieutenant Commander
LCI	Landing Craft, Infantry
LCVP	Landing Craft, Vehicle, Personnel
LOD	Line of Departure
LSD	Landing Ship, Dock
LST	Landing Ship, Tank
LT	Lieutenant
LVT	Landing Vehicle, Tracked
LVT(A4)	Landing Vehicle, Tank
MDSU	Mobile Diving Salvage Unit
NAAS	Naval Auxiliary Air Station
NAS	Naval Air Station
NATS	National Air Transport Service

NHHC	Naval History and Heritage Command
OSU2	Observation Seaplane, United Aircraft Division
PATSU	Patrol Aircraft Service Unit
PBEC	Pacific Basin Environmental Consultants
PPC	Patrol Plane Commander
RADAR	Radio Direction and Ranging
RADM	Rear Admiral
ROV	Remotely Operated Vehicle
SOPA	Senior Officer Present Afloat
SS	Submarine
TFD	Task Force Dagger
UDT	Underwater Demolitions Team
UN	United Nations
U.S.	United States
UXO	Unexploded Ordnance
VADM	Vice Admiral
VF	Fighter Squadron
VP	Patrol Squadron

PROLOGUE

On 4 May 1944, submarine USS *Flying Fish* (SS-229) efficiently slipped its berth in Mujaro, Marshall Islands, escorted out of the harbor by the new destroyer escort USS M*anlove* (DE-36), and proceeded west toward the Philippines. So began the veteran boat's tenth war patrol. Six weeks later, it was on patrol 12 miles (20 kilometers) north northeast of the San Bernadino Straits lighthouse. This was an optimal position to detect and intercept vessels using this route to transit from the relatively enclosed Samar Sea to the open Philippine Sea to the east. Its placement was intentional (*Flying Fish* 1944:2).

As the United States prepared to execute Operation FORAGER, the invasion of the Marianas Islands, they needed reliable information on any Japanese naval efforts to contest them. The Navy had set up a robust submarine picket line to collect this vital information. *Flying Fish*, part of this picket line, detected heightened Japanese naval air patrol activity near the Straits at 0630 on 15 June 1944. Nine hours later, the submarine observed two Jake (Aichi E13A) long-range patrol seaplane aircraft "suspiciously staying to the SE near Biri Head on the east channel." Hedging east in their direction, it soon observed additional aircraft, possibly carrier-based, at 1633. Two masts were spotted through the periscope just thirteen minutes later. *Flying Fish* closed the distance at high speed to establish the identity of the surface contacts.

The faraway masts quickly developed into a large Japanese task force, assessed as an "estimated three carriers, three battleships, several cruisers and destroyers"(*Flying Fish* 1944:19). The enemy fleet was heading 080°, almost directly away from the U.S. submarine, at 20 knots. *Flying Fish* could not develop an attack solution or even shadow this enemy force because of the shallow water (<100 ft./31 m) and even shallower nearby banks. Regardless, the submarine surfaced and sent a contact report an hour after losing contact (*Flying Fish* 1944:19).

This report, in conjunction with a previous sighting by USS *Redfin* (SS-272) and later reports by USS *Cavella* (SS-244) and USS *Sea Horse* (SS-304), began a series of events that culminated in one of the most significant naval actions of the war (Morison 1953:237, 241). The Battle of the Philippine Sea demolished what was left of the Japanese naval air forces, further hobbled the Japanese Combined Fleet, and paved the way for follow-on U.S. operations against the Empire of Japan. This action left an extraordinary historical legacy that has been studied and evaluated even before the after-action report ink dried. It also left an unparalleled archaeological legacy that has only received similar attention in recent decades, much of which still awaits discovery.

CHAPTER 1: INTRODUCTION

Before beginning this archaeological and historical journey, it is essential to establish a baseline knowledge regarding the island of Saipan, previous archaeological activities, and existing resources available to the contemporary scholar. More important is to present what and why questions this thesis seeks to answer – essentially its *raison d'être*. These issues, and more, are addressed presently.

1.1. HISTORY OF SAIPAN

Saipan, a once peaceful and nondescript Pacific Island, was thrust into the global spotlight by the great contest between Japan and the United States (U.S.) It became one of the most brutal killing fields of a particularly vicious war, upon which hinged hope for ultimate victory by both belligerents. The Japanese viewed it as part of the "Absolute Defense Sphere" that must be defended at all costs (Drea 1998:187). The U.S. recognized it as the key to breaching the inner Japanese defense perimeter, with Admiral Ernest King, Commander in Chief, U.S. Fleet and Chief of Naval Operations himself, championing the plan to seize them, arguing, "The Marianas are the key of the situation because of their location on the Japanese line of communication" (Crowl 1960:6–7). Admiral King found an unlikely ally in the fledgling Army Air Force (AAF), which desired Saipan as a base for strategic bombing. AAF planners asserted, "plans for the acceleration of the defeat of Japan would place emphasis upon the seizure of the Marianas at the earliest possible date, with the establishment of heavy bomber bases as the primary mission" (Crowl 1960:12).

Although the Marianas gained newfound significance due to their central strategic location in the Pacific, they had been under colonial occupation since they were "discovered" by Ferdinand Magellan in 1521. The island group was alternately known throughout history originally as “Islands of the Lateen Sails,” then derisively as “Islands of the Thieves” due to misunderstandings regarding the communal view the Chamorro peoples held regarding personal property. Then, finally, as “The Marianas,” today’s naming convention, in tribute to Spain’s Queen Mariana (Hallas 2019:4–5). Spain spent the three hundred years following Magellan’s discovery primarily concerned with converting the Chamorro people to Catholicism. This process, combined with disease and draconian suppression of rebellion, dramatically reduced the original inhabitants' numbers from 45,000 to just 5,000 by 1693 (Denfeld 1997:1).

After the U.S. defeated Spain in the Spanish-American War, Guam was occupied as a coaling station in 1898. Spain was allowed to sell the rest of the Marianas to Germany for $4.5 million (Hoffman 1950:12). German control was quickly extinguished after the Japanese declared war on them in 1914 during World War I as a pretext to seize German possessions in the Pacific. Japanese possession was validated in 1920 by a mandate from the United Nations (UN), allowing for their administration of all islands in the Marianas group except for Guam, which the U.S. still occupied. Japanese occupation revolutionized the sugar industry in Saipan and witnessed a massive influx of Japanese citizens, especially farmers from Okinawa. Thus,

> The population in 1936 was reported to be about 23,800, the greater part being Japanese with the remained mostly Chamorros, Koreans, and Kanaka natives. In 1941, the civilian population was estimated to be between 30,000 and 35,000. Garapan, the principal town located on the west coast just south of Tanapag Harbor, was estimated to have a population of about 10,000. (CINCPAC 1944:46)

Beyond this broad pre-war historical overview, the optimal way to describe and assess the Marianas, and Saipan in particular, is through the eyes of the U.S. operational planners to highlight their importance to both combatants. The Marianas Group, of which Saipan is just one of 15 islands, extends 450 miles (mi.) (724 kilometers [km]) from north to south in an evenly shaped arc. The northern islands, except for Pagan, were of limited military significance. The southern islands are raised coral formations with volcanic cores, consisting of Saipan, Tinian, Rota, and Guam, and were “important bases in the Japanese island defenses and communications” (CINCPAC 1944:45). Saipan, the second largest island in the Marianas Group, was the principal Japanese position in the area and was thus selected as the first objective for capture. This island is approximately 12.5 mi. (20 km) long, oriented from the northeast to southwest, and has a maximum width of 5.5 mi. (9 km) (CINCPAC 1944:44–45). Although wartime planners believed it encompassed approximately 72 $mi.^2$ (116 km^2), a more accurate contemporary assessment is 47 $mi.^2$ (76 km^2) (Hallas 2019:4).

The terrain is generally mountainous but has considerable arable land dedicated to sugar cultivation. The critical terrain of the island is a mountain ridge stretching about 7.5 mi. (12 km) down the center of the island. Mount Tapotchua is the most prominent feature, located almost in the center of the mountain ridge, its highest point towering 1,554 ft. (474 m) above the island. The sides of the northern mountain ridge are broken up into numerous terraces separated by rocky cliffs. Abundant ravines characterize the southern mountain ridge. Caves and mountain caverns are ubiquitous. Moving further south and southeast away from Mount Tapotchua, mountain ridges give way to the flat plateaus, punctuated by several steep breaks, that comprise the island’s eastern peninsula. On the west side of the island, between Garapan and Agingan Point, rests a low and poorly drained coastal plain with a small lake and swampy ground. Areas of land not being cultivated were generally wooded or covered in scrub (CINCPAC 1944:45–46).

Saipan’s approximate 40 mi. (64 km) of coastline is characterized by steep, rocky cliffs on the north, east, and south coasts and is unsuitable for landings. In contrast, the island's western side has sandy beaches for most of the island’s length, with gently sloping terrain extending 500 to 5,000 yd. (457 to 4,570 m) inland. A protective barrier reef and prevailing easterly trade winds ensured generally light surf conditions on the western coast. Beyond the barrier reef is a shallow shelf that extends a considerable distance offshore. The Saipan Shelf, with depths of less than 20 fathoms (ftm.) (120 ft./37 m), provided an exceptional anchorage and operating area for a substantial number of ships (CINCPAC 1944:46–47). Unanticipated by U.S. Navy planners, it also served as a mooring area for PBM-3D Mariner seaplanes.

As the clouds of war gathered in the 1930s, much of the Japanese effort shifted from sugar cultivation to military infrastructure, with a heavy emphasis on airfield construction development in defiance of their UN mandate (Denfeld 1997:6). Consequently, on the eve of the invasion, there were three airfields on Saipan. Aslito Field in the south was the most important and capable, with hangars and major repair facilities. Two other strips, one in the west near Chalan Kanoa and one in the north near Marpi Point, were small with limited facilities. The Japanese military also realized the potential for seaplane operations, and constructed a seadrome in Tanapag Harbor on the west coast, complete with two seaplane ramps, barracks, shops, warehouses, and three steel hangers (Denfeld 1997:9). This small harbor could accommodate as many as twelve ships or more and served "as a fueling and supply station for ships en route to and from the Empire" (CINCPAC 1944:46).

Intelligence estimates as late as 29 May 1944 identified "12 coastal defense guns, 5 dual-purpose single mounts, 30 or more heavy anti-aircraft guns, 90 or more medium anti-aircraft guns, and numerous machine guns" (CINCPAC 1944:47). Post-battle assessment later determined this represented just a fraction of the heavy artillery Japan had at its disposal on Saipan. Only a third of their heavy weapons were mounted and prepared for combat; the rest were victims of the earlier-than-anticipated arrival of the invasion and an effective submarine campaign that choked Saipan of desperately needed defensive construction materials (CINCPAC 1944:46). U.S. planners underestimated the number of Japanese defenders. They were surprised to learn later that 29,702 Japanese servicemen from all branches were present to contest their conquest of Saipan (Hoffman 1950:17).

In June 1944, a supporting campaign was aggressively implemented to isolate the Marianas and disrupt or destroy enemy land-based air capability within the amphibious objective area. On the morning of 15 June 1944, two reinforced Marine Corps divisions, the Second and Fourth, stormed ashore over four beaches in the southwest portion of the island. Resistance was fierce. The Army's 27th Infantry Division, acting as the floating reserve, was committed to the fray to support the Marine attack and remove them from harm's way once it was learned the Japanese First Mobile Fleet had sortied.

Despite being largely unprepared for this contingency, Vice Admiral (VADM) Spruance and the Fifth Fleet reacted swiftly in anticipation of a climactic battle at sea. A detachment of Patrol Squadron (VP) 16's new-to-theater PBM-3D Mariner patrol planes was ordered to Saipan and anchored on the congested Saipan Shelf in an open ocean seadrome to provide long-range Radio Direction and Ranging (RADAR) surveillance for the fleet. A Mariner from this detachment detected the Japanese fleet at extended range, but a communication problem thwarted their efforts to provide a contact report until after their return. The U.S. Navy lost the initiative but, thanks in part to the late report, was prepared for the coming aerial assault.

The Fifth Fleet absorbed wave after wave of Japanese aerial attacks but broke the back of the Japanese naval air arm during the ensuing "Great Marianas Turkey Shoot." A risky evening U.S. maximum-range carrier counterattack, the "Mission Beyond Darkness," severely damaged the Japanese fleet. Still, prudence demanded that the carriers remain near the invasion fleet to protect them adequately, so aggressive pursuit was not an option. The Battle of the Philippine Sea ended as the bloodied but intact Japanese fleet escaped to the west.

Ashore, combat continued to rage unabated. Progress was painfully slow, but the Marines and soldiers made steady gains directly enabled by overwhelming U.S. firepower. They cleared most of the island and pushed Japanese resistance into a pocket of defense in the northern portion of the island. Then, in the early morning darkness of 7 July 1944, the remnants of the Japanese garrison committed to a final full-scale bonsai charge known as a *gyokusai* (Cabrera 2015:21–22). Despite a spirited defense, the gyokusai quickly overran two Army 27th Infantry Division battalions. This attack culminated in front of the tubes of the 10th Marine's 155mm artillery pieces and collapsed. Although organized Japanese resistance on the island ended, mopping-up operations continued for many months. The Battle of Saipan was over.

That Saipan is not more prominently known is likely due to the timing of the invasion. Just nine days before the Marines stormed ashore, Operation OVERLORD, the long-anticipated Allied invasion of Europe, commenced. All eyes were on the decisive battle shaping the war against Germany. This does not diminish the criticality of the conquest of the Marianas in any way. After the Battle of Saipan ended, the U.S. had its coveted airfield, and B-29 Superfortresses began striking Japan from Isley Field (formerly Japan's Aslito Field) in November 1944 (Hallas 2019:458). The neighboring island of Tinian played host to the B-29s that delivered the first — and only — nuclear weapons ever used in war. As the U.S. celebrated its victory in the Marianas, the Japanese lamented defeat and recognized the full scope of their loss. Premier Tojo remarked, "Japan has come to face an unprecedently great national crisis" that ultimately toppled his military faction. Yet Fleet Admiral Osami Nagano best summarized Japanese sentiment when he said of the loss of the Marianas, "Hell is upon us" (Crowl 1960:1).

1.2. PREVIOUS ARCHAEOLOGICAL EFFORT

Given the historical significance of Operation FORAGER, especially the Battle of Saipan component, there has been no shortage of recent archaeological efforts dedicated to rediscovering, documenting, and interpreting the past. This includes numerous archaeological surveys beginning in the 1980s through today. These projects ranged from National Park Service (NPS) surveys, surveys directed at master's theses, Commonwealth of the Northern Marianas (CNMI) Historic Preservation Office (HPO) efforts, and others (Thomas and Price 1980; Miculka and Manibusan 1983; Miculka et al. 1984; Carrell 1991; Pacific Basin Environmental Consultants (PBEC) 1985; Burns 2008a; Burns 2008b; Guerrero 1987; Bell 2010; McKinnon and Carrell 2011; DeFant 2012; McKinnon and Carrell 2014; Pruitt 2015; and Adamson 2020).

Due to the submerged lands mandates of the NPS, HPO priorities on heritage tourism, and the prolific quantities of archaeological and culturally significant materials inshore, previous efforts focused almost exclusively on Tanapag and Garapan Lagoons near Tanapag Harbor and Flores Point seaplane base areas. Consequently, little effort has been dedicated to locations beyond the reef and deeper water, such as the Saipan Shelf. Even as the near-shore archaeological site surveys continue, attention may shift to places beyond the barrier reef. As such, this thesis turns its attention west across Saipan's barrier reef and makes an inaugural archaeological effort in deeper water.

1.3. LITERATURE REVIEW

A historiography and literature review of the immense body of work addressing the Pacific War reveals extraordinarily little contributory material regarding the employment of seaplanes during Operation FORAGER. Books addressing the war's operational and strategic levels are almost voiceless concerning long-range seaplane searches during the Battle of the

Philippine Sea. Alternately, they extensively address concurrent search efforts by the established submarine screen, Task Force 58's short-range carrier search efforts, and even the intelligence community's efforts to intercept, decipher, and direction find Japanese radio transmissions.

Biographies of the key U.S. leaders during the battle, which one could expect to address all the resources these leaders employed broadly, and efforts made to find, fix, and destroy the Japanese fleet, are similarly silent on the issue. VADM George Carroll Dyer wrote the two-volume biography on VADM Richmond Kelly Turner, Commander, Joint Expeditionary Force, Task Force 51, including his actions during Operation FORAGER, at the behest of Rear Admiral (RADM) Ernest "Judge" Eller, then acting as Director of Naval History, Naval History Division (Dyer 1972). *The Amphibians Came to Conquer* does not mention the activities of seaplanes or seaplane tenders during the Saipan campaign, even though VADM Turner was personally responsible for ensuring that USS *Ballard* (AVD-10), a destroyer seaplane tender that provided initial support for seaplane operations at Saipan, was initially present with the invasion fleet. E.B. Potter's (1976) definitive biography of Admiral Chester Nimitz, eponymously titled *Nimitz*, also speaks extensively regarding the contributions of submarines, carrier aircraft, and intelligence efforts but capriciously omits any reference to PBM Mariner activities or observations.

Thomas Buell's (1974) biography, *The Quiet Warrior,* about VADM Spruance, the man responsible for the conduct of the Fifth Fleet during the Battle of the Philippine Sea, does a more thorough, yet still subdued, job of addressing the participation of VP-16 PBMs during this campaign. Buell speaks to Admiral Spruance's direction to VADM John Hoover, Commander, Central Pacific Forward Area, and Pacific Ocean Area, to deploy long-range seaplanes to Saipan in response to *Flying Fish*'s detection of the Japanese fleet passing through San Bernadino

Straits. After a follow-on sighting by submarine *Sea Horse*, Buell states, “Hoover was to send the long-range seaplanes to Saipan to begin immediate searches to the west” (Buell 1974:263). A third and final mention of long-range seaplanes communicated VADM Spruance’s annoyance at receiving the VP-16 sighting report eight hours late.

Ronald Spector (1985), well regarded for his definitive single-volume account of the Pacific War titled *Eagle Against the Sun*, commits only a single sentence: “A contact report by a long-range flying boat which had found the Japanese fleet an hour after midnight never reached Task Force 58” to the subject (Spector 1985:309). This statement is misleading. The contact report reached VADM Spruance, albeit eight hours late, but still in time to provide a warning that helped the U.S. fleet anticipate and prepare for the coming Japanese onslaught.

In a later book, *At War at Sea*, Spector (2002) omits any reference to the seaplanes’ participation in the Battle of the Philippine Sea. More egregious is his statement that no air search occurred during the night of 20 June 1944. Following the Great Marianas Turkey Shoot and the Mission Beyond Darkness, the U.S. admirals allowed their Task Force 58 pilots much-needed rest following a day of particularly grueling combat. While they slept, six RADAR-equipped PBM-3D Mariners were again prowling the vast Pacific expanses, searching for the enemy fleet to allow morning strike targets for the rested carrier pilots. Although those searches were unsuccessful, Spector again inadvertently leaves the reader with a false impression that materially misconstrues the conduct of the battle.

In his definitive book *Combined Fleet Decoded*, John Prados (1995) focused on the U.S. intelligence efforts against the Japanese. He addressed radio intercepts and direction-finding activities during the Battle of the Philippine Sea. He singles out naval vessels, saying “American submarines complemented the radio intelligence units” as supporting these intelligence activities

(Prados 1995:570). He also communicated that the Japanese, in their eastward transit, made sure to remain clear of the search radius of long-range B-24 Liberators based in Manus in the Admiralty islands (one of which, a B-24 from the 371st Bomber Squadron, 307th Heavy Bombardment Group, 13th Air Force was piloted by Lieutenant Anthony). Yet, in a glaring omission, he inexplicably makes no mention of the detachment of PBM-3D Mariners that moved forward to Saipan expressly to fill the gap in long-range aerial search requirements.

Volumes that address the Japanese perspective of the war and dedicate copious pages specifically to the Battle of the Philippine Sea as a pivotal engagement are similarly silent on the issue of U.S. long-range patrol plane capabilities and operations. John Toland's (1970) *The Rising Sun*, and especially Paul Dull's (1978) *A Battle History of the Japanese Navy*, speak to Japanese battle plans that relied upon their longer-range carrier aircraft and ability to operate from nearby bases such as Truk, Yap, Guam, and Rota to provide them with the naval search advantage with which to seize the operational initiative. Attention is given to Japanese considerations regarding the risk of enemy submarine or carrier-based search aircraft detection. Yet, their planning calculus seemingly never addressed the potentiality of U.S. long-range seaplane search aircraft. Likely, they felt confident their adversaries could not forward deploy long-range search aircraft to an unprepared expeditionary location during the height of combat operations. If so, their confidence was misplaced.

Samuel Eliot Morison (1953) stands alone amongst the preeminent authors of the Pacific War in his thorough treatment of the long-range seaplane participation and contribution to the Battle of the Philippine Sea. In *Volume VIII*, *New Guinea and the Marianas*, of his *History of United States Naval Operations in World War II* series, he details the decision to deploy PBM aircraft from Eniwetok to the open ocean seadrome off Saipan (Morison 1953). He goes on to address the extreme operational challenges these aircraft endured while executing their mission from their atypical anchorage and friendly fire hazards faced by allies unaccustomed to seaplanes, especially the new arrival and unfamiliar PBM Mariner, operating in the forward area during an amphibious assault without a prepared seadrome. Most importantly, Morison goes into detail in addressing the potential campaign-changing detection of the Japanese fleet and subsequent communications failure by one of these aircraft on the eve of the battle. No other text speaks to the operational challenges regarding the deployment or provides this context, as does Morison's (1953).

Other volumes dedicated to the operational and tactical execution of the battle fare no better in their attention to the PBM issue. In his book *Battles of the Philippine Sea*, VADM Charles Lockwood (1967), who served as Commander, Submarines, Pacific Fleet, during the war, addresses only the unreceived contact report provided by PBM pilot Lieutenant (LT) Arle, absent amplifying information.

In *Red Sun Setting* (1981), William Y'Blood does a better job of addressing the searches conducted by the PBMs on the night of 17–18 June 1944 and again focuses extensively on the missed contact report on the night of 18–19 June 1944. Interestingly, on this book's end sheet art is a Task Group 58.1 Combat Information Center chart that depicts a friendly fire engagement in which a division of F6F Hellcats attacked a returning PMB just west of Guam. The chart entry reads, "Coke 1 attacked PBM 2V2U by mistake and heavily damaged it" (Y'Blood 1981:end sheet). This engagement played a critical role in creating the conditions for the subsequent loss of the aircraft central to this thesis. However, no other Task Force 58 information regarding the incident has yet been located.

The passage of time, enhanced availability of primary source documents, and previous academic work on the subject have not positively impacted this imbalanced perspective. Evan Mawdsley's (2024) *Supremacy at Sea*, dedicated to Task Force 58 operations, lacks information regarding seaplane activities in the Marianas despite devoting 71 pages to operations there.

Other books that aim to address the air war in the Pacific holistically are also scant on details regarding the services provided by seaplanes. Barrett Tillman's (2011) *Whirlwind: The Air War Against Japan 1942-1945*, a decidedly AAF-centric book, devotes a scant 4 of 336 pages to seaplane operations; these exclusively address their activities in terms of their ability to rescue the aircrew of fighters and bombers lost in combat. Eric Bergerud's (2000) *Fire in the Sky: The Air War in the South Pacific* is also painfully short on information regarding seaplane operations, never once so much as mentioning the PBM Mariner, an indispensable component of the Navy's seaplane fleet, despite being a 723-page tome.

Although hundreds of books are devoted to aviation operations during World War II, just three are dedicated to holistic seaplane operations during this conflict. Michael Kammen penned two of these at the request of the Navy's Research Division of the Bureau of Aeronautics. These are the paired *Operational History of the Flying Boat*, one addressing selected campaigns in the Pacific (1959) and the other European operations (1960). The last title considered is David Bruhn's (2019) *Eyes of the Fleet: The U.S. Navy's Seaplane Tenders and Patrol Aircraft of World War II*. This relative newcomer comprehensively accounts for Pacific theater-wide seaplane operations.

There is a glaring gap in the literature associated with World War II seaplane operations and the employment of VP-16 PBM-3D Mariners during the Battle of the Philippine Sea. Beyond the general omissions of their presence, this inattention of the subject sows a mistaken perception of when and how they were employed. Indeed, the almost singular focus on the failed contact report gives the impression that not only were these aircraft ineffective in a search role, but even when successful, their crews could not convey this critical information properly. Except in two notable cases, Morison's (1953) *New Guinea and the Marianas* and Y'Blood's (1981) *Red Sun Setting*, there is a complete lack of context regarding the unplanned immediacy of the deployment, the insufficient seaplane tender support, or the extraordinarily harsh operating environment these aircraft were thrust into. In this case, context is everything. Only by closing these gaps in the existing literature can the actual contributions of VP-16's deployment to Saipan be understood and properly appreciated.

1.4. RESEARCH AIMS AND QUESTIONS

This thesis strives to help close gaps within the existing literature by answering one primary and four supporting research questions:

1. What conditions and characteristics led to the innovative establishment of the open ocean seadrome, and what contributions did it and the aircraft it supported have to the Battle of the Philippine Sea and the overall war effort?

1.1. How effective was the seaplane tender support in the open ocean seadrome, and how did it influence future seaplane tender operations?

1.2. What archaeological remains, if any, of Saipan's original open ocean seadrome still exist?

1.3. What can the archaeological investigation of the bowser boat, anchorages, and PBM Mariner Bureau Number (BuNo) 48173 communicate regarding the operations within the open ocean seadrome?

1.4. How can site formation studies of the BuNo 48173 deep-water wreck contribute to understanding World War II seaplane operations?

Addressing these questions will explore the underrepresented contribution of seaplanes and seaplane tenders during the opening stages of Operation FORAGER. It will set the conditions to locate and archaeologically survey what remains of an atypical seadrome explicitly established to support this operation and how it was operated and optimally lead to the discovery of the wreckage and remains of a PBM-3D Mariner, a refueling bowser boat, and residual anchorage.

These artifacts represent an enduring archaeological legacy created in just five days during June 1944. Finding them will enhance and contextualize a deeper understanding of the Battle of the Philippine Sea and the war material involved in this event. Due to the unique circumstances surrounding the loss of this aircraft, it will also have an outsized impact on our understanding of site formation theory. The use of innovative new technology in searching for this site is also important for the continued evolution of maritime archaeology as a discipline.

Equally important is evaluating the impact of the open ocean seadrome on the historical record. Although exceptionally well documented, the Battle of the Philippine Sea remains highly controversial due to some decisions made by some United States commanders during the battle, namely in not being more aggressive in prosecuting attacks on the Japanese and willfully ceding the initiative to them. Understanding the contribution, or lack thereof, by the patrol planes operating from the open ocean seadrome materially contributed to the mindset and decision-making by these commanders. This misunderstood aspect of the battle and its impact on its conduct shed a brighter light on this still controversial subject. Achieving this thesis’s goals will enhance and contextualize this culturally significant site's archaeological and historical legacy.

1.5. HISTORICAL AND ARCHIVAL RESEARCH

Given the lack of secondary source information regarding the experience of VP-16 and their PBM-3Ds during Operation FORAGER, as discussed in the literature review, a determined effort to research primary sources was required. Much of this could be accomplished online via the digital military record database Fold3. The National Archives have done an exceptional job digitizing and making available to the public the prolific primary source documents, many of which were relied upon heavily while conducting research for this thesis. Primary source documents were prioritized, although secondary sources added context or corrected the record based on new information.

Chief among these were unit diaries and histories of U.S. squadrons, most notably VP-16, whose sunken Mariner is the focal point of this thesis, and supporting vessels and commands. Operational and attack orders regarding Operation FORAGER writ large, as well as those specific to the invasion of Saipan (Operation TEARSAIL), provided invaluable information governing the planning and conduct of the invasion. Similarly, after action reports were extensively reviewed. The National Archives is a trove of quality images from the Battle of Saipan, and many found their way to these pages, which visually reinforced some of the discussed concepts. Finally, a review of captured Japanese intercepts and intelligence rounded out this effort. A mosaic of information emerged from these documents that, when combined, formed a sum greater than its component parts.

This thesis's units of measurement use specific metrics employed in these primary sources and associated metric/imperial conversions as required. Although this occasionally presents an inconsistent methodology in the text, it is appropriate to maintain faith to the primary sources.

Unfortunately, in some cases, documents associated with the campaign have yet to be declassified and, therefore, are unavailable. In 2009, President Barack Obama signed Executive Order 13526, which established a standardized protocol for declassifying documents with permanent historical value after the 25-year mark. It has not been evenly applied. Naturally, government agencies remain committed to having proper declassification authority review documents before making them available. There is a shortfall in the capacity to do so, which invariably creates gaps in document availability.

The situation regarding VADM Hoover's personal and professional papers, fourteen boxes held at the Naval War College, is instructive. Because he was responsible for the operations of all air bases and patrol plane activities in the Pacific Theater, including during Operation FORAGER, this collection undoubtedly contains germane material that remains classified and unavailable that could materially inform this thesis. Hoover's papers have not yet been declassified, inhibiting their contents from informing the historical record and future potential archaeological efforts.

If there were a singular failure in primary source research, it was the inability to locate the Fifth Fleet's anchoring plan for the invasion of Saipan. This single document, a ubiquitously distributed map provided in duplicate to every ship involved in the Saipan invasion, conclusively shows the anchoring locations managed by the Senior Officer Present Afloat (SOPA). Most vessels in their unit diary specify which anchoring berth they were in when specific incidents or activities occurred. Locating this map would open the aperture on numerous aircraft and surface vessel loss locations often provided as a relative bearing and distance from a specific anchoring berth. Obtaining this document could dramatically shrink the proverbial haystack and enable the discovery of many known lost needles, the locations of which are often referenced by direction and distance from anchoring berths.

1.6. TERMINOLOGY

Finally, a brief note on the open ocean seadrome terminology used throughout this paper is warranted. Typically, seadromes were established in sheltered lagoons or harbors to shield aircraft from harsh environmental factors, such as ocean swell, and protection from prevailing winds. These were accompanied by a robust infrastructure ashore that provided maintenance facilities, arming and fueling points, barracks and life support facilities for crew and maintainers, and even hangars to protect aircraft from the elements completely; significant quantities of fuel, ammunition, and other material support were stored there. Dedicated runaways within this protected area that had been carefully swept of obstacles, established outside regular maritime traffic lanes, and often marked with lights or buoys were common.

However, it was accepted that seaplanes might sometimes be compelled to use advanced basing, borne of operational necessity when required. The 1942 *Current Tactical Orders and Doctrine, Volume 3: Patrol Aircraft,* prescriptively laid out requirements in these cases. An advanced base's paramount consideration should be safeguarding plane operations from attacks by enemies due to their vulnerability. They were recommended to be "close to the area of active operations" yet "desirable that they be sufficiently remote from enemy bases to decrease the probability of their being seriously damaged by enemy air raids" (*Patrol Aircraft* 1942:73).

Ammunition, fuel, and personnel should be dispersed in isolated areas ashore. Similarly, seaplanes and their support vessels were to use inlets and bays and leverage headlands and islands to obscure their presence from the enemy. If detected, the manual recommended they be immediately relocated to a discrete location, even at the expense of scouting operations.

Concealment was the primary defense against destruction, as well as scattering the moorings to properly disperse the aircraft and using dummy aircraft to distract any attacker. An air attack was considered the most significant threat, but enemy surface and submarine actions were not ruled out. Land-based RADAR equipment with shore and carrier-based fighter support was essential to defending an advanced seaplane base (*Patrol Aircraft* 1942:73).

Advance bases were established in “roadstead” environments to protect from the elements. Roadstead anchorages are “semi-protected offshore anchorages for oceangoing vessels” (Port Construction 1964:22). A roadstead uses reef systems or islands to protect seaplanes from damaging ocean swells and provide a breaker for high winds. Some level of shore facilities was still necessary for the effective operation of patrol seaplanes, along with sufficient fuel and material support. Although a roadstead anchorage enjoying these characteristics was suboptimal compared to a fixed base with advanced and specialized infrastructure, it was enough to support seaplane operations on an enduring basis with these features.

The initial seaplane anchorage at Saipan had no roadstead characteristics. It was well outside the island’s barrier reef in the open ocean. Established 4 mi. (6.5 km) from the island, it offered no protection from ocean swell and very little from prevailing winds from the east. It had no access to shore facilities, which at that time were still under complete control of the Japanese defenders.

In addition to attack by enemy aircraft as anticipated by *Current Tactical Orders and Doctrine, Volume 3: Patrol Aircraft* (1942), VP-16 PBMs found themselves under constant observation by the Japanese on the island in defiance of doctrinal advance base guidelines. They were also sometimes taken under fire by enemy shore batteries, a situation nobody could have conceived of, even in the days immediately leading up to the invasion of Saipan. None of the characteristics associated with a roadstead seadrome were available to the squadron, save a sufficiently shallow anchoring point on the Saipan Shelf to affix themselves, established only the night before their arrival. In sum, their initial anchorage was not a roadstead environment by any metric.

For this reason, this thesis uses the non-traditional term "open ocean seadrome" to reflect the unique operating conditions of this anchorage. Although numerous sources holistically refer to the location as the "Garapan anchorage," "Garapan Roads," or "Saipan Seadrome," none of these were specific to the initial open sea operating area assigned to the VP-16 PBMs (Adamson 2020:36; Kammen 1958:8). Later in the campaign, as the situation ashore improved, these aircraft continued to shift forward toward a proper roadstead anchorage and eventually occupied the repurposed permanent Japanese seaplane base in Tanapag Harbor. However, the activities addressed in this thesis took place exclusively in the first five days of the campaign from 17–21 June 1944, well before this landward march began and completely within the confines of the open ocean seadrome.

CHAPTER 2: HISTORY

To fully appreciate the archaeological and historical legacy of the open ocean seadrome, a foundational knowledge of the U.S. Navy's operational objectives in establishing this innovative facility must be understood. Similarly, a knowledge of the men and machines, seaplane and seaplane tender alike, leveraged to achieve these goals, is instrumental.

2.1. PBM-3D MARINER

The U.S. Navy, seeking to professionalize and modernize during the 1930s, devoted considerable attention to the aviation patrol arm that served as the fleet's probing eyes. This included the seaplanes and tenders that cared for them and developed a new generation of pilots. Understanding the development and addition of the PBM and subsequent evolution of the PBM-3D to the patrol air arm and the criticality of this airframe is essential.

The Navy incorporated the instantly recognizable Consolidated PBY Catalina as a "patrol bomber" in 1935. Attention soon turned to complementing this aircraft with a larger, heavily armed flying boat capable of greater range and enhanced offensive capability. Consolidated, Sikorsky, and the Glen L. Martin Company submitted designs for a four-engine seaplane. Although Consolidated won the contest with a design that eventually became the PB2Y Coronado, the Martin Company continued its design using company funds. The Navy, realizing the excessive cost of purchasing and operating the new four-engine Coronado, opened another competition for a two-engine variant aircraft to bridge the gap between the less capable PBY Catalina and the exorbitantly expensive PB2Y Coronado (Hoffman 2004:1).

The Martin Company's entry, Model 162, provided enhanced speed, load, and armament advantages compared to the PBY Catalina while costing significantly less than the PB2Y Coronado. This entry was the winning combination the Navy was looking for, and the Martin

Company earned a contract to field a single prototype dubbed the XPBM-1; XPB being the Navy's terminology for Experimental Patrol Bomber and the M represented "Martin." The Model 162A "Tadpole Clipper" was a successful 3/8s scale model; its performance validation expedited the procurement of the entire contract, and the Navy offered Martin a production contract in1937. Soon, 21 PBM-1s were delivered for $5.1 million. The original XPBM-1 Bureau Number BuNo 1939 took to the air on 13 February 1939 (Hoffman 2004:2–4; 12–14; *Wings* 1972:8).

The Navy placed a follow-on order for 379 PBM-3s in November 1940. Significant improvements were made despite an outwardly similar appearance to its predecessor. Additional armor was incorporated, engine nacelles were lengthened to double as the airplane's bomb bay to accommodate an increased ordnance payload, and fixed-wing floats replaced the retractable version. A shift to enhanced Wright 2600-12 1,700 horsepower engines, each providing an additional 100 horsepower over the previous version used by the PBM-1, was the most crucial change (FIGURE 2.1). Engine reliability and power problems plagued the PBM-3, even with the newer engine and extra horsepower (Hoffman 2004:6).

Mariner variants continued to evolve to meet the unique needs of various theaters and mission sets after war descended upon the nation. A PBM-3S antisubmarine version, PBM-3R transport, and a PBM-3D patrol bomber became widely employed, while a single stand-alone PBM-3E RADAR testbed was also developed. In all, 677 PBM-3s were eventually constructed to meet Navy requirements (Hoffman 2004:9).

The first PBM-3 variant to arrive for operational use was the PBM-3R transport, which fulfilled a desperately needed National Air Transport Service (NATS) requirement. These aircraft had reinforced flooring, cargo doors, and hoists to facilitate their cargo-centric roles and handle their 8,000-pound (lbs.) (3,629 kilogram [kg]) capacity load, including up to 20 people (Ginter 2013:34; Hoffman 2004:18–19).

FIGURE 2.1: Wright 2600-14 engine displayed at the Pima Air Museum, Arizona (Image courtesy of Pima Air Museum).

The PBM-3C Patrol Bomber was introduced by the Navy as an upgraded version of the baseline PBM-3 which added self-sealing fuel tanks, additional guns, and a search RADAR for detecting submarines (Ginter 2013:37). On 1 December 1942, the first PBM-3Cs were assigned to Patrol Squadron 32 for service in the Panama Canal Zone gradually spreading throughout the Atlantic Theater to squadrons assigned anti-submarine warfare (ASW) duty (Hoffman 2004:19). The Navy recognized the ASW campaign in the Atlantic required further theater specific optimization of the PBM-3C. These modifications capitalized on the near absence of enemy airborne opposition and optimized for the ranges needed. On 13 July 1943, the Navy held an Anti-Submarine Measures Conference that updated the evolution of a stripped-down variant that removed 6,400 lbs. (2,903 kg) of equipment, creating the PBM-3S (Anti-Submarine Conference 1943:2):

> The items being removed consist of the following major ones bow, upper and tail turrets, one side waist gun, all armor, bomb-sight and stabilizer, self-sealing fuel cells, oxygen, large auxiliary power plant, most comfort items including galley table and seats, all but two bunks, all lockers, galley and sink, including cabinets and refrigerator, smoke tank installation, one of engine work platforms, hoisting sling and a number of smaller items. (Anti-Submarine Conference 1943:2)

The distinct operating conditions of the Pacific Ocean demanded yet another variant of the PBM-3. Unlike their Atlantic cousins, Mariners assigned to the Pacific performed myriad duties, just one of which was ASW patrols. They ranged ahead of the U.S. fleets during the island-hopping campaign, scouring the ocean for signs of Japanese air, surface, and submarine activity. The Imperial Japanese Navy (IJN) retained a capable fleet that posed a genuine threat to the U.S. advance until it was finally crippled during the Battle of Leyte Gulf in October 1944. Still, IJN elements, including the super battleship (BB) *Yamato*, sortied from the home islands during the Okinawa campaign in 1945 and might have inflicted damage on the invasion fleet if not for the early detection by PBM Mariners.

Mariners probed the vast distances of the Pacific, searching for the enemy, and often encountered enemy patrol aircraft doing the same. Thanks to strong defensive armament and robust armor, the PBM-3D was generally advantaged when these encounters developed into running gunfights between patrol aircraft. Yet such aerial engagements paled compared to encounters with Japanese interceptors and combat air patrols (CAP). Mariners routinely attacked targets protected by an aegis of Japanese Mitsubishi A6M Zeros, Nakajima A6M2-N Rufe floatplanes, or other fighter variant aircraft purpose-built to shoot enemy aircraft down. PBMs often faced heavy anti-aircraft fire while attacking Japanese shipping or shore installations. Some conducted search and rescue patrols to locate and recover survivors of shot-down or otherwise disabled aircraft and sunken ships. These rescues sometimes necessitated a harrowing landing in the open ocean, risking one's aircraft and life to save another.

A sturdy, heavily armed, and armored patrol seaplane was required to enter this fire cauldron and emerge safely on the other end — it was the PBM-3D Mariner, optimized for combat conditions in the Pacific (FIGURE 2.2). It possessed self-sealing fuel tanks, three power turrets, a Norden bombsight, and enhanced armor protection for the crew and critical aircraft components. It was upgraded with 1,900-horsepower Wright R-2600-22 engines and new four-bladed propellers to assist with the power requirements of this added weight. These, too, proved underpowered for the challenging operations that awaited the aircraft despite being a marked improvement over the original PBM-1's Wright 2600-6 1,600-horsepower and the earlier PBM-3 variant's Wright 2600-12 1,700-horsepower engines.

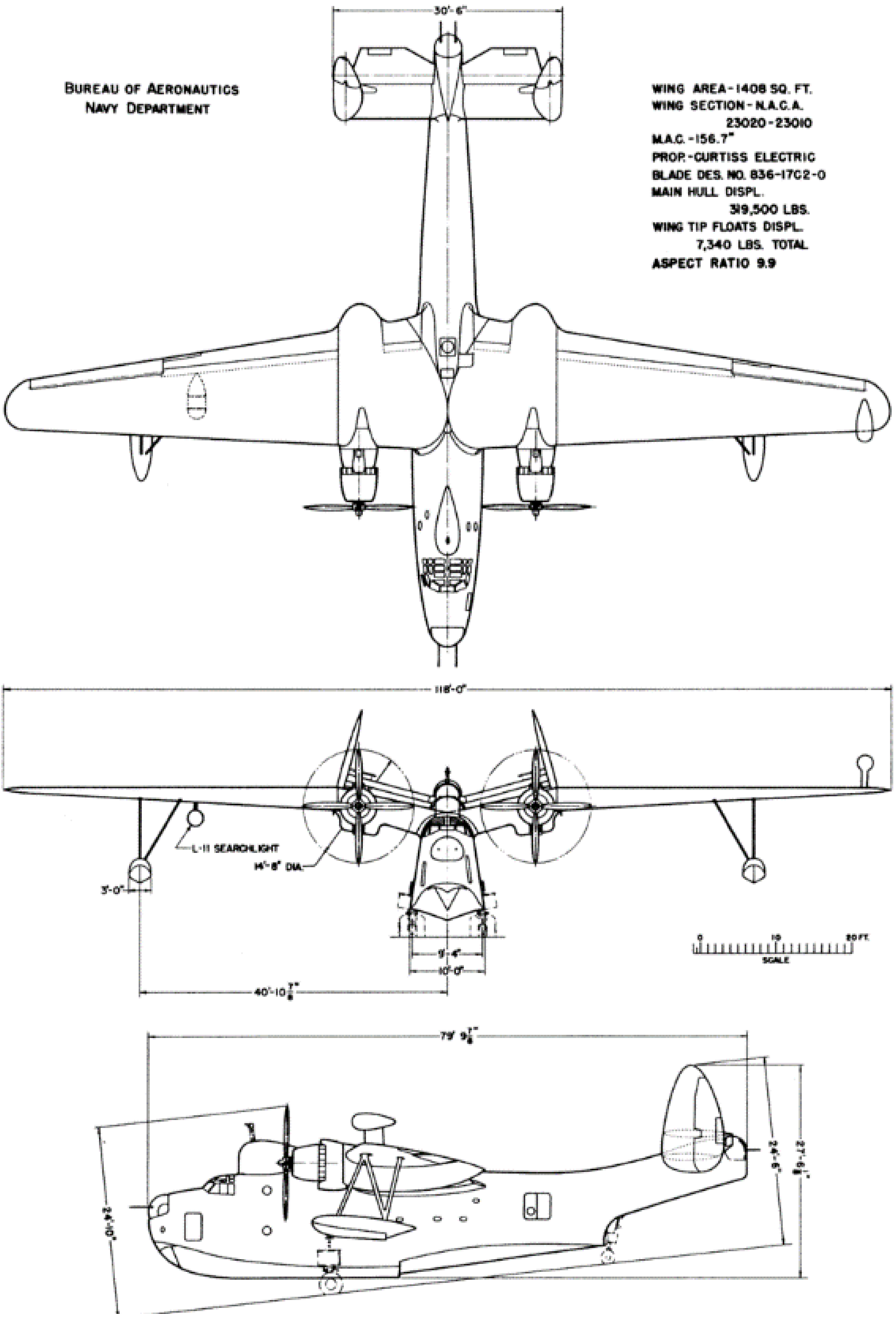
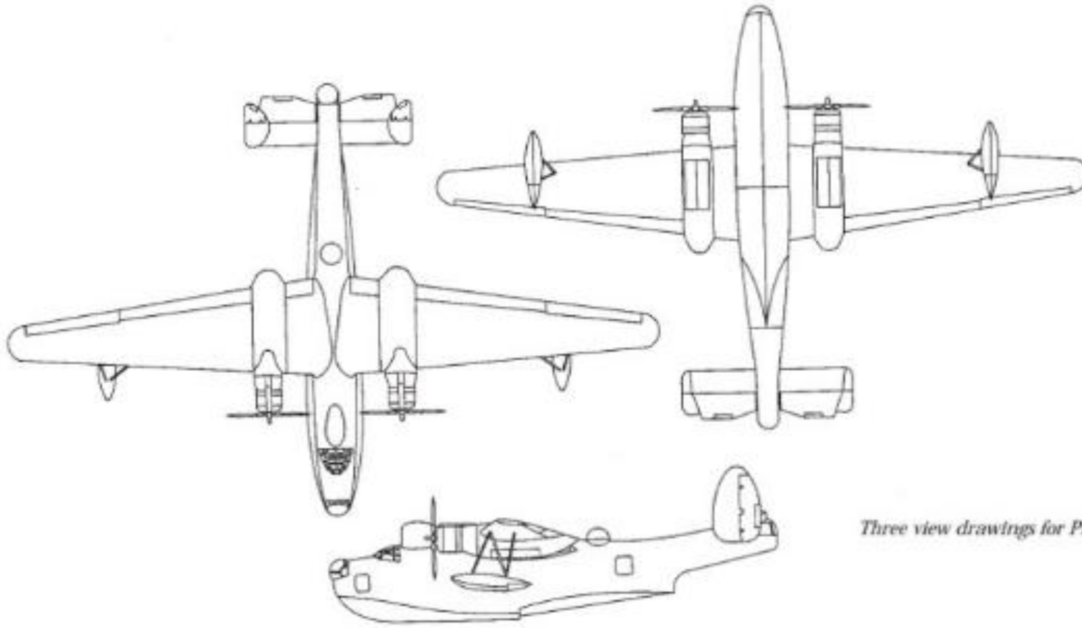


FIGURE 2.2: Schematic of the PBM-3D (Image from *Handbook of Flight Operating Instructions for U.S. Navy Model PBM-3D*).

An integrated search RADAR provided day and, importantly, night search capability and was a significant shared feature with the PBM-3C/S. The AN/APS-15 "Mickey" air-to-ground RADAR system was placed in a prominently covered dome on top of the aircraft just aft of the cockpit. Its operator sat just aft of the flight deck (Ginter 2013:42). This system provided a capable sensor to conduct night surface searches in the relative security of a blackened sky to protect this still vulnerable patrol plane from the enemy. VP-202 operated this RADAR in Saipan, reporting reliable detection of land formations up to 90 mi. (145 km) away and surface ships between 40 and 50 mi. (64 and 80 km) distance, well beyond visual detection ranges during daytime operations (VP-202 1944:4). This system gave the U.S. a significant edge in maritime patrol, allowing long-range searches conducted around the clock, day and especially night.

The aircraft's *Handbook of Flight Operating Instructions for U.S. Navy Model PBM-3D* (1944) described it as "a two-engine high-wing, medium-range flying boat which may be used as a patrol airplane, bomber, or torpedo airplane. The approximate dimensions are listed as: length, 79 feet 10 inches; height, 28 feet 2 inches; and span, 118 feet. The normal gross weight is 46,500 pounds" (FIGURE 2.3). Significantly, its fuselage was divided into five watertight compartments like those of a ship. The aircraft maintained positive buoyancy in the event of a single-compartment flood. Unfortunately, this was the case if two adjacent watertight compartments were compromised, as dramatically demonstrated during the Battle of Saipan. These aircraft played a dominant role in the patrol arm and campaigns in the Pacific. When they arrived as reinforcements, they were a welcome addition to the force (FIGURE 2.4).



Three view drawings for PBM-3D.

FIGURE 2.3: Top: Three-view drawing for PBM-3D. Bottom: Three-quarter view of PBM-3D (Image from *Handbook of Flight Operating Instructions for U.S. Navy Model PBM-3D*).

FIGURE 2.4: 1942 World War II Martin Aircraft propaganda poster featuring the Martin PBM Mariner (Image courtesy of the Glenn L. Martin Company).

2.2. PATROL SQUADRON 16 (VP-16)

VP-16 stood up at Naval Auxiliary Air Station (NAAS) Harvey Point, North Carolina, on 20 December 1943. In addition to the aircraft, the Martin PBM-3D Mariner, the squadron received its officers and sailors, commanded by Lieutenant Commander (LCDR) William J. Scarpino (FIGURE 2.5). As with any massive military buildup, these personnel were largely untested and extremely limited in operational experience. Only 4 lieutenants and 4 lieutenants (junior grade) out of 61 officers had any operational or combat experience beyond the squadron commander. All the other pilots reported directly from Naval Air Station (NAS) Banana River, Florida, following two months of initial training in PBMs (Patrol Squadron 16 War History [VP-16 History] 1945:8,12). Although they all had basic ratings in the PBM, few in the squadron had ever seen, much less flown, the new PBM-3D variant before arriving at NAAS Harvey Point. A parallel challenge existed within the squadron ground officer experience (VP-16 History 1945:Annex 3). A robust squadron program sought to improve this inexperience.

The next four months were spent at NAAS Harvey Point conducting extensive training activities, heavily emphasizing ASW operations in anticipation of this likely mission. A week of advanced training was performed later at NAS Key West, using friendly submarines as active targets for squadron searches and mock attack runs, and introduced the squadron to the use of sonobuoys (VP-16 History 1945:16–17). Although the NAS Key West ASW training was excellent by all counts, it was suboptimal in preparing the aircrews for the long-range night RADAR searches they ultimately conducted in the Marianas. Also, due to the compressed timeline and scarcity of seaplane tenders, training for operations from these seaborne platforms was necessarily omitted. Finally, adverse weather, engine problems, and material support shortfalls conspired to hinder the execution of the total training syllabus dramatically. These training limitations later hampered the success of the squadron's first deployment (VP-16 History 1945:12).

FIGURE 2.5: LCDR William J. Scarpino on 13 February 1945 during the time he was in command of VP-16 (Photo courtesy National Archives photo #80-G-302684).

Less than five months after commissioning, VP-16 was sent to the Pacific to assume combat duties. After a challenging transit from the U.S. plagued by engine problems, resulting in three airplanes and one aircrew crew lost, the squadron was fully assembled and settled into Eniwetok by 13 June 1944 (VP-16 History 1945:32–34). Just three days later, on the evening of

16 June 1944, the officers were called together for a brief at 2130. By midnight, all hands knew the squadron was to deploy to the forward combat zone — destination Saipan immediately. This compressed deployment timeline did not afford the luxury of a proper briefing, even if information or intelligence was available.

VP-16 aircrews took off only three days after they arrived in the forward theater and a mere eight hours after learning of their destination. With no understanding of their mission or role in Saipan, they departed, not knowing where they were to land, anchor, or be supported. Such was the situation's urgency and the need to get long-range RADAR-equipped PBMs “on station” in Saipan (FIGURE 2.6). Six crews and two backups were designated for a 0600 launch on 17 June 1944, led into Saipan by their commanding officer, LCDR Scarpino (VP-16 History 1945:35).

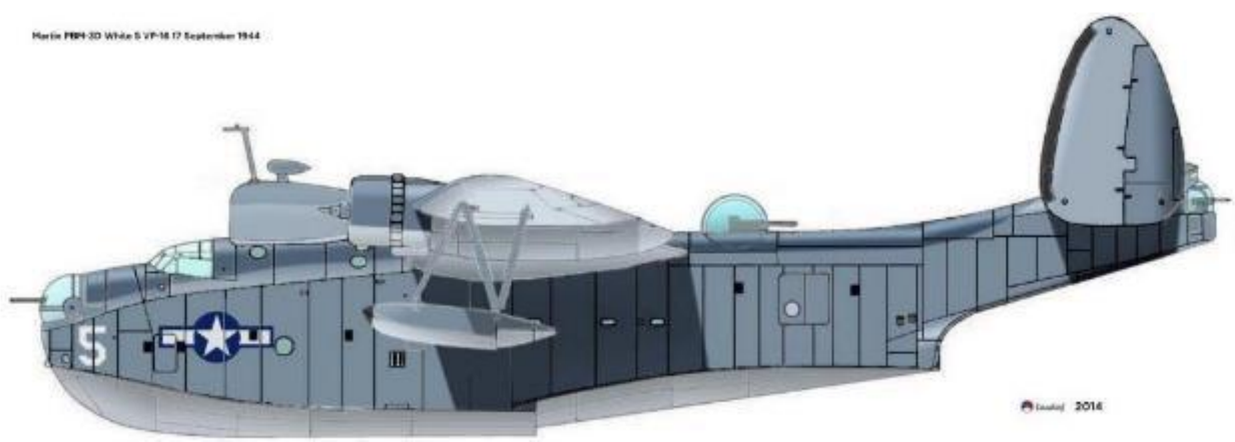


FIGURE 2.6: VP-16 PBM-3D Mariner as configured in September 1944, shortly after Operation FORAGER (Image courtesy Wings Aviation).

2.3. SEAPLANE TENDERS

The capability to establish and maintain the open ocean seadrome at Saipan was entirely predicated on the ability of seaplane tenders to set and sustain moorings and tend to the Mariners' aircraft and crews. Three seaplane tenders participated: USS *Ballard* (AVD-10), USS *Onslow* (AVP-48), and USS *Pokomoke* (AV-9). Each was a different class vessel with wide-ranging capabilities, but all contributed to operations in the open ocean seadrome (Bruhn 2016:314). It is necessary to understand the capabilities and limitations of the participating seaplane tenders to appreciate the services rendered to VP-16's operations from 16–21 June 1944.

2.3.a. USS *Ballard* (AVD-10)

USS *Ballard* was the most consequential tender for the initial operations of the open ocean seadrome. It began as one of 156 *Clemson*-class four-stack destroyers produced during the U.S.'s massive World War I wartime building effort. Midshipman Edward J. Ballard, killed during the storied engagement between USS *Chesapeake* and HMS *Shannon* on 1 June 1813 during the War of 1812, was the vessel's namesake. *Ballard* was completed after the drums of World War I fell silent, and too late to participate in that conflict. Bethlehem Steel Corporation launched the vessel in Squantum, Massachusetts, on 7 December 1918. It was commissioned on 5 June 1919. Initially assigned to the Atlantic Fleet, *Ballard* led an undistinguished existence cruising throughout Europe and the Mediterranean (FIGURE 2.7). It was later transferred to the Pacific Fleet, decommissioned, and placed in reserve on 17 June 1922, just three years after its original commissioning (Mooney 1959:88).

Ballard was deemed too ancient and vulnerable for frontline service in a contemporary war, yet it retained value for the Navy. Therefore, it was selected for conversion to a destroyer seaplane tender to fill an identified capability gap until enough purpose-built tenders became available. *Ballard* was recommissioned in ordinary on 25 June 1940 to begin the process (Bruhn 2016:19). Conversion work focused on removing offensive weaponry and two of the original four boilers to create space for tender-specific equipment. This expanded available deck space and added a 30,000-gallon (gal.) (113,562 liter [L]) aviation fuel tank, with lubricating oil storage, to allow fueling and servicing of seaplanes. It increased storage space to maintain aviation-specific equipment, spare parts, munitions, and other necessary equipment. Two 30 ft. (9 m) motor launches, each carrying 600-gal. (2,271 L) bowser tanks, were added to supplement seaplane refueling operations. Enhanced living spaces and messing facilities boosted life support for embarked aircrew.

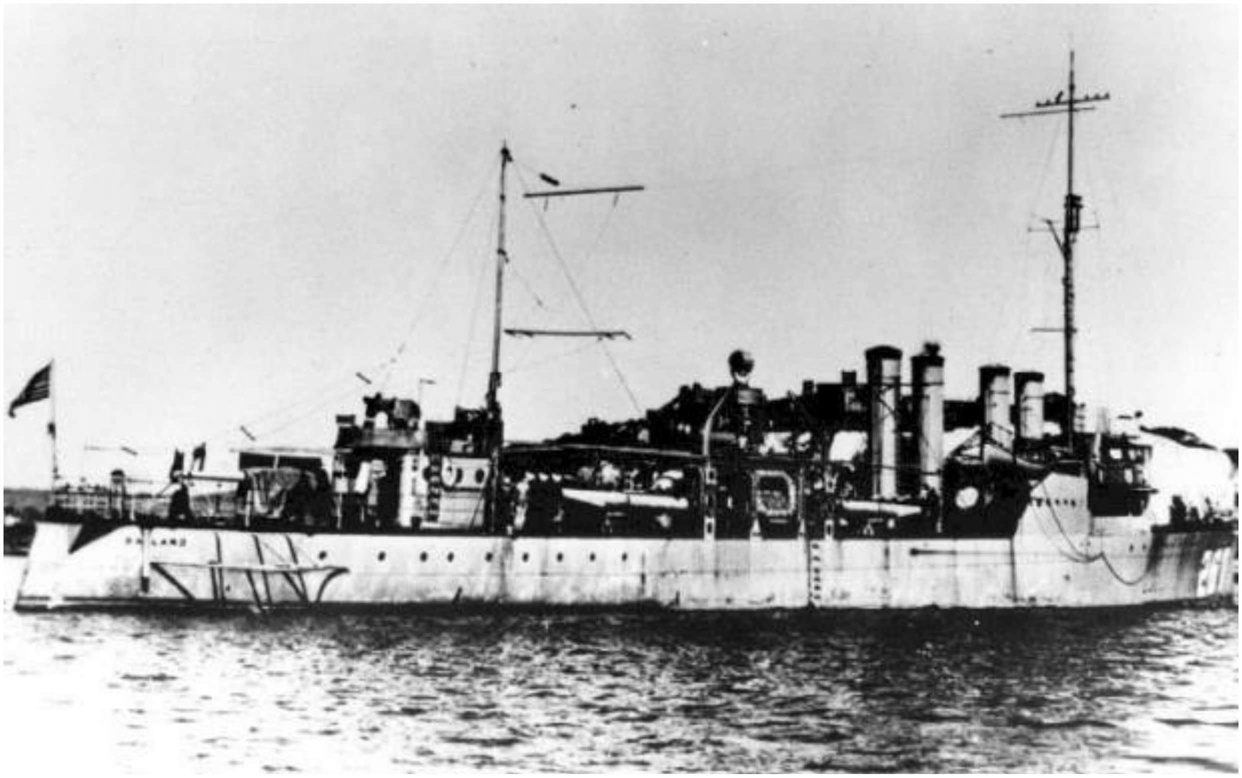


FIGURE 2.7: Photo of USS *Ballard* (DD-267) in 1920, two decades before its conversion to a seaplane tender (Photo courtesy U.S. Navy Historical Center #NH78139).

Ballard was equipped with new 500-lb. (227 kg) anchors as more modern and capable seaplane mooring anchors became available. Unfortunately, its anchor stowage racks were not designed for those anchors. The new heavier models did not fit below as intended and were instead stored on the open deck, posing safety and maintenance challenges. *Ballard* petitioned to return to smaller models and was reissued five 150-lb. (68 kg) Danforth and five Northill 200-lb. (91 kg) anchors, all then in stock at the shipyard (FIGURE 2.8). The small anchors, sufficient for smaller Curtiss-Wright SOC Seagull, Vought OS2U Kingfisher, and even PBY Catalinas in moderate weather conditions, were not intended to be used with an airplane as large as the Martin PBM Mariner.

FIGURE 2.8: Northill print advertisement for its compact, folding seaplane anchor (Image courtesy 9 May 1940 *Flight* magazine).

Ballard was then a seaplane tender in every sense of the word and was redesignated destroyer, seaplane tender (AVD) 10, or AVD-10 once this conversion was complete (FIGURE 2.9). It was placed in full commission on 2 January 1941 and reported for duty to Aircraft Scouting Force on 5 March 1941. It was assigned to Fifth Fleet's Northern Attack Force to support naval gunfire spotting floatplanes during Operation FORAGER and present at Saipan during the initial invasion on 15 June 1944.

FIGURE 2.9: USS *Ballard* (AVD-10) at Mare Island Navy Yard 30 December 1943 as it looked before Operation FORAGER (Photo courtesy San Francisco National Archives, Mare Island Navy Yard Ship Files).

2.3.b. USS *Onslow* (AVP-48)

USS *Onslow* was a purpose-built vessel constructed after the Navy recognized the need for additional seaplane tenders to support a burgeoning naval aviation patrol arm. Although 7 Barnegat-Class small seaplane tenders (AVP) were authorized in 1938, the number grew to 31 by war's end. This class of vessel was named for small bodies of water and, in *Onslow*'s case, a concave indentation of the North Carolina Coast anchored by Cape Lookout in the north and

Cape Fear to the south. These bespoke tenders possessed capabilities that allowed them to perform many functions, chief among them tending seaplanes. They also performed at-sea aircraft salvage, escort duties for large tenders, and other duties such search and rescue.

Onslow incorporated the latest technology and designs to include aircraft and weapons repair shops; aircraft crew and support crew facilities; weapons and fuel storage capacities; operating range and ability to conduct operations independent of other fleet vessels; air defense and fire support capabilities; and the ability to navigate and turn around in shallow or restricted waterways (Bruhn 2016:21). The 24th vessel in the class, its hull was laid on 18 May 1942 and it was placed in full commission on 22 Dec 1943 for service in the Pacific (FIGURE 2.10). It departed Hawaii on 17 March 1944 and arrived at Majuro in the Marshall Islands on 4 April 1944. *Onslow* joined Fifth Fleet in Eniwetok on 9 June 1944 and tended to VP-16's PBM-3D Mariner aircraft there in anticipation of its imminent deployment to Saipan (FIGURE 2.11).

FIGURE 2.10: Launching of the USS *Onslow* (AVP-48) at the Lake Washington Shipyards, Houghton, Washington (Photo courtesy of National Archives #80-G-216474).

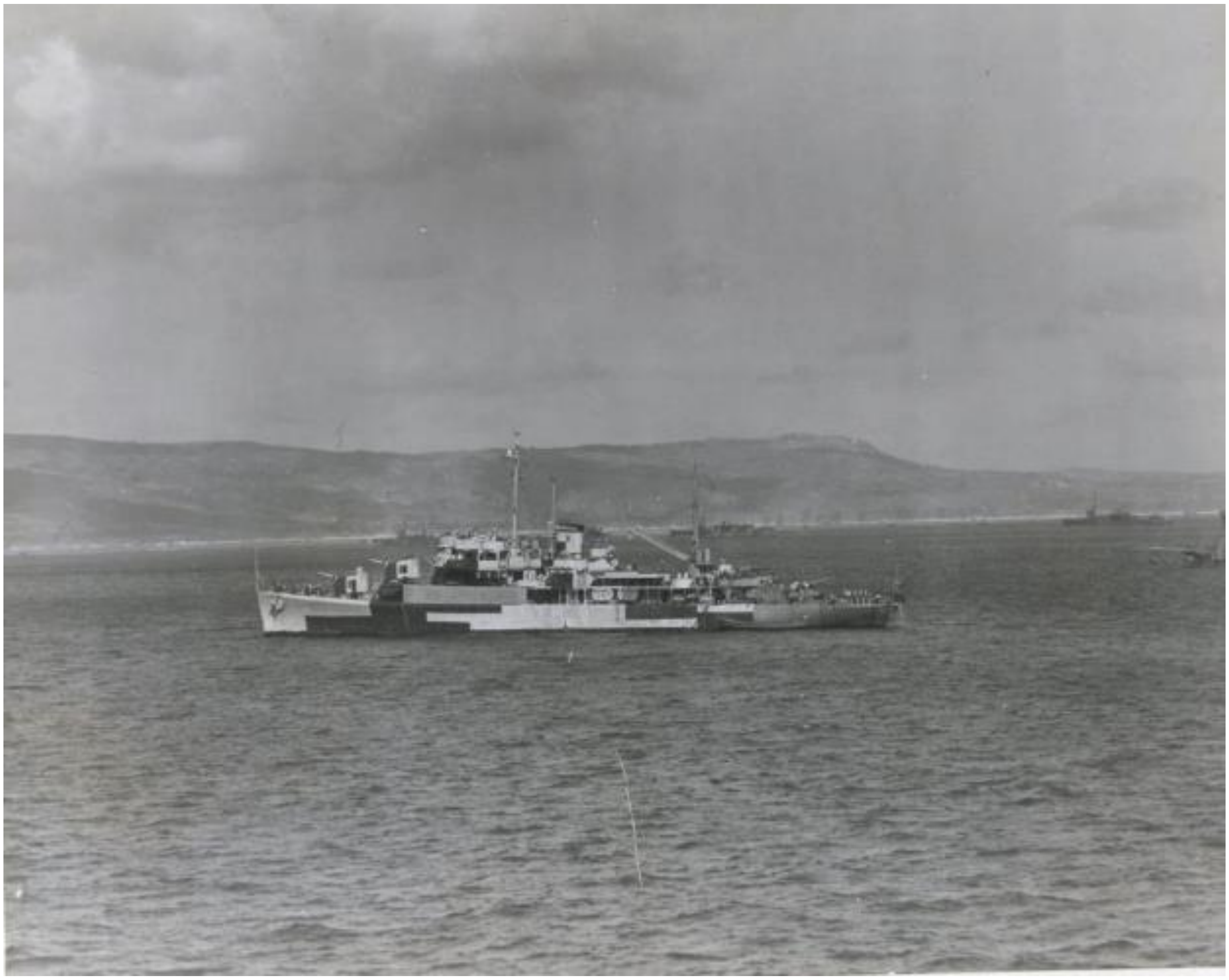


FIGURE 2.11: Side view of USS *Onslow* (AVP-48) at Saipan Island in the Marianas as seen from USS *Pokomoke* (AV-9) on 22 June 1944 (Photo courtesy of National Archives #80-G-238469).

2.3.c. USS *Pokomoke* (AV-9)

USS *Pocomoke*, the largest and most capable of the three tenders employed in Saipan's open ocean seadrome, was a large seaplane tender (AV) intended to support medium (PBM Mariner) and heavy (PB2Y Coronado) seaplanes. It began as a Type C3 Liberty Ship, SS *Exchequer*, built by Ingalls in its Pascagoula, Mississippi yard (FIGURE 2.12). *Exchequer*, notable as the first ship to be entirely made with steel plates welded end to end and traditional overlapping plates riveted together, was delivered by Ingalls Corporation to the U.S. Maritime

Commission on 16 October 1940 and then by the commission to the U.S. Navy on the same day at Mobile, Alabama, to begin its conversion (Anderson 2012).

FIGURE 2.12: SS *Exchequer* in Pascagoula, Mississippi 1940 (Photo courtesy of Ingalls Corporation).

Pokomoke's capabilities were significantly greater than those of *Onslow* and *Ballard*. It lacked the versatility of the smaller tenders, but it provided substantially more capability as a large seaplane tender. Its deck could facilitate three Seagull or Kingfisher Observation Seaplane, United Aircraft Division (OSU2) floatplanes or one larger patrol seaplane, including the PBM

Mariner, for maintenance or salvage (FIGURE 2.13). It possessed substantial aviation fuel tanks, spare parts capacity, work and machine shops, and berthing space sufficient for an entire patrol squadron. In short, *Pokomoke* provided a singular seaplane tender capability.

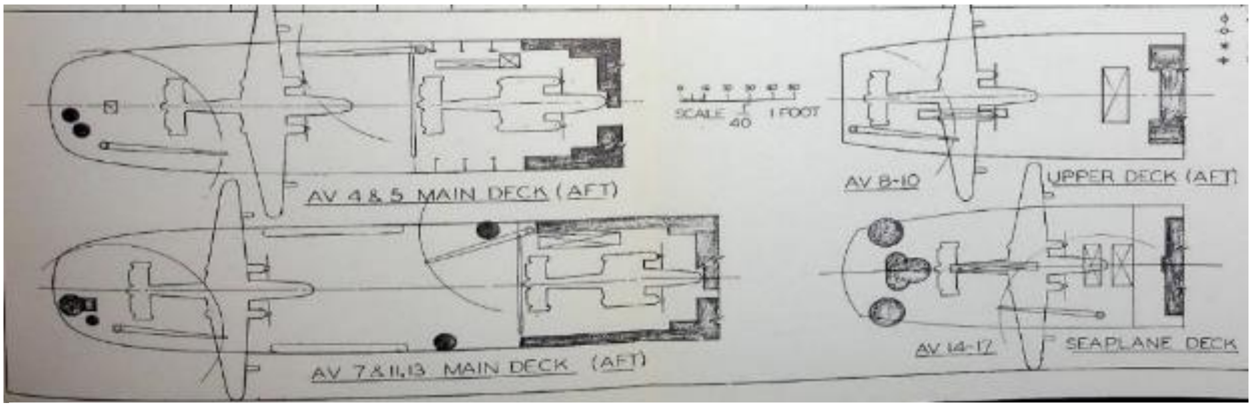


FIGURE 2.13: Diagram of large seaplane tender deck configurations. Top right depicts *Pokomoke*; the single crane and deck space for just one large seaplane is evident. On the left, the *Curtis* and *Carrituck* classes sport multiple cranes and deck space for two large seaplanes (Image courtesy Michael Kammen).

It was completed, fully mission-capable, and combat-ready on 30 November 1941, only a week before the U.S. was thrust into war. *Pokomoke* was initially assigned to the Atlantic Fleet but transferred to the Pacific and Fifth Fleet as the importance and demands of the Pacific War grew. It was forward-based to Eniwetok for Operation FORAGER in anticipation of its deployment to Saipan, where it played a pivotal role in supporting VP-16 operations in the open ocean seadrome (FIGURE 2.14).

FIGURE 2.14: USS *Pokomoke* (AV-9) at Kwajalein, Marshall Islands. This photograph was taken on 9 June 1944, just eight days before *Pokomoke* would arrive at Saipan (Photo courtesy of National Archives #80-G-265980).

2.4. SAIPAN'S OPEN OCEAN SEADROME

Establishing the open ocean seadrome was not a preplanned activity but an expedient response to an emergent operational challenge. Although some planning had gone into developing an on-order seadrome later in the campaign in Saipan's sheltered waters, primarily for refueling spotter float planes, these initial steps played heavily into the ability to respond to this more significant task in short order. Notably, a destroyer seaplane tender was assigned to the Northern Invasion Force and was immediately available for service. Previously conducted intelligence preparation allowed U.S. Navy planners to adjust to changing circumstances rapidly.

2.4.a Planning

There was no plan, nor even passing consideration, for establishing a seadrome in the open ocean when the Marines stormed ashore onto Saipan on 15 June 1944. Fifth Fleet carrier-based aircraft were relied upon exclusively for airborne ASW activities and surface searches. The large PBMs planned to forward deploy only after Tanapag Harbor and its sheltered lagoon were secured and an advance base established later in the battle (FIGURE 2.15). This base was anticipated to meet the conditions to provide a permanent facility offering the full range of seaplane service requirements for employing large amphibious patrol aircraft consistent with advance base doctrine. Until then, conventional wisdom held that there was no way to deploy or support large seaplanes in Saipan. Six seaplane tenders, including *Pocomoke* and *Onslow*, and several patrol squadrons, including VP-16, were forward deployed to Eniwetok and Kwajalein Atoll. Those ships anticipated deploying on order to Saipan once conditions for establishing the seadrome were met, followed by the patrol squadrons once facilities were able to receive them.

Navy planners recognized the operational necessity of a temporary seaplane base to service smaller OSU2 Kingfishers and SOC Seagull floatplanes assigned to battleships and cruisers as naval gunfire spotters. By untethering floatplanes from their parent ships and assigning support functions to a designated seaplane area, the bombardment ships could stay on the gunline, focused on Japanese targets instead. VADM Turner, Commander, Task Force 51, prepared a detailed plan as Annex (M) of Operation Plan A10-44 for both a "Seaplane Tender Base" or an "Improvised Seaplane Base," depending upon resources available (COM 5th PHIBFOR War Diary 1944:309). This was to be executed "when the situation permitted the planting of mooring buoys in sheltered water, the anchoring of the seaplane base vessel close by, and the safe operation of seaplanes from the area" (COM 5th PHIBFOR War Diary 1944:310).

Ballard was assigned to the Northern Assault Force as the "seaplane base vessel" to fulfill this mission. This had the fortunate effect of placing it off the invasion beaches on the first day of the Battle of Saipan instead of 1,000 mi. (1,609 km) away in Eniwetok. Although the temporary seaplane base concept never came to fruition as events quickly overcame plans, *Ballard* was in place and ready to accept alternate tasks. It did not have to wait long.

FIGURE 2.15: The bombing of the Japanese seaplane base at Flores Point, Saipan, by plane from USS *White Plains* (CVE-66), July 3, 1944. Seaplane ramps visible in the center of this photo would be in use by PBM-3D Mariners just seven days later (Photo courtesy of National Archives #80-G-384164).

2.4.b. Establishment and Operations of the Open Ocean Seadrome

The unplanned participation of U.S. Navy Martin PBM-3D Mariners in the early days of Operation FORAGER was a direct response to the unanticipated reaction of the Japanese First

Mobile Fleet. Intelligence estimate continued to suggest, “Major units of the Japanese Fleet are capable of opposing our operations against FORAGER. It is believed that these units of the Japanese Fleet will not interfere with our operation against FORAGER except for “hit and run” raids on detached units of our forces, but will conserve their strength until a time when they can go into action in waters nearer their main bases” (COM 5th PHIBFOR 1944:137). Academics and civilian analysts reinforced that the IJN would not seek a fleet engagement to senior leadership (Kirafly 1943:45).

VADM Spruance was caught off guard when the Japanese First Mobile Fleet contested the U.S. invasion. In retrospect, it is difficult to imagine that the intended conquest of the Marianas that brought the Japanese home islands within range of America’s newest long-range heavy bomber, the B-29 Superfortress, could not provoke such a reaction. The Commander, Fifth Fleet, responded by ordering six VP-16 PBM-3Ds forward. These aircraft were to conduct night surface RADAR searches up to 700 mi. (1,127 km) west of Saipan, far beyond the more limited range of carrier aircraft, and provide the Fifth Fleet with vital intelligence on the First Mobile Fleet. Two additional tenders, *Pokomoke* and *Onslow*, were also ordered to Saipan to support them.

Meanwhile, *Ballard*, already at Saipan, was immediately pressed into service to establish the open ocean seadrome. It was to detach from its task group and proceed to the Saipan Shelf on the evening of 16 June 1944 to set moorings and buoys for the Mariners’ arrival the following morning. *Ballard* worked through the night and was ready to receive the PBMs by the morning of 17 June 1944. It may be assumed that the anchors used were the reissued Northill 200-lb. (91 kg) and Danforth 150-lb. (68 kg) anchors, as there is no record of *Ballard* altering its anchor storage lockers to accommodate larger anchors.

The selected offshore location sought to balance suitability for seaplane operations with protection from Japanese attack (USS *Ballard* History 1945:10). The area, 4 mi. (6.5 km) offshore in water 100 ft. (31 m) deep, performed neither function well. Waves were excessively high that far out with no shelter to break the high winds, yet it was still within the far reaches of Japanese shore-based artillery and coastal defense guns. There was no elegant solution available to solve this wicked problem. However, the selected location provided reasonable protection from the Japanese while still allowing the PBMs to operate, albeit outside their normal limits. These suboptimal conditions were accepted, given the importance of the long-range RADAR search mission to the security of the Fifth Fleet. It was the first time the Navy had attempted to operate from such an innovative open ocean seadrome.

Aircraft and aircrew relied upon seaplane tenders for all their needs, given the complete absence of terrestrial support facilities; the importance of the tenders to seaplane operations cannot be overstated. Billeting and messing spaces for aircrew, maintenance teams, replacement parts for aircraft, transportation to and from moored aircraft, and availability of fuel and oil to feed the engines during their 14-hour-long patrols were all wholly dependent upon the tenders. *Ballard* was initially responsible for all these tasks and more.

Although *Ballard* planned to support the small OSU2 Kingfisher of SOC Seagull floatplanes, it became responsible for supporting the inaugural detachment of six PBM-3D Mariners scheduled to arrive on 17 June 1944. The Mariner was a beast compared to small floatplanes. *Ballard* possessed just 30,000 gal. (113,562 L) of aviation fuel while the PBM tank capacity was 2,914 gal. (11,030 L); as such, it could only refuel the six initially deployed PBM aircraft perhaps twice before depleting its stores. It had no PBM spare parts or personnel required to conduct significant maintenance on the Mariners. It could not have reloaded bombs, torpedoes, or depth charge munitions even if they were available. Yet this lone, insufficiently capable tender did, by necessity, become the foundation for the open ocean seadrome. Few additional berthing spaces were available aboard *Ballard*, and the 60 crewmen that comprised this Mariner complement could not be accommodated appropriately, forcing many men to live aboard the aircraft.

The maritime environment from which the aircraft were to operate was equally crucial to seaplane operations as the tender support received. An expeditionary forward seaplane base was usually established in a sheltered harbor or lagoon to protect the planes, and tenders from the worst nature had to offer. These protected waters should optimally have been deep enough not to interfere with seaplane taxiing or takeoff but sufficiently shallow to facilitate the easy placement of seaplane moorings and runway markings, while mitigating the size of the waves and ocean swell. Although ruggedly built, patrol seaplanes were still vulnerable to excessive sea conditions and could be damaged or worn down by the continuous beating of a heavy sea. In sum, "Weather conditions had a far more serious impact upon flying boat operation than they had on operation of land-based aircraft assigned to fixed airstrips" (Kammen 1958:68).

Seaplane flight operations necessitate limits to wind and waves to take off and land safely. Excessive sea state reduced fuel and weapons load an aircraft could sortie with to lighten the takeoff load, thus reducing range and offensive potential. They also risked damage to the aircraft and injury to the crew. An appropriate seadrome needed sufficient ramps and maintenance areas so a seaplane could be fully pulled out for inspection and maintenance. A ramp was vital if an aircraft was damaged in battle or a routine accident. Even the most minor damage to an aircraft could result in catastrophic loss if it began taking on water and could not be safely hoisted or beached; this reality was dramatically reinforced at Saipan.

Saipan’s open ocean seadrome had none of these features. Instead, it was established well offshore beyond the outer reef, initially 4 mi. (6.5 km) seaward. The seaplanes needed to operate this far offshore to remain out of small arms and light-caliber artillery range as the Japanese occupied the whole island when they deployed. Regardless, they remained under the guns of heavier Japanese coastal defenses and artillery until the Marines pushed the Japanese sufficiently far inland to neutralize this threat. Takeoffs from the leeward side of the island into the wind took them closer to the Japanese stronghold, making them vulnerable to anti-aircraft fire. Japanese air attacks also targeted the PBMs, beginning just hours after their arrival (VP-16 History 1945:37).

Enemy actions were only one of the many challenges, the water depth being another. The Saipan Shelf's water depth sometimes exceeded 100 ft. (31 m), pushing mooring capabilities to their limits and precluded using marker buoys to designate takeoff and landing areas. This was especially critical at night when many operations were conducted because lighted buoys could not be permanently emplaced to guide the airplanes, and illuminating ships to assist remained dangerous under the Japanese guns.

The wind and sea state determined takeoff direction and taxiing requirements. Established in the northernmost portion of the transport anchoring area and maximally away from surface vessel traffic, there was never enough room to maneuver. The risk of striking another ship or seaplane, especially under the blackout conditions normally operated under, was always high. A collision with a surface vessel disabled a Mariner on the first night. Errant ships and boats, floating debris, and numerous derelict and wayward landing craft compounded the hazards to these aircraft (USS *Alhena* 1944:7).

The impact of the weather and sea state was felt immediately upon the arrival of the Mariners in Saipan on the afternoon of 17 June 1944. They found "man-sized" waves awaiting them, and each bounced back into the air between three and six times before settling safely upon the water (VP-16 History 1945:37). Take-offs were similarly dangerous. If the aircraft could not obtain a smooth run, it risked bouncing from one wave to the next in a dangerous hydrodynamic oscillation known as porpoising. In addition to preventing the speed necessary for takeoff, the aircraft risked nosing into a wave. This could result in catastrophic damage to the airplane, crushing the nose, ripping engines off the wing mounts, and sheering off wing pylons. More than one aircraft was stricken from the record due to the devastating damage received during a takeoff or landing on Saipan's unforgiving seas later in the campaign.

Even if an airplane were not destroyed, metal bent, rivets popped, and crewmen seriously injured as a matter of routine by these harsh conditions. The structural stress these aircraft took from repeated takeoffs and landings and being anchored in these conditions dramatically reduced the time required between significant overhauls. The continual abuse suffered by sensitive onboard electronic equipment was yet another factor. Never intended to handle the shock and forces of repeated takeoffs and landings in these kinds of sea states, fragile equipment such as the Mark III Identification, Friend or Foe (IFF) and long-range High Frequency (HF) radios lost efficacy when repeatedly exposed to this abuse (Morison 1953:242). These conditions potentially caused a critical missed sighting report and, due to IFF failures, numerous friendly fire incidents resulting in lost aircraft and crew.

The high sea state made support and refueling operations equally challenging. Standard hose refueling protocols had to be dramatically adjusted to facilitate fueling operations. Bringing an aircraft close to the tender risked collision, and the shock of the waves on the tender was amplified over the length of the refueling hoses many times over and joltingly transferred to the aircraft. Extension booms were jury-rigged to tenders to add separation distance and reduce energy transference. This innovation became a standard procedure for the seaplane tender fleet (USS *Onslow* 1944:2).

Still, it took time and effort to taxi or tow an aircraft to a tender, and on smaller seaplane tenders, only one aircraft could refuel at a time. Moving a seaplane through the anchorage could also be a hazard in and of itself during hours of darkness. All maintenance took place on the water, and valuable time was lost whenever an aircraft taxied or was towed. PBMs were maintenance-intensive aircraft, requiring approximately two hours of maintenance for every hour flown, and even a modest loss of maintenance time dramatically impacted aircraft readiness levels (Kammen 1958:25).

Seaplane tenders also had other tasks and responsibilities, such as refueling or re-arming other escort vessels, and fuel and supplies aboard tenders were finite. They sometimes had to depart from the anchorage to take on fuel, ammunition, and stores from supply, munitions, and fuel ships further removed from the seadrome area. The negative operational impact of these absences led seaplane tenders to encourage these replenishment vessels to instead come to the seaplane anchorage when conditions permitted.

Another refueling solution was to use dedicated refueling bowser boats, although this, too, presented challenges. These small refueling craft with fuel bladders and pumps were not designed for open ocean activity, difficult to control in high seas, and sometimes posed a threat to the aircraft they were servicing. A bowser boat from *Ballard* struck and unbalanced the propeller of a PBM, rendering the aircraft *hors de combat*, on the very first night of seaplane operations (VP-16 War History 1945:40). Days later, another bowser boat from *Pokomoke* lost control and punctured the skin of another PBM, BuNo 48173, causing it to take on water rapidly and sink (Campbell 2018:379). Moreover, the capacity of a bowser boat was about 600 gal. (2,271 L) and grossly insufficient to provide the almost 3,000 gal. (11,356 L) of fuel that an empty PBM required, thus necessitating multiple trips to refuel each aircraft, a time-consuming and hazardous ordeal.

Still, VADM Spruance deemed conducting operations for the open ocean seadrome worth the risks. The threat posed to the Fifth Fleet by the enemy was immense. The Japanese possessed air bases near enough to conduct effective naval search missions and the attack aviation, land and carrier-based, to capitalize upon any detections. Despite being bloodied by this stage of the war, the Combined Fleet was still a potent force, and Japan retained the means to meet the U.S. in battle with something resembling parity — on paper at least. U.S. commanders took this threat seriously and honored it by ordering the establishment of the open ocean seadrome. A VP-16 detachment of six aircraft was ordered forward. No more than six seaplanes could be initially supported in Saipan given that only a single insufficient destroyer tender was available. *Pokomoke* and *Onslow* arrived 48 hours later, bringing an additional tender capacity to support more Mariners.

Five of the six intended aircraft arrived in Saipan on the afternoon of 17 June 1944; the last suffered engine problems and was delayed in Eniwetok. VP-16 managed the 1,000 mi. (1,609 km) transit from Eniwetok west to Saipan without difficulty despite an absence of navigational assistance or even information on winds aloft. Upon arrival, they surveyed the area, located the seadrome and anchoring points, and made their approach and landings individually. The Commanding Officer was the first to set down, followed by the remainder of the flight.

Soon after, a Japanese single-engine aircraft, identified alternatively as an Aichi D3A "Val" or a Kawasaki Ki-61 "Tony," burst through the overcast just as the sun set at 18:47 and began its attack run on the anchorage. A barrage of anti-aircraft fire rose to meet the intruder commencing with USS *Jupiter* (AK-43) (USS *Jupiter* 1944a Reps:5). *Ballard* and USS *Hercules* (AK-41) joined in, but not until after the aircraft dove to 300 ft. (91 m) and released a bomb in the seaplane anchorage that landed between two of the PBMs moored 100 yards (yd.) (91 m) apart (*Ballard* 1944a:5; *Hercules* 1944b:9). None were seriously damaged, and all remained mission capable. One Mariner, cut loose from *Ballard* while refueling during the air attack, taxied out to sea, where it became lost for the night, further reducing the ready aircraft for that night's mission. The Japanese recognized the arrival of the Mariners as a threat to their own fleet's security and focused on them in their attacks (VP-16 History 1945:37).

Another consequence of this air attack was the loss of a refueling bowser boat. *Ballard*, in its haste to get underway after casting off the refueling PBM, struck one of its bowser boats with its port screw; *Ballard* was severely damaged, and the bowser sunk. Then, as they turned hard away from the beach, their starboard propellor became entangled in an aircraft buoy and cable (USS *Ballard* 1945:26). It was an inauspicious start to the open ocean seadrome.

Yet despite this interruption, four patrol planes were ready for that night's mission. Although these searches were intended to be dusk takeoffs and dawn landings, conditions in the seadrome, including weather conditions and enemy attacks, caused sufficient delays to necessitate a nighttime takeoff (Kammen 1958:77). The fifth PBM, having taxied away from the anchorage during the air attack at sundown, now found itself hopelessly lost in the darkness. Unable to relocate *Ballard* or its squadron mates, it spent the evening taxiing to various vessels, seeking directions back to the open seadrome. A Landing Craft, Mechanized (LCM) took it under tow at 2200 and came upon the *Hercules* at 2300 (USS *Hercules* War Diary 1944:9).

Securing astern of the cargo ship (AK), the patrol plane commander (PPC) went aboard to use the ship's systems to communicate with the VP-16 squadron commander aboard *Ballard*. He was instructed to request and await a tow back to the anchorage. While aboard *Hercules*, the PPC encountered a disturbing lack of familiarity with the PBM amongst the surface vessel's crew that foretold significant challenges with identification by friendly forces, with dire consequences, very shortly. Finally, at 0205, a salvage boat took the errant PBM under tow and returned it to the seaplane anchorage at 0530. Suffering engine damage during the hectic maneuvering during the earlier air attack, likely from a browser boat drifting into its propeller, it was no longer mission capable and could not participate in future patrols (VP-16 History 1945:40).

The four remaining Mariners began conducting searches for the First Mobile Fleet that evening. That night, a RADAR surface search took the aircraft 600 mi. (966 km) west and within 500 mi. (805 km) of the Philippines. Search planes were assigned to sectors 245° to 265° and 275° to 295°, out 600 mi. (1,111 km). The sector between these two, 265° to 275°, was not covered due to "plane failure" (Commander Fifth Fleet 1944:21).

At the last minute, LCDR Scarpino appealed to his higher headquarters to have the night's mission scrubbed, given the adverse weather and hazardous operating conditions. RADM Harry Hill, Commander, Commander, Western Landing Group and SOPA, responded personally to "explain the importance of mission and need to get planes off" (USS *Ballard* War Diary:11).

Subsequently,

> At 2300, the four planes were manned preparing to take off in the most adverse weather conditions to which any pilot had ever been subjected. In addition to the hazardous swells in the takeoff area, the sea was choppy, and the winds were continually shifting. No marker buoys could be obtained, and the total overcast, with intermittent showers, reduced night visibility to zero. But the missions were urgent if the fleet was to avoid surprise attack by the enemy, so the high command risked violation of the blackout by lighting the area with two powerful searchlights. (VP-16 War History:38)

These searchlights were from *Ballard* and USS *Phelps* (DD-360). At 2240, *Phelps* detached from its fire support mission, navigated through the transport area, and took station 500 to 1000 yd. (46 to 92 m) from *Ballard* to assist with launch operations. The searchlights were found to have a blinding effect and were more of a hindrance than a help, and summarily extinguished. *Phelps* returned to its fire support station after completion of takeoffs at 0038. After six hours, it had taken two damaging large-caliber enemy shell hits and suffered numerous casualties, punctuating the threat posed by Japanese guns (USS *Phelps* War Diary 1944:7).

Takeoffs under these conditions were extremely difficult. Several aircraft had to make numerous runs once they began to porpoise upon the high waves too badly to avoid crashing. One pilot smashed his face into the windshield frame, causing bleeding so severe that he had to relinquish control to the copilot even before all four aircraft managed to take flight and proceed on mission. An ordnanceman fractured his leg (VP-16 History 1945:39).

The first night of searches yielded no results. The enemy fleet was still beyond even the extended range of the PBMs. Meanwhile, Japanese attacks against the anchorage continued. The anchorage was disrupted by another enemy air attack even before aircraft had returned from their patrols. Concurrently, fire from a Japanese shore battery struck *Ballard* soon after sunrise. A single armor-piercing shell “smashed through the rearming boat which was in the starboard skids aft” (USS *Ballard* 1945:26). The round came perilously close to the aviation fuel storage tanks. A catastrophe was narrowly avoided because the round failed to detonate due to the thin armor of the tender, allowing it to pass through the vessel relatively cleanly (USS *Ballard* 1945:13).

The four patrolling aircraft returned by noon on 18 June 1944 and immediately began preparing for the next mission. Air attacks caused frequent interruptions and impeded refueling operations. The evening missions were again delayed and not ready to launch until sunset, in darkness and essentially a repeat of the problematic night before. Another pilot impacted the windshield frame during forceful contact with the water and was injured badly enough that a co-pilot again had to take over the flight (VP-16 History 1945:42). However, unlike the previous night, several of this evening's missions proved to be highly eventful.

As these missions unfolded, two additional seaplane tenders, *Pokomoke* and *Onslow*, finally arrived from Eniwetok to augment the hard-pressed *Ballard*. With their arrival, the open ocean seadrome finally had the tender support necessary to support VP-16's Mariners properly. *Pokomoke* brought bunk space to allow aircrews to move from their aircraft to proper shipboard berths, showers, and messing facilities to provide hot meals. It had sufficient fuel, armament, spare parts, and maintainers to tend to the flying machines properly. Critically, it had a crane and deck space to retrieve a PBM from the sea to prevent damaged aircraft from sinking or to perform higher echelon maintenance on board. *Ballard* and *Onslow* now provided auxiliary support to *Pokomoke* and performed whatever required tasks. Importantly, with three seaplane tenders at the open ocean seadrome, the rest of the squadron could begin to join their command forward.

Back in the air, a PBM had made RADAR contact with a large force of approximately 40 ships near the end of his outbound leg. Closing the distance, he confirmed this to be the main body of the enemy fleet and the object of the squadron's search (FIGURE 2.16). The Mariner,

> immediately started to radio its position in the hope of bringing about the engagement between our task force FIFTY-EIGHT and the enemy, which the Navy had been praying for. But Lieut. Earle's lot was not to be the hero who brought about the destruction of the enemy fleet. His radioman could not establish communications on the primary frequency, nor was he successful on any of the secondaries. The pilot even tried voice but to no avail. (VP-16 History 1945:42)

Finally, unable to raise the fleet, the PPC set a return course for Saipan to communicate this potential war-changing information as rapidly as possible (VP-16 History 1945:42).

The Fifth Fleet Commander only received this sighting report when the PBM arrived back in Saipan almost eight hours later. This delay significantly reduced tactical options for the Fifth Fleet. The prospect of a daytime surface engagement by VADM Augustus “Ching” Lee Jr., Commander, Battleships, Pacific Fleet’s superior U.S. surface fleet, had evaporated. VADM Lee declined when the opportunity for a night surface engagement and communicated, “Possible advantages of RADAR more than offset by difficulties of communications and lack of fleet training at night” (Morison 1953:244).

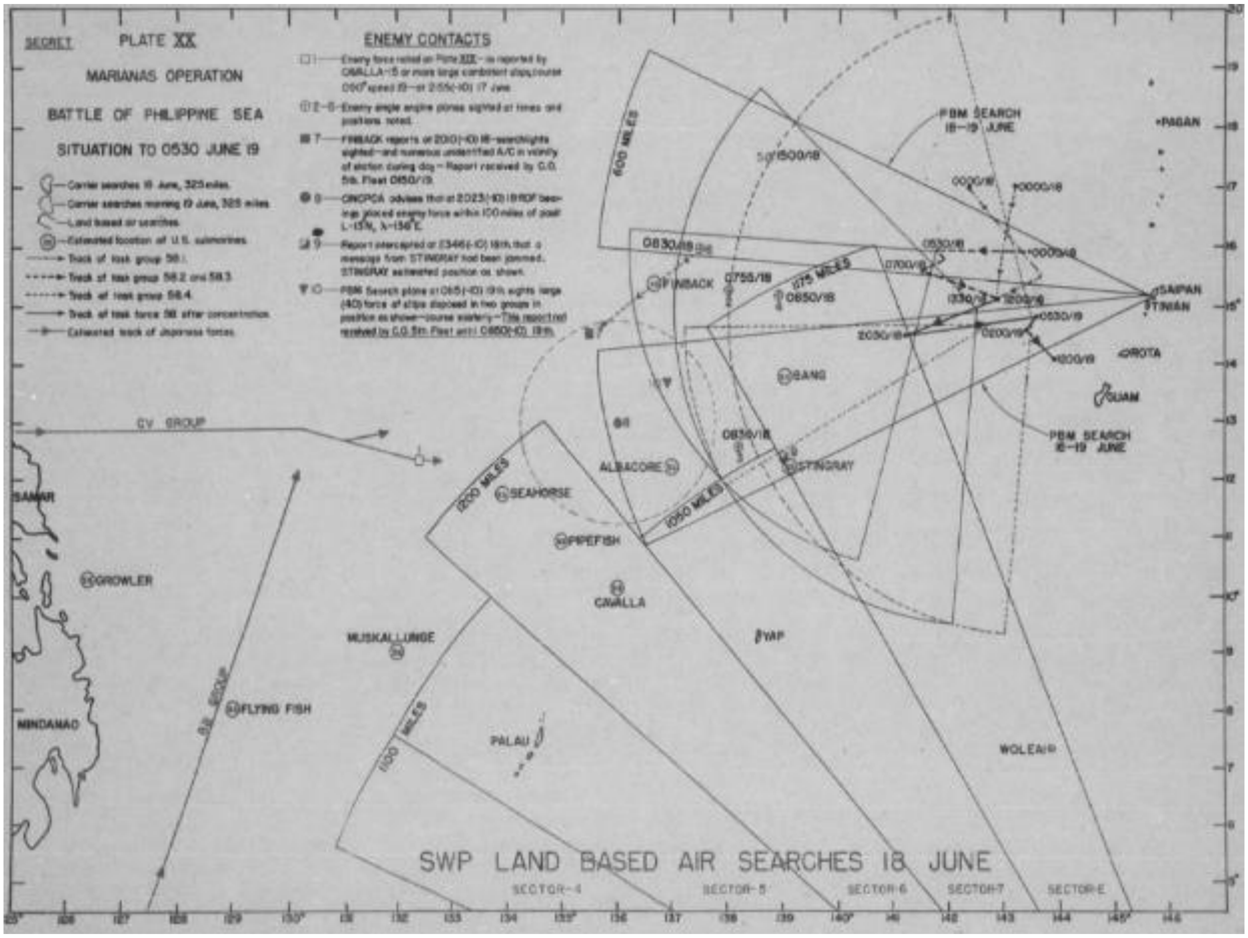


FIGURE 2.16: Diagram showing air search fans for land-based air searches on 18 June 1944. Note location of Japanese fleet detection by PBM that went unreported for eight hours due to communications challenges. (Map from CINCPAC Report of Action:135)

The squadron ascribed the failure to the onboard communications equipment, subjected to repeated harsh treatment takeoffs and landings in the open ocean seadrome and an assumed HF "blind spot" west of Saipan. Unfortunately, Admiral Nimitz's report was less sanguine, attributing the failure to "material and personnel failures in the plane" (CINCPAC 1944:130). This contact report was purportedly heard by other non-VP-16 patrol aircraft and a seaplane tender at Eniwetok, highlighting how atmospherics and HF radio wave propagation patterns can play havoc in long-range communications. Unsubstantiated rumors, most certainly untrue, of the aircrew having failed to unreel an HF trailing antenna and radio watch failures to log the message aboard *Pokomoke* properly also circulated (Morison 1953:255). Famed naval historian

Samuel Eliot Morrison graciously offered, “It was just another communications failure; nobody’s site formation

fault” (Morison 1953:255).

Regardless of the cause, the damage was done, and Admiral Nimitz observed, “This report, had it been received within a reasonably short time, might have altered the outcome of the Battle of the Philippine Sea and resulted in a much greater destruction of the Japanese Forces” (CINCPAC 1944:130). Consequently, additional radio watches were established aboard the seaplane tenders to mitigate the potential for future communication failures.

Regrettably, this was not the only excitement from the night’s patrols. Another seaplane was on the final leg of its return journey when it encountered a U.S. fleet 100 mi. (161 km) west of Guam. After turning to give the fleet a wide berth, it encountered a friendly CAP of four F6F Hellcats. This division of F6F Hellcats mistook the Mariner for a Japanese interloper, likely a Kawanishi H8K “Emily” flying boat (FIGURE 1.17).

Despite standing orders that all seaplanes in the area be treated as friendly and specifically identifying PBMs as operational in this zone, these fighters misidentified the Mariner and commenced an attack run. The Hellcat division made a single pass, and the lead two fighters took the PBM under fire, severing the Mariner’s rudder control cables and disabling the deck turret. The order was given to return fire, and the undamaged gun positions in the Mariner each fired up to 150 rounds without effect. The second fighter completed its run, inflicting additional damage (VP-16 War Diary 1944:5).

FIGURE 1.17: A Japanese Kawanishi H8K “Emily” flying boat just before being shot down by a Navy PB4Y-1 bomber on 2 July 1944. Note the general similarity in shape and appearance to a Martin PBM-3 Mariner (Photo courtesy of National Archives photo #80-G-241258).

Additional damage to the Mariner included punctures to the starboard gull, outer wing, and float (FIGURE 2.18). The center hull and starboard bomb bay fuel tanks were perforated, and the cockpit instrument panel was struck, shearing away instrument wiring. The vertical stabilizer took multiple hits, along with the rudder trim tab torque and de-icing tubes (VP-16 War Diary 1944:5).

More seriously, one sailor aboard the stricken aircraft was mortally wounded in the attack, while several others sustained minor injuries. The Plane Captain, Aviation Machinist Mate Second Class Person, took a .50 caliber bullet to his right shoulder and chest. He lost consciousness soon after the attack and was dead by the time the plane staggered back to Saipan 40 minutes later. Following a textbook landing, despite the damage, the aircraft began taking on water as it was delivered under tow to *Pocomoke,* where it was raised to the deck space to save it from sinking (FIGURE 2.19 & 2.20) (VP-16 War Diary 1944:4). The dead and wounded were also brought aboard (FIGURE 2.21 & 2.22).

Efforts to identify the offending fighters were unsuccessful, and guilt for the attack was not established [APPENDIX A provides the author's attempt to do just that] (FIGURE 2.23). This incident highlights the ever-present danger patrol aircraft faced by friends and foes while operating in the open ocean seadrome. Although this unconventional mode allowed these aircraft to operate from the forward edge of the battle area for the first time, it took some time for the rest of the fleet to become accustomed to them despite proactive efforts to do so (FIGURE 2.24).

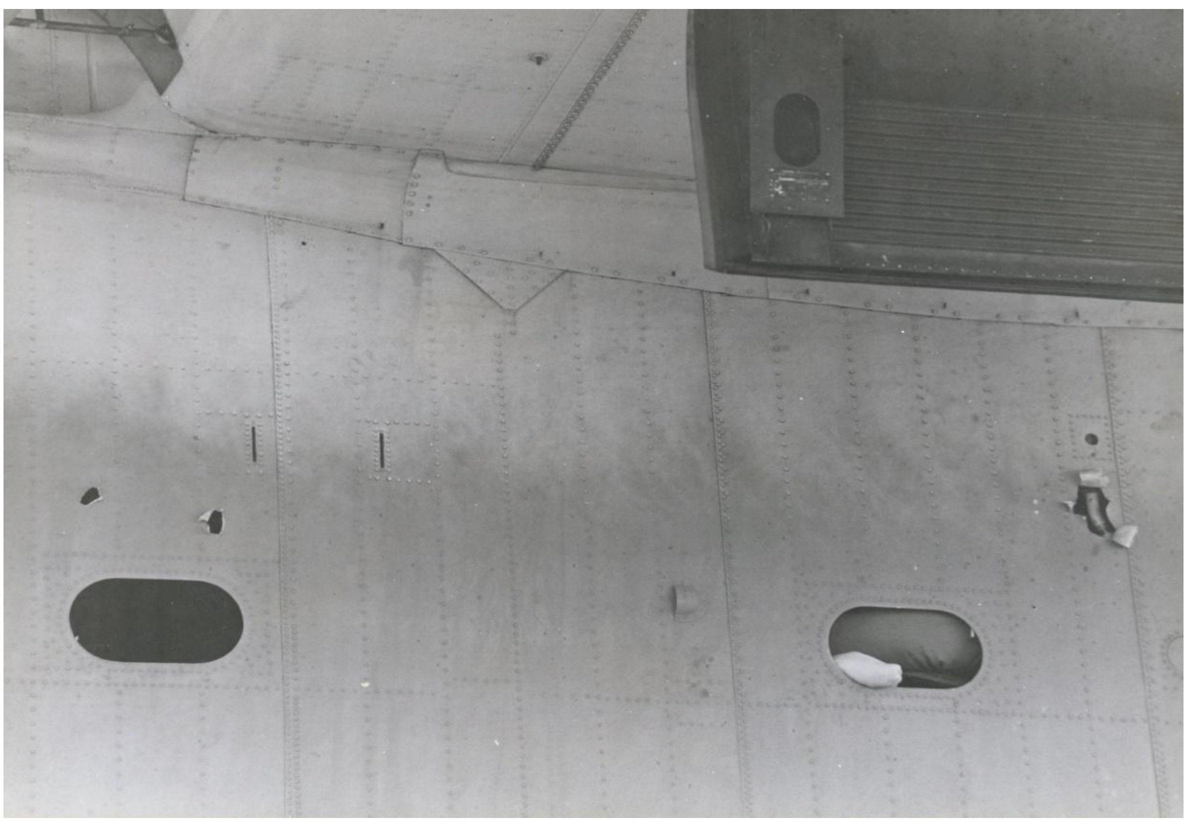


FIGURE 2.18: Damage to aircraft 16-P-1 documented while aboard *Pokomoke*. Note outward bending metal on airframe skin indicating bullet exit holes (Photo courtesy of National Archives photo #80-G-234456).

FIGURE 2.19: PMB-3D 16-P-1 under tow to *Pokomoke* after sustaining damage during an F6F Hellcat friendly fire incident (Photo courtesy of National Archives photo #80-G-238447).

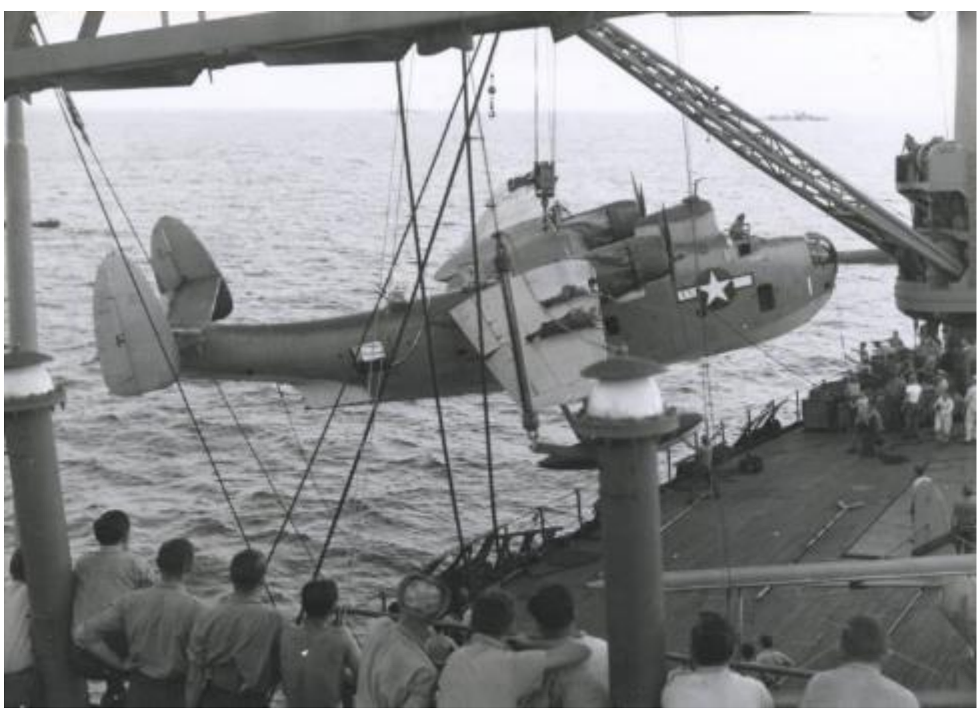


FIGURE 2.20: PBM-3D 16-P-1 being craned aboard *Pokomoke* after sustaining damage during a friendly fire incident (Photo courtesy of National Archives photo #80-G-238454).

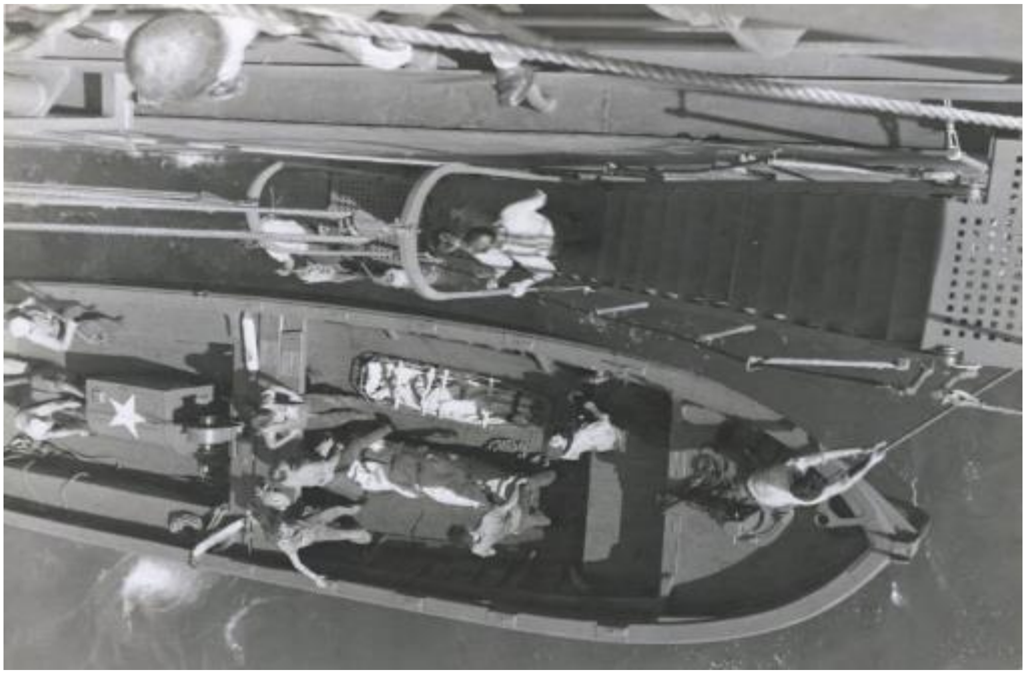


FIGURE 2.21: Motor launch alongside *Pokomoke* with deceased Aviation Machinist Mate Second Class Person and other wounded aircrew (Photo courtesy of National Archives photo #80-G-23438).

FIGURE 2.22: Aviation Machinist Mate Second Class Person's remains being recovered aboard *Pokomoke*. He was interred at Saipan following an autopsy (Photo courtesy of National Archives photo #80-G-234410).

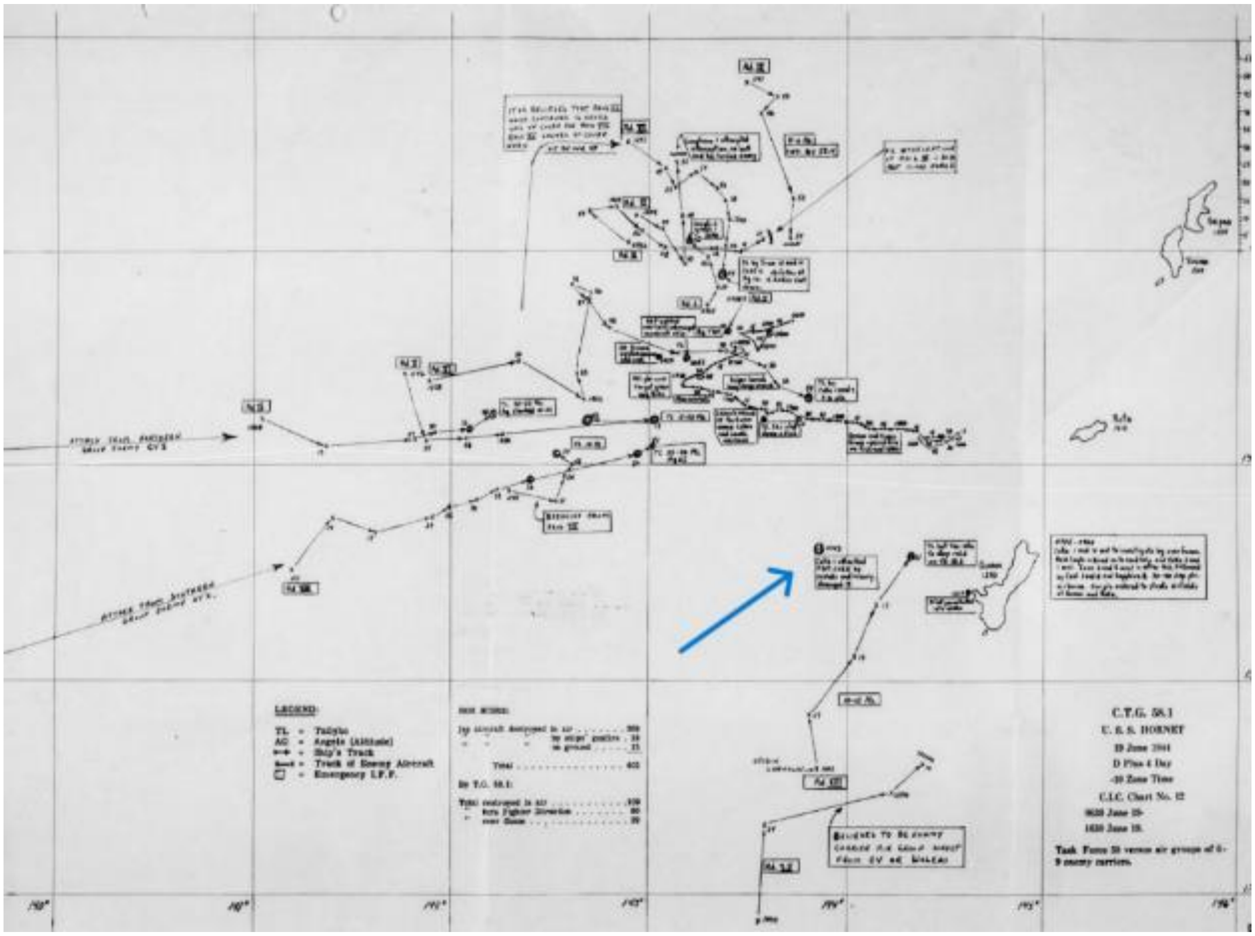


FIGURE 2.23: June 1944 chart plot from CTG 58.1's Combat Information Center identifying track of CTG 58.1 and location of Coke 1's engagement with VP-16 PBM-3D at 0743 [blue arrow added by author] (Image from CTG 58.1 Report of Action).

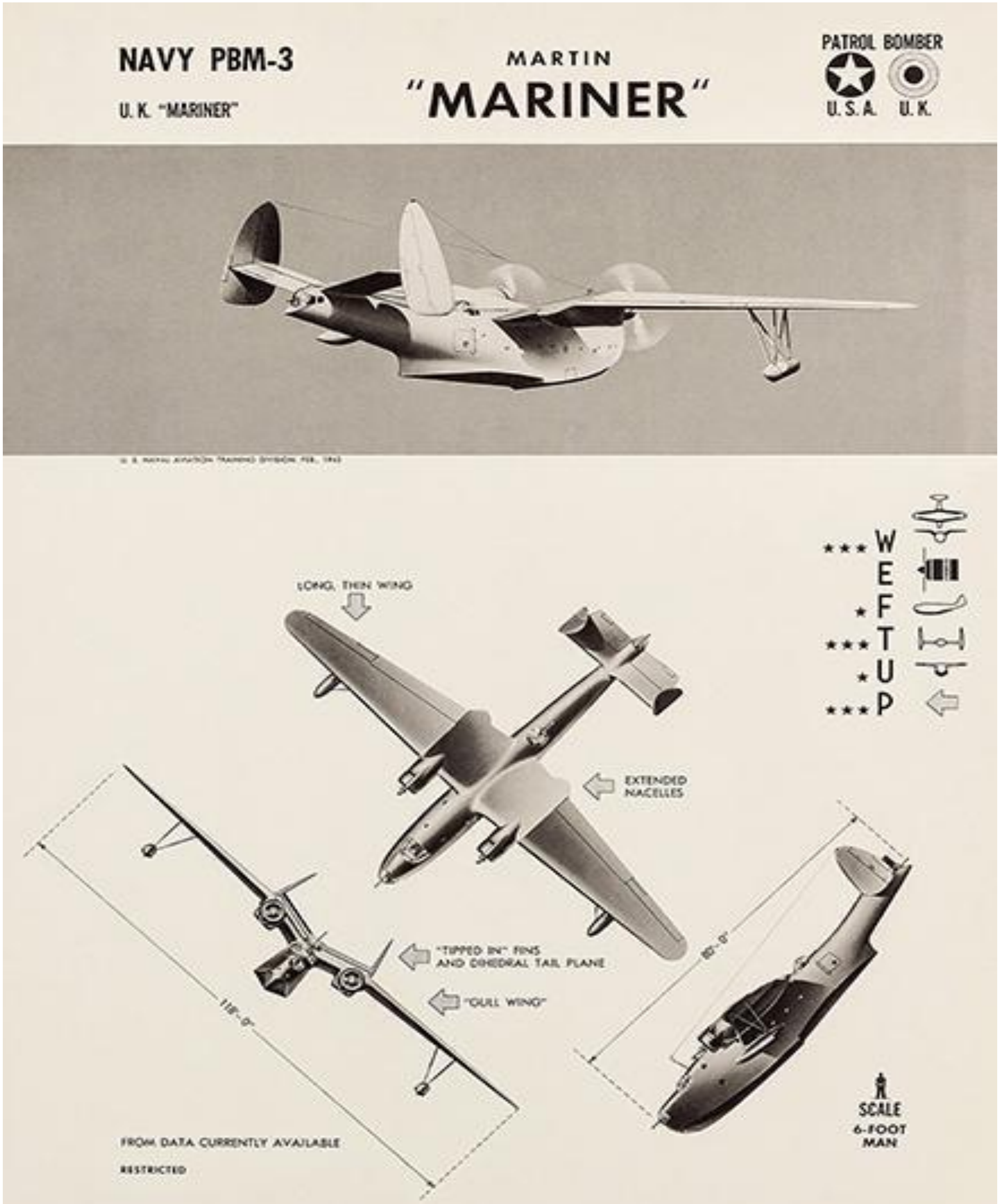


FIGURE 2.24: Navy PBM-3 Martin "Mariner" Patrol Bomber recognition poster designed to facilitate easy recognition to help avoid friendly fire incidents (Image courtesy U.S. government).

2.4.c. The Loss of BuNo 48173

Another catastrophic incident occurred as the friendly fire battle-damaged PBM was being craned to *Pocomoke*'s deck. BuNo 48173 had just returned from its search and was prepared to be serviced and refueled. At 1130(K) [local time], *Pocomoke*'s bowser boat #2 moved forward to refuel it (FIGURE 2.25). The rough sea prevented a successful rendezvous, and as the coxswain of the bowser boat turned away, its stern struck the Mariner, "venting the seams and puncturing the hull from the port bow hatch to the port beaching hatch" (Campbell 2018:379–380). Ironically, the decision to stop using the refueling boats due to the high sea state borne of this concern had already been made but had yet to be promulgated down the chain of command.

The forward two of the aircraft's five watertight compartments had been compromised. Rags, pillows, and steel wool were inserted, but the water inflow could not be stymied. The crew activated and supplemented the aircraft's ten-gallon-per-minute electric bilge pump with manual pumps. Additional gasoline-powered pumps were brought aboard. Water continued to flow in, outpacing efforts to pump it out. The aircraft assumed a nose-down attitude. USS *Perry* (DD-340), having just transferred 100 rounds of 3- inch (in.) shells to *Ballard*, maneuvered close, making a bid to secure the aircraft, but the line sent over was too thick to pass through the Mariner's tail-towing eye (Campbell 2018:380; USS *Ballard* 1944b:14). Despite dedicated efforts by the aircrew, bowser crew, and nearby vessels, it was a losing proposition.

Once the outcome became inevitable, the PPC and crew deplaned. Two minutes later, BuNo 48173 began its nose-first descent to the bottom of the Saipan Shelf 17 ftm. (102 ft./31 m) below where it remains (Campbell 2018:380). The sinking event, starting to finish, lasted approximately three hours.

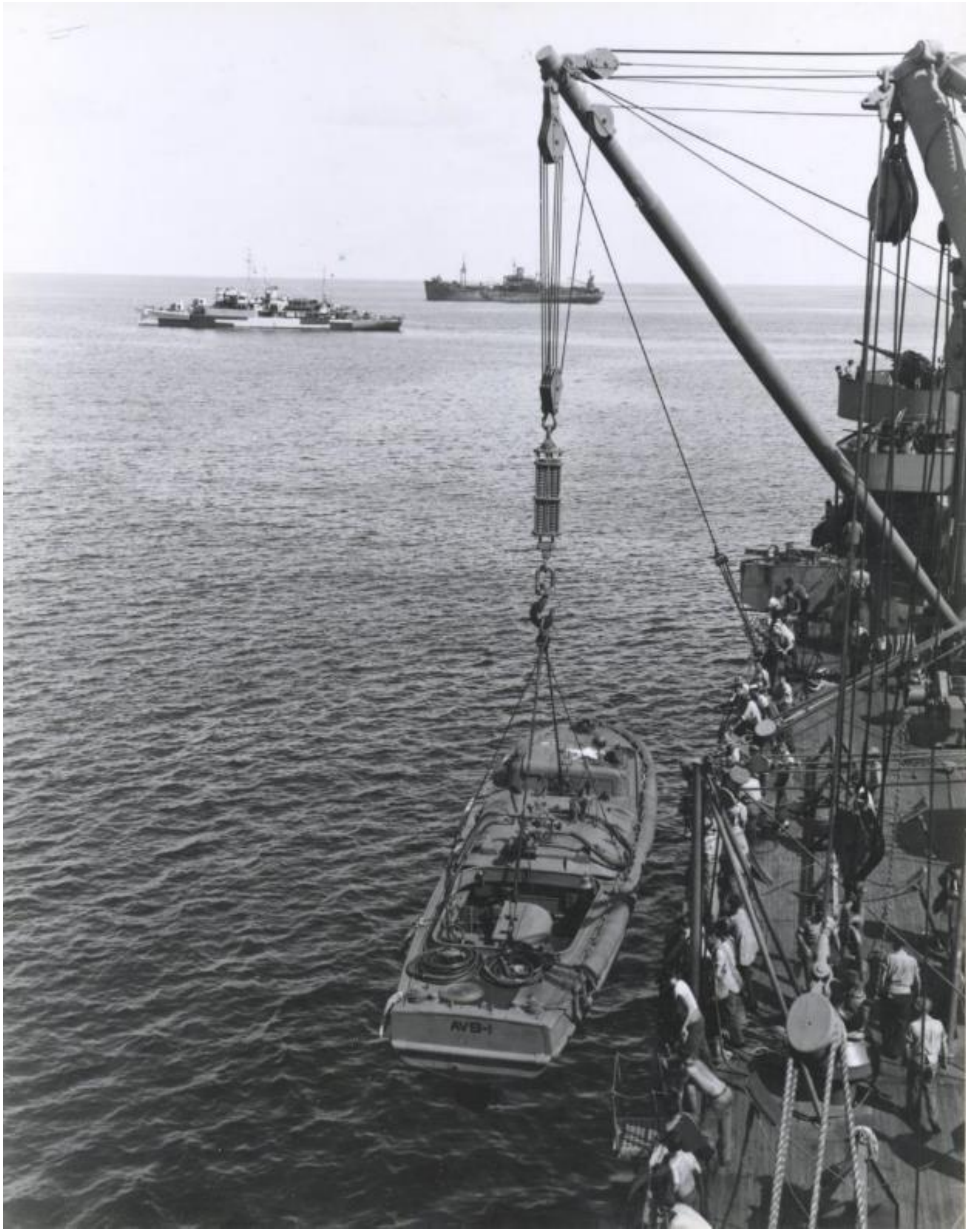


FIGURE 2.25: USS *Pokomoke* lowers #1 aviation fuel barge into the water preparatory to fueling squadron of PBMs. This photograph was most likely taken at Kossol Passage, Palau Islands in September 1944. It was the #2 aviation fuel barge from *Pokomok*e that sank BuNo 48173 (Photo courtesy of National Archives #80-G-286316).

2.4.d. Endgame

This last incident brought PBM operational losses to three: one with an unbalanced propeller due to collision, another the victim of friendly fire, and the last lost to the depths after a mishap during refueling — all within two days of arrival to Saipan. After *Pocomoke* and *Onslow* arrived, these losses could be made up as the balance of VP-16 deployed forward. At 1400 on 19 June 1944, four additional PBMs departed Eniwetok bound for Saipan's open ocean seadrome. Inexplicably, these flights still had no more information regarding their destination or expectations upon arrival than the original flight. The late departure ensured they arrived after sundown, necessitating a night landing in an unfamiliar destination amidst combat operations. Lighted buoys were towed in tandem to light the landing site. Despite suboptimal timing and circumstances, all aircraft safely landed. (USS *Pocomoke* War Diary 1944:3). A final VP-16 PBM-3D arrived on 23 June 1944, delayed by ubiquitous engine issues until after the open ocean seadrome was disestablished (VP-16 History 1945:46).

As this unfolded, VADM Hoover, as Commander Forward Area, Pacific, and ultimately responsible for the performance of all patrol aircraft and seaplane tenders in theater, decided to fly to Eniwetok himself to assess the situation directly (FIGURE 2.26). He had "earlier expressed concern over the failure of two of the first six planes sent forward from Eniwetok to the Marianas to conduct night searches" (Commander Forward Area 1944:201–202). VP-16 had a difficult first 48 hours in the open ocean seadrome between challenges deploying and conducting the first night's searches, a damaged seaplane in the anchorage, a failed contact report, loss of an aircraft and sailor to friendly fire, subsequent loss of BuNo 48173 during refueling, and unwanted attention from a senior Flag Officer.

FIGURE 2.26: Vice Admiral John Hoover, Commander, Forward Area, became personally involved after the rocky initial deployment of VP-16 to Saipan. (Photo courtesy of National Archives #80-G-42110.)

Meanwhile, the Battle of the Philippine Sea raged. Although VP-16's failed sighting report did not facilitate a potential surface action or possible first strike, it did provide Task Force 58 advance notice of the Japanese fleet's proximity in conjunction with several submarine contact reports. This allowed Task Force 58 to prepare to receive the inevitable Japanese air assault. In what came to be known as the Great Marianas Turkey Shoot, Japanese air attacks were eviscerated by superior U.S. aircraft, aviators, and anti-aircraft fires. Retaliatory strikes, launched late in the day and requiring aircrew to return after sunset in the Mission Beyond Darkness, did severe, though not crippling, damage to the Japanese forces.

The Task Force 58 commander, following the significant actions of that day, chose not to send carrier-based search aircraft out to give these aircrews a much-needed respite. VP-16 supported the Fifth Fleet with another five aircraft night RADAR patrol that night. Despite searching where the Japanese fleet should have been on the night of 19–20 June 1944, the Mariners inexplicably did not locate the enemy. Now, the lack of intelligence regarding the enemy's location again hindered the ability of Task Force 58 to strike a crippling blow. The undetected Japanese fleet was withdrawing, with U.S. forces cautiously probing behind them.

VP-16's final contribution to the battle came the next night. A Mariner located the enemy fleet at 0130 on 21 June 1944, sent a contact report, and shadowed this force for almost three hours. It reported their "size, course, and speed, sometimes approaching to within three miles and at one time near enough to see the wake of one of the enemy's ships" (VP-16 History 1945:47). VP-16 considered this sighting and reported to be "its most tangible contribution to the Marianas campaign" (VP-16 History 1945:47). It observed damage to Japanese ships, some with oil trailing in their wakes, giving Task Force 58 hope of catching stragglers or damaged vessels to deliver a *coup de grâce*. Bomb-laden Hellcats launched the following morning, searching for 300 mi. (483 km) for targets. None were found, and pursuit was broken off (Y'Blood 1981:203 204). The Battle of the Philippine Sea was over.

The need for long-range night RADAR patrols abated after the Japanese First Mobile Fleet withdrew. By 20 June 1944, other PBM squadrons began arriving in Saipan, and the need for space in the seadrome expanded. The Marines and soldiers had also made steady progress ashore, and the threat to the Mariners receded along with the Japanese defenders. The crisis had passed, as did the need for the open ocean seadrome.

On 21 June 1944, conditions were sufficient to begin shifting the seadrome closer to shore into calmer, protected waters (FIGURE 2.27). *Ballard* was again tasked with collecting seaplane anchorage floats and laying a new mooring field much closer to land. The open ocean seadrome was disestablished just five days after its historic establishment. The Squadron History is quite poignant when it communicates, "As the only squadron of long-range search planes available when the security of the United States fleet demanded long-range night searches, VP-16 had stepped into the breach." That breach had now been closed, and VP-16 terminated night RADAR patrols on 24 June 1944, just a week after they began. VP-16 considered it "the longest week in the squadron's history" (VP-16 History 1945:50)

FIGURE 2.27: The Saipan seadrome as seen from USS *Pokomoke* on 30 June 1944, after the open ocean seadrome had been disestablished but before the Tanapag Harbor seadrome had opened. Note the congested waters these Mariners had to operate from (Photo courtesy National Archives #80-G-241408).

CHAPTER 3: THEORY

The sinking of BuNo 48173 has opened the door to a trove of contemporary archaeological potential regarding Saipan's open ocean seadrome site. Presently, no evidence suggests the sunken PBM-3D (BuNo 48173) was salvaged or even rediscovered, and to date, no known dedicated effort has been made to do so. Given the proximity to shore (4 mi./6.4 km), relative shallowness (approximately 100-110 ft./30-33 m), and comparatively passive conditions of its sinking compared to most aircraft in the maritime environment, it is reasonable to assume this aircraft remains generally intact. It is, therefore, an exceptional potential candidate for efforts to relocate and survey *in situ* for its probable significant contributions to both the historical and archaeological record, especially regarding site formation characteristics.

3.1. THEORETICAL CONSIDERATIONS

Extensive academic effort has been put into archaeological site formation theory, beginning with Keith Muckleroy's (1978) seminal work, Ingrid Ward and colleagues' (1999), and Martin Gibbs' (2006) continued efforts to advance theory development. More recently, Samantha Bell (2010) applied an inaugural level of attention to site formation theory specifically geared toward submerged aircraft wrecks. This chapter conducts a predictive site formation analysis leveraging the works of these theorists and surveys undertaken previously on similar sites. Given the unique circumstances of this PBM-3D loss, it is an excellent candidate to leverage these theoretical considerations and advance the record regarding aircraft-specific site formation characteristics.

These considerations extend to the impact of post-loss environmental factors. It is understood "that aircraft, particularly World War II aircraft, are not constructed to last for substantial lengths of time" (Whipple 1995:11). Additionally, aircraft are manufactured of lighter material for longer flight times and aerodynamic properties (Bell 2010: 25). Their aluminum construction, designed for the “strength and lightness” required for flight, is “highly susceptible to corrosion in salt water and would not have the durability of shipwrecks built using base metals” (Jung 2008:8). Unlike boats and ships explicitly designed for the rigors of the marine environment, aircraft are not designed to operate in nor endure these conditions for any period. Even today, corrosion control efforts are of central importance for the maintenance cycle of any aircraft operated from a ship or in the maritime environment. This fragility extends to their performance and survivability on the battlefield and the time beyond, especially in the marine environment.

Although aviation technology and design significantly enhanced the durability and ruggedness of many aircraft variants as development continued, they were still intended for very different operating environments (air environment) than traditional ships (marine environment). While this generalization broadly holds, there are atypical variations of these conventional dynamics, for example, the PBM-3D Mariner. Peter Fix explains, “Seaplanes and amphibious planes, by design, are intended to land and navigate on water” (Fix 2011:1001). As such, a seaplane is a conceptually hybrid aircraft designed to operate in both the air and maritime environments. It must be engineered and reinforced to handle both the traditional forces that act upon airplanes — lift, drag, weight, and thrust — and those that act upon ships. Other factors such as extended periods in a corrosive saltwater environment, poor hydrodynamic handling characteristics, and excessively high sea states are just some of the conditions that must also be contended with.

Considering a harsh, high-energy transition was required between these two operating environments during a takeoff and landing, a seaplane deserves special design recognition and consideration when assessing aircraft durability and theoretical site formation characteristics. This was especially true for VP-16's Mariners operating well offshore in the unprotected waters of the open ocean seadrome. Military hardening and survivability characteristics undoubtedly transfer to the inherent ability of these aircraft to survive in the severe maritime environment. Despite such enhancements, seaplanes remain susceptible to degradation and are impacted by traditional cultural and environmental site formation factors like any other naval wreck.

This dynamic associated with seaplanes was borne out during the Australian government's early 21st-century efforts to protect the legacy of flying boats participating in a nationally historically significant evacuation effort:

> On the morning of 3 March 1942, an armada of fifteen flying boats was at anchor in the waters of Roebuck Bay, not far from the jetty serving the township of Broome on the Kimberley coast. Bound for Perth with the last of nearly 8000 refugees fleeing the Japanese advance into the Netherlands East Indies (NEI), the aircraft were delayed in their take-off by a combination of low tide and the need to refuel. Caught unprepared, they were subsequently destroyed by Japanese warplanes that arrived overhead at 0930 that day. The pilots apparently had orders to seek out only military targets and this they did to good effect…. (Jung 2008:7)

These 15 aircraft rate highly across the board in various categories important for their consideration for special treatment in the Australian Register of Historical Places. Some of these categories include:

> Scientific Value: Test excavations have shown that each aircraft (including those often accessed by visitors) contains a remarkable range of materials. Much of what remains below the seabed is well preserved in the anaerobic sediments and each assemblage has the potential to yield information that will contribute to the understanding of technical aspects of the operation and construction of the Flying Boat type.
>
> Social Value: The place is important to community, service, and ex-service groups, for its cultural and historical associations with the flying boat service, the aerial attack and the consequent loss of life.
>
> Condition: The current potential of the sites to contain archaeological material is high. Despite the removal of some material that may detract from the archaeological record, the current management strategies are serving to prevent further degradation. There is a high expectation that many disturbed deposits are present within the site.
>
> Integrity: As a result of the raid it became a World War Two wreckage site and it remains so. It has a high level of integrity.

> Authenticity: As with underwater heritage sites generally, the fabric of each aircraft has been altered from March 1942 only in respect of what has been removed by cultural processes or altered by natural processes such as tidal effect, corrosion and the like, i.e. the machines and their contents are 'as lost'. As a wreckage site the place has a high level of authenticity. (Jung 2008:5–6)

The Government of Australia presciently recognized that this eclectic concentration of aircraft offers a unique archaeological opportunity that must be preserved. Similar approaches have been collaboratively employed in the U.S. between the NPS's History Department and the Navy to "help preserve what remains of aviation material culture" (Foster 1993:6). These efforts provide precedent for preserving and protecting the wreckage of BuNo 48173 *in situ*.

As appropriate as this example is, there is another case study that is even more germane — the study of four aircraft wrecks in the protected harbor of Tanapag Lagoon in Saipan. These aircraft include "an Aichi E13A (Aichi) Japanese search floatplane, a Kawanishi H8K (Kawanishi) flying boat, Martin PBM Mariner (Mariner) U.S. flying boat, and a TBM Avenger (Avenger)" (Bell 2015:50). Bell conducted an extensive investigation into site formation theory to inform these aircraft losses. She offers keen insights and assessments in this MA thesis regarding the applicability of "theoretical and methodological practices in submerged aircraft archaeology and the application of site formation theory" (Bell 2010:2). Her efforts are comprehensive and continue to build upon the theoretical work of Muckelroy (1978), Ward et al. (1999), and Gibbs (2006). According to Bell:

> All three of these studies contribute to the understanding of site formation processes creating and affecting the observed seabed distribution of shipwreck sites. Research in this area enables maritime archaeologists to understand the environmental and cultural factors affecting shipwreck sites. These works also provide the basic theoretical and methodological framework for this research. Nonetheless the application of these studies to the investigation of submerged aircraft is minimal…. (Bell 2010:18)

To rectify the latter point, she developed an original model to address submerged aircraft site formation (FIGURE 3.1). Bell's model is used for this study to analyze and make a theoretical predictive assessment of BuNo 48173's site formation.

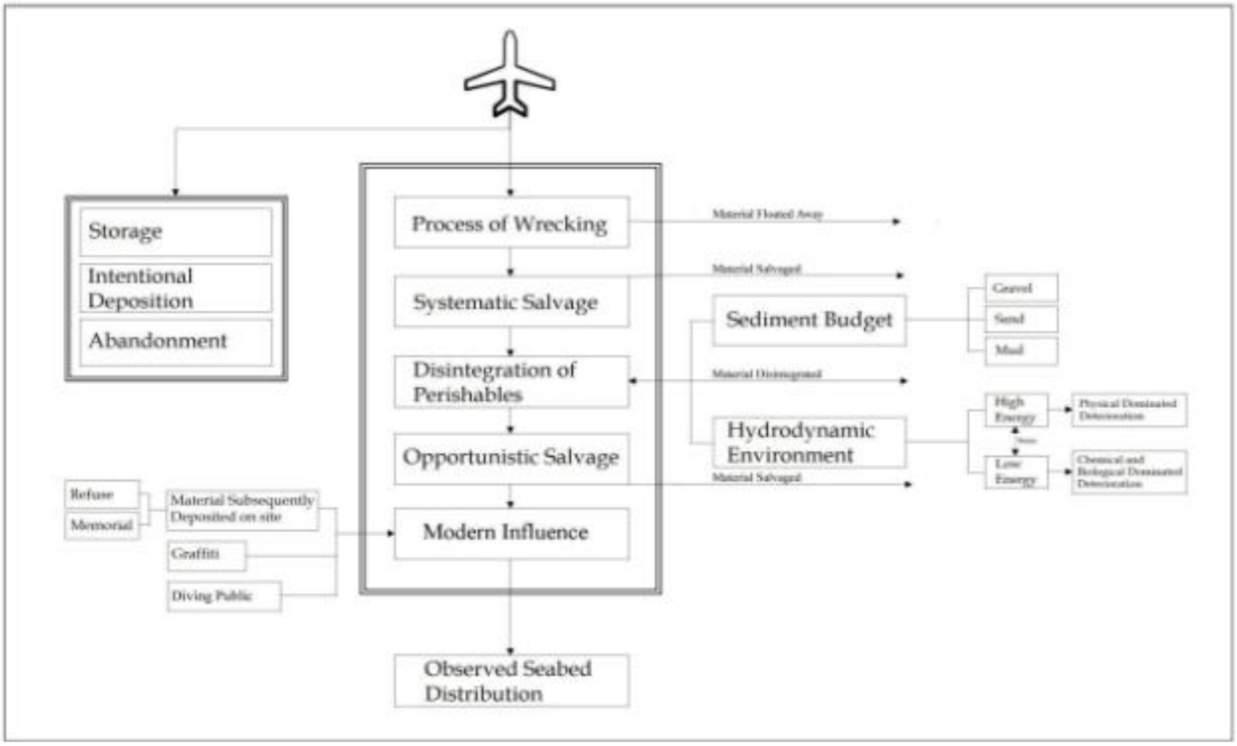


FIGURE 3.1: Processual model developed by Samantha Bell for consideration to submerged aircraft site formation analysis. (Diagram courtesy Samantha Bell.)

3.2. PBM- 3D BUNO 48173: A PREDICTIVE SITE FORMATION ASSESSMENT

On 19 June 1944, PBM-3D BuNo 48173 unexpectedly suffered collision damage to the two forwardmost of its five watertight compartments at anchor by a refueling bowser boat. While maneuvering the boat, the "stern of the [bowser] boat struck the plane's side, venting the seams and puncturing the hull from the port bow hatch aft to the port beaching hatch," commencing the process of wrecking (Campbell 2018:379–380). Aggressive but unsuccessful efforts were made to shore the punctures with rags, pillows, and steel wool; the water inflow could not be stymied. The aircraft possessed a ten-gallon-per-minute electric bilge pump augmented by manual pumps. Gasoline-powered pumps were brought aboard when these were unable to keep pace with the flooding. Still, water continued to flow in, outpacing efforts to pump it out, and the aircraft gradually assumed a nose-down attitude.

Most effort by the crew was directed at pumping out water and regaining watertight integrity. Losing the battle, the crew probably turned to what Bell (2010) describes as systematic salvage to save what they could and lighten the aircraft. Some high-demand, low-density, easily removable equipment or items with an operational security component would have been removed. Otherwise, this aircraft presumably sunk with a full complement of equipment, ordnance, and the personal and professional effects of the crew, who spent most of their time aboard even while at anchor. It is unlikely that many of these items floated off as the aircraft is essentially an enclosed environment, even with the collision damage.

At the time of the damaging strike [1130(K)/local time], the tide was going out for the next hour and twenty-four minutes (COM GR 1 5th PHIBFOR 1946:141; Campbell 2018:379). This suggests a current flow away from the island that initially pulled the Mariner to the west of its mooring and generally oriented its nose toward the east. Yet the aircraft did not sink instantly and foundered for another three hours. Low tide occurred at 1254, and the water flow gradually reversed toward the island, pulling boats and aircraft toward the island to the east (COM GR 1 5th PHIBFOR 1946:141). Finally, at 1424, damage control efforts ceased and the crew exited the plane. At 1426, BuNo 48173 disappeared beneath the waves (USS *Ballard* 1944b:14). Given the tides at the time, it likely settled onto the bottom to the east of its mooring, potentially oriented toward the west.

With the two bow compartments flooded, the aircraft descended 18 ftm. (108 ft./33 m) to the bottom nose first. The anchoring hatch may have already been underwater and inaccessible, given the nose-down attitude and forward position of the anchoring hatch, making it impossible to detach the aircraft from its mooring line. Absent significant structural harm, the Mariner descended intact. The nose of the plane, the first structural feature to impact the bottom, likely suffered some degree of crushing damage. PBMs were also known to have its engine mounts dislocated on hard landings. Although unlikely, assuming the impact with the bottom was jarring enough, one or both of its Wright R-2600-22 engines may have separated from the aircraft at this point. Otherwise, the plane likely settled on the bottom in one piece.

There is a trend of aircraft settling on their back when lost in the maritime environment. This is well documented by Silvano Jung (2009a) during his extensive efforts documenting the World War II flying boat remains in Darwin (1996, 2001, 2007a, 2007b, 2009b, and 2013) and reinforced by the experiences of the seaplanes in Tanapag Harbor by Bell (2010), James Pruitt (2015), and Jack Adamson (2020). PBM-3 vertical stabilizers protrude markedly above the aft fuselage. Assuming this inversion trend held for BuNo 48173, these stabilizers likely suffered crushing damage and partial collapse as the aircraft's weight was transferred to these non-load-bearing surfaces. As it may also remain affixed to its anchorage, lateral movement may have been constrained both during the sinking event and after for as long as the robust mooring equipment remained intact.

During the sinking, the area remained an active combat location; no consideration was given to salvage efforts. The depth and lack of salvage equipment made any immediate efforts impossible even if there had been consideration for doing so. Therefore, systematic salvage beyond what took place during damage control activity was nonexistent. The aircraft and perishable items aboard soon began degrading due to the environment, consistent with the trends observed in the four other aircraft wrecks surveyed in Tanapag Lagoon.

BuNo 48173 is not situated in a protected lagoon and is potentially subjected to higher hydrodynamic energy. This environmental impact could be especially pronounced during typhoon activity, many of which have occurred since 1944. Consequently, BuNo 48173 may have become dislocated and shifted from its original location, although the wreck's depth and the coral composition of the ocean floor may have insulated it from these effects. Any movement may also have been restricted due to its mass and the aircraft's possible attachment to its anchorage. The sand and coral seabed have prevented it from sinking into the ocean floor.

Because the location of this wreck remains unknown, it is doubtful that any later opportunistic salvage occurred. However, the area is in a deep-water anchorage location, so an anchor or chain scope from a large ship may have impacted the site. This area served as a primary anchorage for the U.S. military during and after the Battle of Saipan. It also serves as a contemporary anchorage for large military and commercial vessels, and the risk they pose to the wreckage cannot be ignored. Other cultural impacts are likely minimal, and the environment is the critical factor in determining the seabed distribution of the wreck and its current condition.

Chief among these are the corrosive effects of saltwater. While corrosion and degradation continue, the impact is less significant than immediately following the sinking event. Highly degradable items will have largely perished, while more durable materials remain and have achieved a state of near stasis and environmental equilibrium. Coral growth and encrustations, beginning immediately after the sinking, will have developed on various portions of the wreck, making surveys more challenging. Marine life has likely occupied and thrived on the wreckage as an artificial reef and should be found in abundance. The sooner BuNo 48173 can be located, and conservation can begin, the more impactful its contribution to site formation theory and management of environmental factors. For maximal analysis, interpretation, contextual understanding and preservation this should be done *in situ*, meaning this wreckage should be studied exclusively in its original location and position, with an absolute minimum of invasive or damaging activity. What is lost through destructive archaeology can never be regained.

3.3. PBM-5A BUNO 59172: A CAUTIONARY TALE

This paper draws upon a growing body of work to adapt early shipwreck site formation models to aircraft wreckage. Despite the attention given to the research of underwater aircraft wrecks in recent years, there remains a realization that this is still an emergent field that demands continued theoretical and methodological attention from scholars and archaeologists. As recently as 2018, James Delgado acknowledged, “Submerged aircraft are a newly emerging area of study in underwater archaeology” (Delgado et al. 2018:145). This recognition provided significant emergent attention to underwater aircraft wreckage in the past decades.

Governments, corporations, and private individuals are making extraordinary efforts to preserve what has been lost. This work is prolific, and “since the late 1960s military aircraft crash sites have been intensively targeted for amateur excavations, to such an extent that it is often suggested that few accessible sites now remain undisturbed” (Holyoak 2001:657). Unfortunately, “many terrestrial sites have been plundered or improperly excavated” resulting in a significant loss of contextual information that can never be recovered (Fix 2011:996).

This exploitation of terrestrial aircraft remains has compelled attention to turn to underwater sites, sometimes to obtain museum-quality aircraft to restore for display (Fix 2011:996). These efforts are dramatically illustrated by another PBM's experiences and serves as a cautionary tale. PBM-5A (BuNo 59172) wrecked during water taxiing operations on Lake Washington near Renton, Washington, on 6 May 1949 after it struck a submerged object (Hoffman 2004:191). At the time, the aircraft was being ferried for stowage and, consequently, very likely, did not have its full complement of equipment, thus limiting its archaeological value. Nevertheless, between 1980 and 1981, over one hundred artifacts were removed from this wreck and found their way into the collection at the National Museum of Naval Aviation (Hoffman 2004:192).

Almost a decade later, in 1990, U.S. Naval Reserve Mobile Diving Salvage Unit (MDSU) One's Detachment 522 attempted a full recovery effort. This unit's efforts were prematurely concluded following the work-related death of one of its members due to a previously existing health issue. Following several years of inactivity, consideration was given to making a second attempt to recover the entirety of the wreck to actively restore it and place it in the National Museum of Naval Aviation's collection (Hoffman 2004:192). In a clear demonstration of the many stakeholders and intersecting government, public, and private interest in such an effort, this project was supported by the Mariner/Marlin Association; Washington State Office of Archaeology; the U.S. Army Corps of Engineers, Seattle District; the Boeing Corporation; the Advisory Council on Historic Preservation, Western Review Office; and the Naval Historical Center (now Naval History and Heritage Command [NHHC]). MDSU One spearheaded the effort to recover the aircraft and gain valuable training for its primary mission (Hoffman 2004:192).

Between August and October 1996, more than 500 dives were conducted to position the aircraft for lifting operations. During this effort, the empennage separated from the rest of the plane, after which recovery efforts were suspended. The tail was recovered, documented, and preserved. It can now be seen as a standalone exhibit next to the last remaining Mariner in Arizona's Prima Air and Space Museum. The rest of the aircraft remains at the bottom of Lake Washington *in situ* under the conservatorship of the NHHC. This failure and ensuing damage to an irreplaceable aircraft highlight the sometimes destructiveness of salvage operations and demand for ethically responsible practices when dealing with any submerged artifact (Hoffman 2004:192).

This project also highlights the tension between efforts to salvage aircraft for presentation to the public and interest in preserving and maintaining aircraft *in situ* for archaeological and preservation purposes. *In-situ* conservation is a well-established preservation and management strategy used by federal and state agencies and the NHHC's default position. The Sunken Military Craft Act of 2004 (10 U.S.C 113) places jurisdiction for this site squarely under the NHHC's control (Sunken Military Craft Act 2004). It is now predisposed to manage sites *in situ*.

3.4 *IN SITU* CONSERVATION: THE PATH FORWARD

An *in-situ* assessment would contribute markedly to the theory of submerged site formation, especially when compared with the four other Saipan aircraft wrecks. Furthermore, like the ships of Chuuk Lagoon these aircraft could be interpreted "as 'time capsules', as underwater museums of the war" (Jeffery 2006:139). Due to the circumstances of BuNo 48173's sinking, it will likely provide the closest thing to an intact time capsule of a typical maritime patrol aircraft operation in World War II that exists today. Its condition is also important when considering its cultural heritage standing. For example, the National Registry of Historic Places differentiates aircraft wreckage between a wreck structure and a wreck site. "A 'structure' remains relatively intact, while a wreck 'site' lacks the structural integrity of an aircraft…" (Milbrooke 1998:20). Optimally, BuNo 48173 will be the model of a wreck 'structure.'

In situ conservation offers an exceptional opportunity to study this aircraft without extensive damage, contributes significantly to the theoretical knowledge of aircraft site formation, and adds to the historical and archaeological record. As Bell correctly states, "One of the best ways to broaden our theoretical knowledge of these sites is by researching and understanding their site formation" (Bell 2015:49).

This methodology could still be used appropriately to form a direct link with the public without efforts to recover the aircraft or artifacts. Military aircraft wrecks "are primarily a source of relics to memorialize past heroic events" (Spennemann 2001:6). This becomes significant when considering the cultural importance of a military aircraft wreck site. Understanding and interpreting the dynamics associated with how it was employed, the crew's actions before and after the crash — or, in this case, sinking — sequence, cultural reactions, and responses to a loss are essential.

In past decades, a concerted effort has been made to provide a direct and accessible bridge between Saipan's rich World War II cultural heritage and the many public stakeholders — Chamorro, U.S., Japanese, and Korean — with a direct link to the past. A well-developed WWII Maritime Heritage Trail, including sunken ships and landing craft, airplanes, and even three tanks, is already in place in Saipan, primarily in shallow water, and readily accessible to the public (McKinnon and Carrell 2011).

The discovery of BuNo 48173 would be an obvious addition to the island's cultural heritage. If discovered, it should be included in the trail as an inaugural deep-water entry. Given the distance offshore and greater depth, public access is minimized, but it remans a worthy addition. Importantly, it would also fulfill a public outreach role, connecting people with their heritage while ensuring reasonable *in situ* protection of this irreplaceable artifact. The first step toward this addition is determining a methodological approach to resolving its location.

4. RESEARCH METHODOLOGY

Holistically, there has been an extensive archaeological effort in Saipan, but no previous dedicated efforts have been made to locate or document the wreck of BuNo 48173. Jack Adamson, in his 2020 master's thesis, noted that finding and surveying the original open ocean seadrome and this PBM well offshore could be a valuable continuation of his research. He posits that “Given that this is some two and a half miles from the reef, it is highly likely that the remains of this aircraft exist” (Adamson 2020:118). Understanding submerged archaeological site formation (Muckelroy 1978; Gibbs 2006), especially in its recent applications to World War II aircraft (Bell 2010), provides a heightened archaeological significance in locating and surveying this site.

While the conditions and circumstances that led to the establishment of the open ocean seadrome and the loss of BuNo 48173 are well documented, the precise location of the seadrome site or the remains of the aircraft are not. Establishing the location hinges upon several analytical activities. A rigorous and detail-oriented approach to localizing and then locating this site is required because:

> Submerged archeological fieldwork varies in methodological approach but often requires a combination of diver and remote geophysical survey. The efficacy of any survey depends on the size of the search area, size of the targets, and the submerged environment. Remote sensing surveys can cover large areas and be used to identify submerged terrain features and artifacts, such as wrecks and vessel debris. (McKinnon 2020:14)

Further, “The study of submerged battlefields is guided by current battlefield research methodologies, including analysis of historical documents, terrain, and artifacts” (McKinnon 2020:3). This thesis sought to use this established methodological approach to determine the probable location of this aircraft on the Saipan Shelf within a margin of error that makes discovery likely, thus allowing it to be located and surveyed.

4.1. HISTORICAL AND ARCHIVAL EVIDENCE

The first method, then, evaluates all historical records and documents. Due to the immediacy of this deployment, planning documents with details or overlays depicting the anchorage area, as usually found in planning, operational, and attack orders, are absent. Detailed archival and historical records are also limited. Still, enough relevant material is available to perform an analysis and isolate a probable general location despite the general absence of detailed information.

Historical documents from the ships and squadrons that fought this action, especially those of VP-16 and seaplane tenders *Ballard*, *Pocomoke*, and *Onslow*, are central to this analysis. Other support vessels, especially those from Transport Group ABLE, Transport Division TEN, were assigned to anchorage areas near the open ocean seadrome, and their records are reliable resources. Headquarters documents, operational and attack orders, aircraft records, captured Japanese documents, and other resources also contribute heavily.

Unfortunately, an error in conversion was overlooked during fieldwork planning. Geodetic datum WGS84 was used in survey planning, a system that did not exist until 40 years after the Battle of Saipan, instead of OSGB 1936, which was used by the U.S. military during WWII. Consequently, the margin of error in these plotted locations could be minimal or dramatic, further compounding errors.

The most informative accounts are from the units initially conducting seaplane operations. As notes from USS *Ballard* report, “That afternoon [16 June 1944], we anchored about four miles [6.5 km] from the beach and commenced setting up buoys for the PBMs to moor. Working all that night to put out buoys to have them ready for the planes the next day” (USS *Ballard* 1945:25–26). The arrival of *Pokomoke* and *Onslow* on 18 June 1944 reinforced the distance of the enemy-held beach, with *Pocomoke* reporting, “our anchorage was in the open sea in 17 fathoms [102 ft./31 m] of water and 9,200 yards [8.4 km] from the enemy-held beach of Saipan” (USS *Pokomoke* 1944a:2).

Another valuable resource are the action reports and logs of support vessels situated near the open ocean seadrome. Transport Group ABLE, Transport Division TEN was comprised of: Assault Transport Ship USS *Clay* (APA-39; Flagship), USS *Neville* (APA-9), USS *Middleton* (APA-25), and USS *Feland* (APA-11); Cargo Ships (AK) USS *Hercules* (AK-41) and USS *Jupiter* (AK-43); and Assault Cargo Ship (AKA) ship USS *Alhena* (AKA-9) (Commander, Task Group 52.2 1944:10). Assigned to support the Second Marine Division, these vessels were stationed within Transport Area 3, responsible for flowing troops and material across Red Beach, the northernmost landing area. Based on the monthly diary, war history, and anti-aircraft action reports, this was the transport division nearest to the PBMs. *Ballard* even identified *Alhena* as a vessel providing a bowser boat to assist with seaplane tending operations in the open ocean seadrome further reinforcing its proximity (USS *Ballard* 1944b:10).

Most support vessels were ordered away from Saipan as the Battle of the Philippine Sea loomed, but some critical ships remained. These included USS *Hercules*, USS *Jupiter*, and USS *Cambria*, with “a few LST and LCI” (USS *Hercules* 1945a:10). *Hercules* and *Jupiter* were assigned to anchorage berths A-16 and A-9, respectively, close to *Ballard* in A-13. USS *Cambria* was nearer to shore in B-60 and did not refer to the PBMs in its reporting (USS *Cambria* 1944). On the evening of 17 June 1944, an errant PBM arrived and tied off to *Hercules’* stern at 2300. This vessel observed searchlight activity bearing 030° from its anchorage, possibly *Ballard* searching for its lost seaplane on the first night (*Hercules* 1944b:9).

Although the Saipan anchoring plan was not discovered, archival research produced elements of the plan in a diagram reporting on the torpedoing of battleship (BB) USS *Maryland* (BB-46) on 22 June 1944 while at anchor in Saipan (FIGURE 4.1). Contrasting the anchorage alpha-numeric methodology shown in the rehearsal training plan (FIGURE 4.2) allows for determining the location and probable center point of A-13.

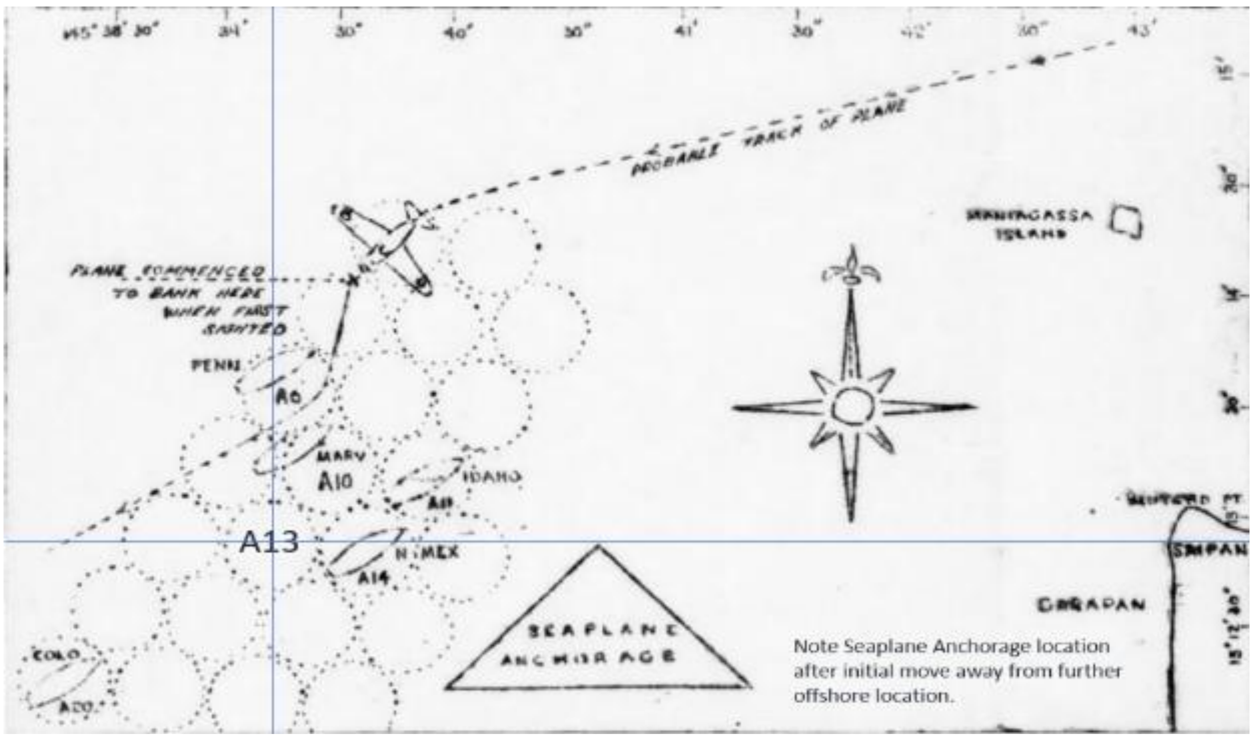


FIGURE 4.1: Map showing anchoring locations during the 22 June 1944 torpedo attack on USS *Maryland* (BB-46) from which berth A-13 was interpolated. The intersecting blue lines were applied to highlight the location used to assess the location of *Ballard*'s anchoring position when it established the open ocean seadrome. The designated triangular seaplane anchorage is depicted only after it moved closer to the shore on 21 June 1944 (Map courtesy USS *Maryland* Report of Torpedo Attack 1944).

The location of *Jupiter* was further isolated by the three reference points it provides during a triangulation sighting. On 16 June at “0744 on directions from Rear Admiral H.W. Hill, Commander, Task Group (CTG) 52.3, anchored in berth A-9, with Marpi point bearing 067°T., Tapotchua Peak bearing 111°T., and shoulder of Tapotchua Peak bearing 128° T” (USS *Jupiter* 1944b:6). This triangulated position is squarely within the northeastern portion of Transport Area 3 on the Saipan Shelf. This information begins to develop a reliable location for BuNo 48173.

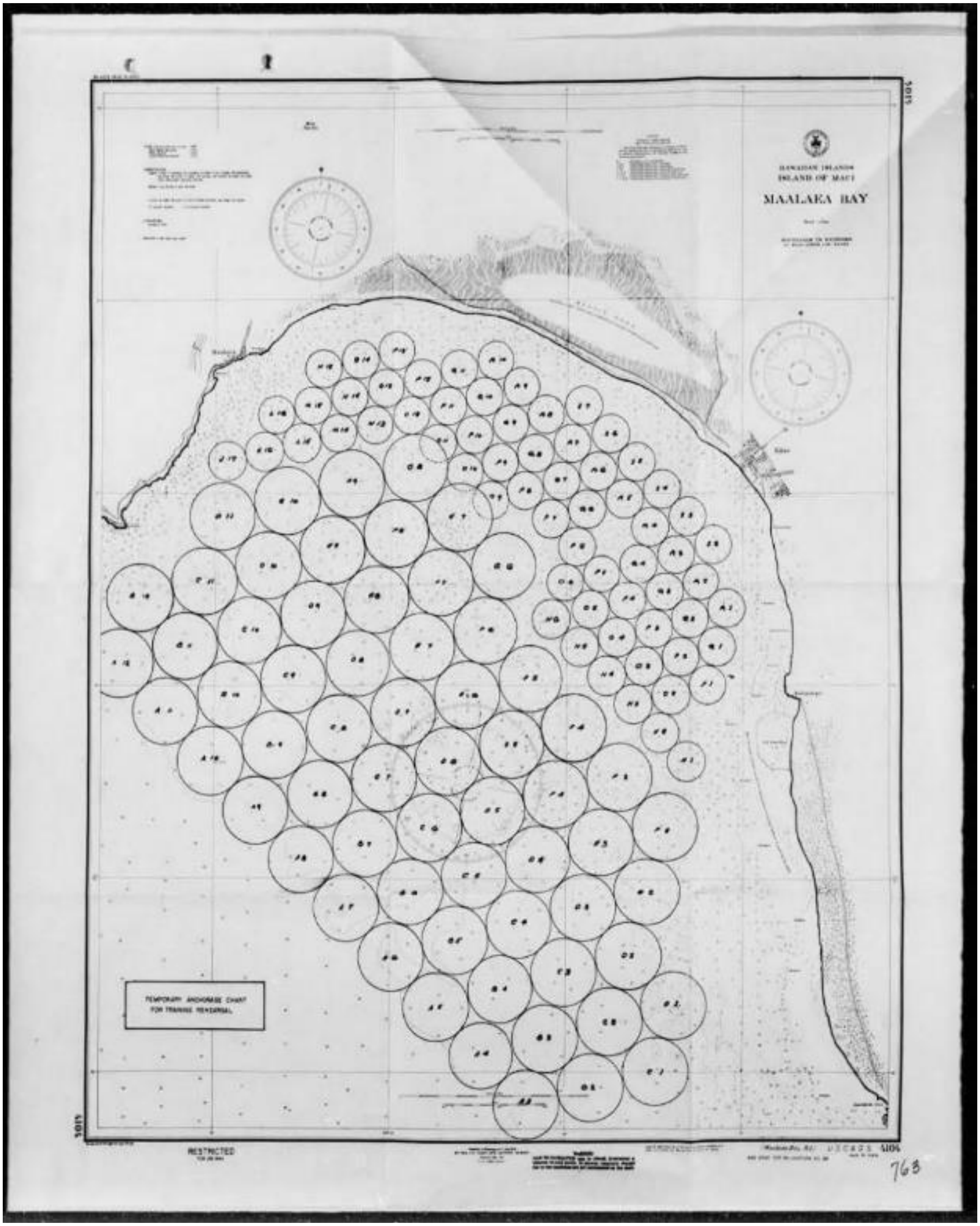


FIGURE 4.2: Anchoring plan from the Operation FORAGER Training Plan. This plan shows individual anchorages in Maalaea Bay, Maui Island in Hawaii. Note the sequential alpha-numeric pattern of anchorages arrayed from southeast to northwest. An anchoring plan such as this would provide definitive evidence of the location of *Ballard* (berth A-13) when it established the anchoring positions of the Roadstead Seadrome. A copy has not yet been located (Map from COM 5th PHIBFOR 1944:763).

4.2. BATTLEFIELD EVALUATION AND ASSESSMENT

A second method is for evaluating the battlefield and determining the most likely location where the open ocean seadrome was established is viewing the tactical challenge as the planners did in 1944. This includes a comprehensive survey of PBM-3D operational capabilities and limitations, Japanese defensive capabilities and tactics, period hydrographic charts, weather, maintenance and support capabilities, and more.

An emergent contemporary method of assessing modern battlefields for archaeological use is a repurposed military tool for terrain analysis. “It encapsulates the analysis of Key Terrain/Decisive Terrain; Observation and Fields of Fire; Concealment and Cover; Obstacles; and Avenues of Approach/Withdrawal” (KOCOA) and has been used successfully in assessing primarily terrestrial battlefields spanning the globe in recent years (Spennemann 2020:753). This methodology gained sufficient credence to emerge as a required tool for those applying for NPS grants (Spennemann 2020:754; Roth and McKinnon 2018:181). Despite its effective utilization in terrestrial engagements, its application across maritime or aerial environments is more limited. Still, Madeline Roth and Jennifer McKinnon (2018) successfully applied the KOCOA concept in analyzing the aerial assault on Midway Island during the 1942 battle.

Later, Spennemann, who enjoyed success in investigating and documenting both a B-24 Liberator (Spennemann1992a) and Grumman TBF Avenger (Spennemann 1992b) lost at Majuro Atoll in the Marshall Islands, recognized the limitations of the KOCOA methodology during his investigation of the Battle of Kiska (Alaska). He theorized, "There is a limited application of KOCOA in a purely maritime dimension.” Specifically, “KOCOA is inherently unsuited for open sea naval warfare as well as for purely aerial warfare. KOCOA is also of limited use in a situation where an opposing force holds an environmentally circumscribed terrain, such as an island…" (Spennemann 2020:754–755).

VP-16's experience in the open ocean seadrome amalgamated these conditions. These aircraft operated from a maritime environment against an enemy in sole possession, at least initially, of an environmentally circumscribed terrain, the island of Saipan. Consequently, the KOCOA concept cannot be uncritically accepted as an interpretive tool. However, Spennemann correctly ascribed KOCOA as having "limited application," rather than none, in a maritime environment. Some KOKOA elements remain directly applicable in this instance, primarily the influence of observation and fields of fire upon the open ocean seadrome.

The key observational terrain on the island is Mount Tapochau, which is readily the most prominent and visible feature at 1,554 ft. (474 m) high. Its commanding view of the island and waterways ensured the Mariners remained under constant enemy observation. As a command-and-control and communications hub, it was also the location from which the Japanese could have directed engagements upon the PBMs, either from fires from the island or far-away aerial forces. Lieutenant General Holland Smith, Commander, 5th Amphibious Corps, following its capture, observed:

> Looking down on the island from the former vantage point of the Japanese, it is easy to see why the enemy fire is so accurate. From the summit of this 1,554-foot mountain, the observer had a Pisgah-sight of Saipan. Practically the entire island stretched visibly before him, like a huge aerial photograph. With the aid of a map and a powerful Japanese telescope we found there, I could study the progress of the battle in detail, with the 72 square miles of terrain reduced to the proportions of a football field. (Smith 1949:102)

The Japanese were aware of the implications of the presence of the U.S. "flying boats" and their long-range search capability. The ability of the U.S. to detect any Japanese surface fleet, or arguably more importantly to the Japanese defenders on Saipan — an optimistically anticipated relief force — with these aircraft was not lost on them. U.S. seaplanes were noted in at least two transmissions of limited outgoing dispatches from the Japanese command. On 21

June 1944, the Japanese reported "12 flying boats in the water" and later noted "about 30" flying boats off Garapan (Japanese Records 1944:14,23). The Japanese correctly noted, "In short, the enemy at present time has complete control of the sea and air in the Marianas area" (Japanese Records 1944:23). As a result, these Mariners received frequent attention from Japanese fires almost certainly observed and directed from Mount Tapochau.

Japanese fields of fire were similarly excellent. Enjoying the advantages imbued to the defender, they had been able to select weapons emplacement positions well before the battle commenced, maximizing firepower toward the anticipated landing and offshore areas on the western side of the island. Japanese defensive doctrine at this stage of the war emphasized meeting and containing the invaders and destroying them at the water's edge (Isely and Crowl 1951:338). This meant placing heavy caliber guns to cover the likely invasion beaches, of which the western approaches were the most obvious and probable. On 5 June 1944, 32 heavy caliber coastal defense guns were operational, including 4 Type 3 120 millimeter (mm) guns and 16 Type 10 (1921) 120mm dual purpose (DP) guns. Fortunately for the U.S. attackers, 32 additional Type 10 120mm DP guns were available, but still in storage or uninstalled at the time of the invasion. By the time the U.S. arrived, just 32 of 89 available coastal defense guns were prepared to repel an invasion (Denfeld 1997:100). Had these additional 57 available guns been operational, the going could have been much more difficult in the open ocean seadrome. Still, smaller caliber anti-aircraft and anti-tank guns, and field pieces were ubiquitous throughout the island (FIGURE 4.3).

A pair of the Type 3 guns were placed in Laulau Bay, covering the eastern approaches to the island, while a third was placed in a concrete casemate at Muchot Point north of Garapan. More numerous was the Type 10. "The Type 10 120mm DP gun was ubiquitous in the Pacific. In

1941, this naval gun, used on destroyers, was placed in the ground anti-aircraft defense role" (FIGURE 4.4) (Denfeld 1997:60). In Saipan, three of these guns found their way to Muchot Point. Three more sat at the east end of Marpi runway in the North, and two more were placed near Aslito Field in the south to maximize their anti-aircraft potential. Flores Point housed two additional guns while others were emplaced near Laulau Bay (Denfeld 1997:100). Most of these guns could be brought to bear on the PBMs in the open ocean seadrome. Targeting was constrained only by the abundance of U.S. targets and concern for counter-battery and aerial retaliation.

These weapon's effectiveness was dramatically demonstrated when shore batteries at Muchot Point and a Type 10 120mm DP southeast of Garapan took USS *Phelps* and USS *Philip* under fire on 18 June 1944, damaging the former with two rounds (Denfeld 1997:60). Only hours before, *Phelps* provided VP-16 assistance in night takeoffs within the transport area by illuminating the water with their searchlight (USS *Phelps* War Diary 1944:7). When coupled with the hit on *Ballard* the same morning, this demonstrated that despite the extended range the open ocean seadrome selected for the PBMs remained vulnerable to Japanese large caliber weapons fire (USS *Ballard* 1945:26).

Still, the extended range of the open ocean seadrome dissuaded Japanese surface-to-surface fires. The guns that could effectively range it were the larger caliber coastal defense guns like those that took *Ballard*, *Phelps*, and *Philips* under fire. Later, during the campaign at the nearby island of Tinian, even larger 6-in. (152mm) shore batteries engaged in a dual with the battlewagon USS *Colorado* (BB-45), scoring 22 hits and killing 43 men, wounding 97 more, and disabling seven secondary guns before they were silenced (Morison 1953:362). Given that relatively few of these larger caliber weapons had been installed, made already significantly fewer by pre-invasion surface and aerial bombardment, the Japanese wisely reserved the attacks by these weapons for more lucrative targets such as warships or troop-laden assault craft. The PBM, a point target at extended range, was not worth engaging and thus revealing a coastal defense gun's position thereby subjecting it to counterbattery fire or aerial attack and subsequent loss. Japanese guns suffered significant attrition before the landings and as the campaign continued. Their anti-aircraft gun experience is illustrative.

> It is believed that many of the enemy's field AA positions were destroyed by our naval, artillery and air bombardment prior to and immediately subsequent to D-Day. Those that were left undamaged by this concentration of fire appeared to be reluctant to engage the comparatively lucrative targets offered by our aircraft. It is felt that this reluctance was due in great measure to the ability of our aerial and ground observers to spot hostile gunfire and the ability of our ships, artillery and aircraft to successfully engage such targets when observed. Once a gun position was spotted, it was almost a certainty that it would either be destroyed or neutralized in a matter of minutes. (COM GEN 5th PHIB CORPS 1945:71)

Large caliber defenses and anti-aircraft positions were singled out as a priority for destruction whenever identified. The overwhelming firepower of the U.S. attack severely limited the ability of the Japanese to influence the open ocean seadrome. Later, as the front lines shifted away from the open ocean seadrome, the threat to the anchored Mariners further diminished, enabling an incremental move closer to shore beginning on 21 June 1944.

The movement toward the shore was critical given the challenges operating in the open ocean seadrome created for the vital maintenance needed to keep these aircraft flying. *Pocomoke* articulated the impact of operating well offshore in suboptimal wind and sea state conditions and the influence of Japanese fire as the decision to move closer to shore was weighed.

> June 21st offered no let-up in the rough operating conditions. Little maintenance work could be accomplished during the period at this anchorage because of the seasickness in the maintenance crew and in the plane crews. The planes were being tossed and jerked at their moorings so violently that it was necessary to be constantly braced. Under these conditions, maintenance could hardly be attempted. Our anchorage was entirely unprotected from the north and northeast winds prevailing. It was apparent that we must move to a more protected anchorage if the planes were to continue operations. Any move toward the beach would bring us within range of the enemy smaller caliber guns, yet the water was conducive to continuing operations if this could be done. Moving toward Charan Karroa [sic] was out of the question as that anchorage was well fitted with ships unloading. (USS *Pokomoke* 1944:3)

FIGURE 4.3: Japanese 25mm anti-aircraft gun on Guam during Operation FORAGER. Smaller caliber guns such as this could not effectively range the open ocean seadrome (Photo courtesy of National Archives).

FIGURE 4.4: Japanese Type 10 120mm Dual Purpose gun emplaced in Saipan. Larger coastal defense guns such as this could engage targets on the Saipan Shelf (Photo courtesy of National Archives).

The threat of Japanese air attack was also constant. VP-16 Mariners were singled out for attack only hours after they arrived in Saipan. This required PBMs and their seaplane tenders to operate near other surface vessels for anti-aircraft fire and defensive smoke screen support. Optimally, seaplane anchorages and operating areas were placed in a restricted area from which other non-direct support vessels were limited. However, the threat of Japanese air attack precluded this operational technique from being initially employed. Placing the Mariners at sufficient distance from friendly vessels to better facilitate safer and more efficient operations left them undefended from air attack and thus vulnerable. Japanese defensive capabilities were again central to defining the location of the open ocean seadrome (FIGURE 4.5 & 4.6).

Another consideration was the hydrography of the water surrounding Saipan (FIGURE 4.7). Seaplane anchorages were usually emplaced in relatively shallow waters to facilitate ease of anchoring. Not only could deep water be prohibitive due to the length of chain and rope required to secure the aircraft properly, but the difficulty in maintaining such anchorages was profound. The only tender to establish the initial open ocean seadrome was the converted World War I four-stack destroyer *Ballard*. Designed to tend significantly smaller aircraft such as the Vought OS2U Kingfisher, it was ill-equipped to establish anchorages in deep water for larger aircraft. Even the relatively modest depth of 100 ft. (31 m) must have taxed its ability to develop an anchorage with organic equipment aboard.

Aircraft limitations imposed another constraint. The *Handbook of Flight Operating Instructions for U.S. Navy Model PBM-3D* (1944) does not explicitly state the criteria but distinguishes between operations in calm and rough water conditions. The maximum gross weight for smooth water operations was 56,500 lb. (25,628 kg). Rough water takeoffs dramatically reduced this gross weight to 48,000 lb. (21,772 kg) (*Handbook of Flight Operating Instructions* 1944:41). These reduced weight requirements imposed operational restrictions. The right nacelle fuel tank was filled with 390-gal. (1,476 L) capacity to extend range, but the port engine nacelle ordnance bays were left empty to reduce weight. This created an asymmetrical weight and balance challenge, destabilizing its equilibrium and further compounding the takeoff difficulties (VP-16 History 1945:38). The takeoffs proved so dramatic, "watching the pilots stiff-arm their twenty-five-ton bucking broncos through the swells for two full minutes and literally pull them off the water proved to be the most thrilling diversion for ship companies for two weeks after daytime takeoffs were initiated" (VP-16 History 1945:39).

The open ocean seadrome parameters were therefore established. Fifth Fleet planners had to find a reasonably suitable location outside the range of all but the heaviest Japanese ordnance, in waters shallow enough to develop effective anchoring positions using only a converted destroyer seaplane tender, with sea conditions suitable for PBM-3D operations and in close enough proximity to other invasion fleet vessels for mutual protection. Only one location could meet these parameters — the Saipan Shelf. This assessment fully supports and corroborates the archival and historical record.

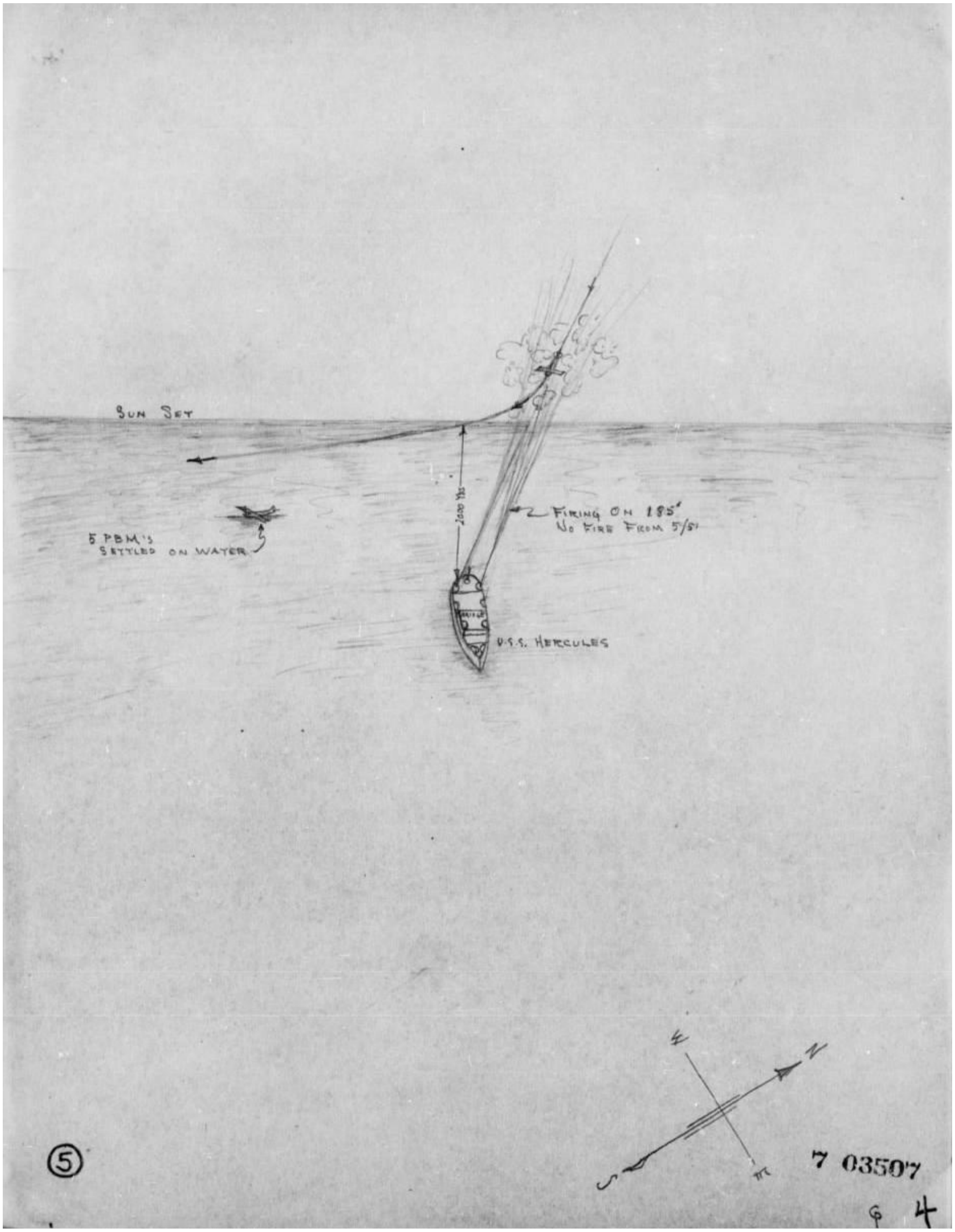
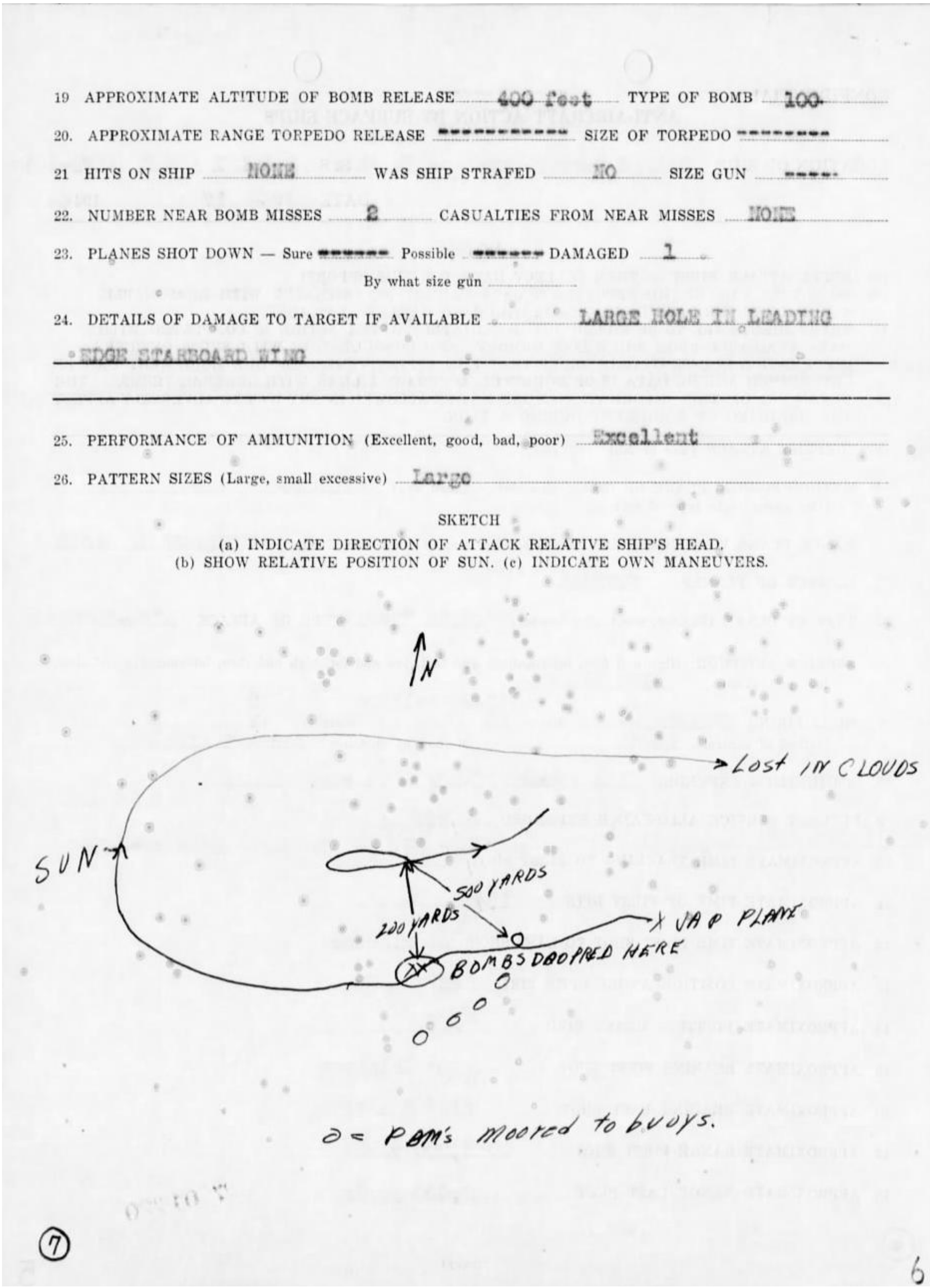


FIGURE 4.5: USS *Hercules*'s graphic depiction of its proximity to the VP-16 Mariners during the 17 June 1944 evening air attack (Image from USS *Hercules* Anti-Aircraft Action Report).



19 APPROXIMATE ALTITUDE OF BOMB RELEASE 400 feet TYPE OF BOMB 100

20. APPROXIMATE RANGE TORPEDO RELEASE ----------- SIZE OF TORPEDO --------

21 HITS ON SHIP NONE WAS SHIP STRAFED NO SIZE GUN -----

22. NUMBER NEAR BOMB MISSES 2 CASUALTIES FROM NEAR MISSES NONE

23. PLANES SHOT DOWN — Sure ------ Possible ------ DAMAGED 1

By what size gun

24. DETAILS OF DAMAGE TO TARGET IF AVAILABLE LARGE HOLE IN LEADING EDGE STARBOARD WING

25. PERFORMANCE OF AMMUNITION (Excellent, good, bad, poor) Excellent

26. PATTERN SIZES (Large, small excessive) Large

SKETCH

(a) INDICATE DIRECTION OF ATTACK RELATIVE SHIP'S HEAD.
(b) SHOW RELATIVE POSITION OF SUN. (c) INDICATE OWN MANEUVERS.

7

6

FIGURE 4.6: Graphic depiction of USS *Ballard*'s proximity to moored VP-16 Mariners during the 17 June 1944 evening air attack (Image from USS *Ballard* Anti-Aircraft Action Report).

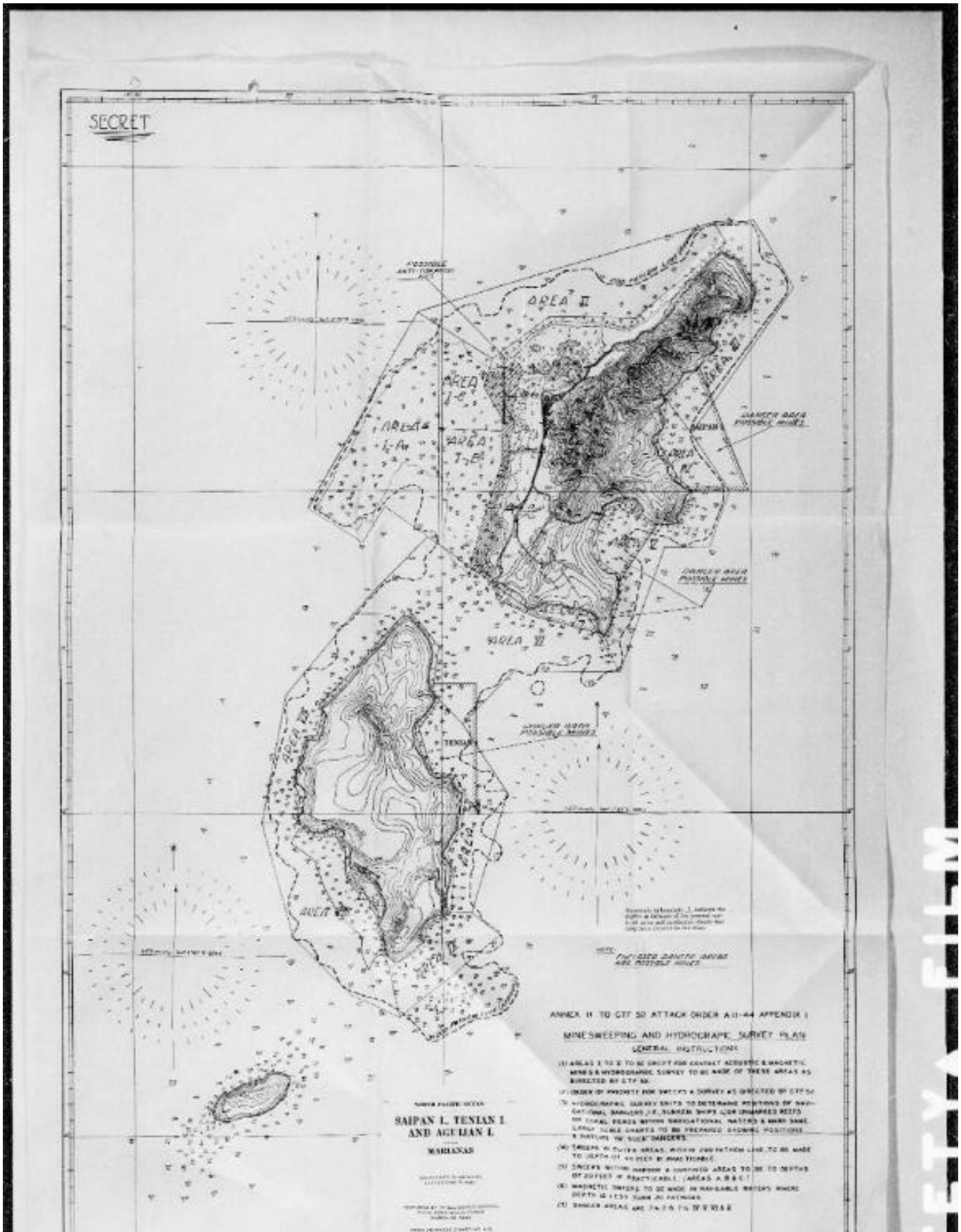


FIGURE 4.7: Hydrographical Survey Plan for Operation FORAGER. Note the location of the Saipan Shelf [Area 1-A in the upper left on the Map]. It is the only shallow water area sufficiently far enough from land to prevent effective Japanese fires from all but the largest Japanese guns. Transport Area 3 was established over this location (Map from COM 5th PHIBFOR 1943:488).

According to evidence collected, the sunken PBM is situated near Transport Area 3 in 17 ftm. (102 ft./31 m) of water. The Aircraft Mishap Report places the loss near where *Ballard* was known to operate in berth A-13 while tending to the PBMs. These two positions are 0.48 mi. (0.77 km) distant from one another, and the most reliable place to begin a survey.

Within this localized area are the remains of BuNo 48173 and the bowser boat sunk by *Ballard* while maneuvering. Finally, as *Ballard* was shifting the anchorage closer to shore, it may not have raised the anchors but instead only collected the attached buoys. As such, the original moorings may remain on the seabed, marking the exact location each of the first six PBM Mariners occupied (USS *Ballard* 1944b:15). Discovering any of these ancillary artifacts, especially should they be the Northill 200-lb., or 150-lb. Danforth anchors employed by *Ballard*, could also answer the question regarding the specific location of where the open ocean seadrome was first established. Armed with this information and analysis, a search for BuNo 48173 was planned and executed and the Mariner VP-16 left behind at Saipan found (FIGURE 4.8).

FIGURE 4.8: PBMs of VP-16 in formation en route to Palau Islands from Saipan, following completion of their storied deployment to Saipan. BuNo 48173 remained behind on the Saipan Shelf (Photo courtesy of National Archives #80-G-286329).

5. ARCHAEOLOGICAL EFFORT

A deliberate search of the area was conducted once research and analysis identified a probable location of the wreckage of BuNo 48173 (FIGURE 5.1). The survey effort to locate this aircraft was a single component of non-profit organization Ships of Discovery's *Exploring deep-water WWII battlefields in the Pacific using emerging technologies*, a grant funded project led by Dr. Jennifer McKinnon in the Spring of 2023. This project had five interrelated goals with eight supporting objectives (Ships of Discovery 2023:2–3). The search for the PBM nested with one of the primary goals of the primary goals to "Utilize existing LiDAR to conduct AI analysis for predictive modeling the location and identification of WWII UCH offshore related to the Battle of Saipan to expand context and an understanding of the battlefield in deeper waters" (McKinnon 2023:2). While this entire project ran from 24 April to 14 May 2023, the search for the PBM was incorporated into Phase II of the operation, which ran from 29 April to 14 May 2023. Three days, 9–11 May 2023, were explicitly dedicated to this effort.

Beyond locating the PBD-3D, secondary artifacts that could be used to determine the location of the open ocean seadrome include the remains of the bowser boat sunk by *Ballard* during evasive maneuvers during an air attack on the evening of 17 June 1944, as well as residual seaplane anchors. Due to the harsh operating conditions in an active combat environment, these may have been discarded rather than recovered by *Ballard* as the anchorage moved closer to shore, especially following the arrival of larger and more capable tenders. The discovery of BuNo 48173, its bowser boat, and these anchors would definitively mark the location of the open ocean seadrome.

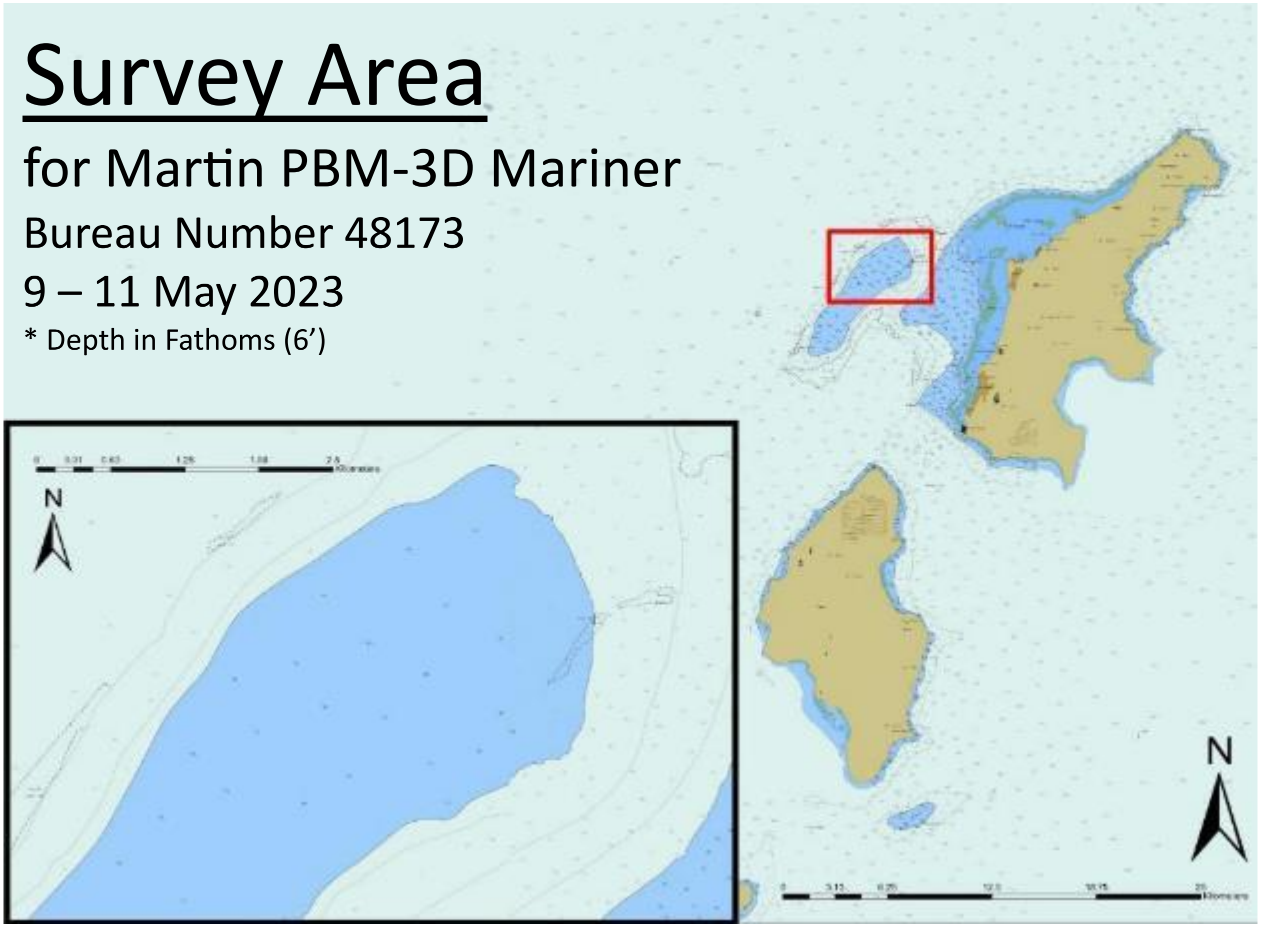


FIGURE 5.1: Targeted dives and visual tow board survey area on the Saipan Shelf, approximately 4 mi. (6.5 km) west of Saipan (Image courtesy of author).

5.1 LIDAR AND ERSI ARCGIS EXPERIMENTATION

Initial efforts to locate the missing PBM focused on surveying sites identified through a review of previously collected LiDAR (FIGURE 5.2). Using biophysical data from Fiscal Year 2020-22 bathymetric and benthic mapping activities financed by a NOAA Ocean Exploration Grant, ERSI ArcGIS Pro development tools were used to develop a machine learning workflow to enable an automated detection process. Regrettably, "the automated detection process using ESRI ArcGIS Pro was unsuccessful which may be due to a couple of factors including low number of training samples, small ground truthed wrecks as training samples, mismatch between training samples and targets, and unknown remains potentially buried under sand" (McKinnon et al. 2024:37).

FIGURE 5.2: Target locations developed by Aleck Tan using NOAA LiDAR data and plotted on Arc GIS by Aleck Tan. Targets 14 and 18 were near the assessed loss location of the PBM-3D and were the initial targets of the initial survey (Image courtesy Ships of Discovery).

Archaeologist Aleck Tan conducted a follow-up effort utilizing the Arc GIS Relief Visualization Toolbox to visually highlight the survey's possible underwater cultural heritage locations. She identified 21 possible target sites. These potential targets were then cross-referenced with archival references and considered high-probability related to the sunk PBM area (FIGURE 5.3). Two of these locations showed promise: Targets 14 and 18.

Target 14 was just 335 m (366 yd.) east of the reported location of BuNo 48173, well within any anticipated margin of error for reporting on a World War II aircraft sinking event. Consequently, Target 14 was prioritized in the initial search effort and made the primary survey point. Regrettably, this location's limited snorkel survey on 9 May 2023 did not reveal PBM-associated artifacts. Results for Target 18 were also negative. Despite the limited success of the ArcGIS products in the search for the missing Mariner in deeper water, there remains potential for using machine learning, AI, and LiDAR surveys, especially in shallow water, to enhance the tools available for detecting and subsequent documentation of underwater cultural heritage.

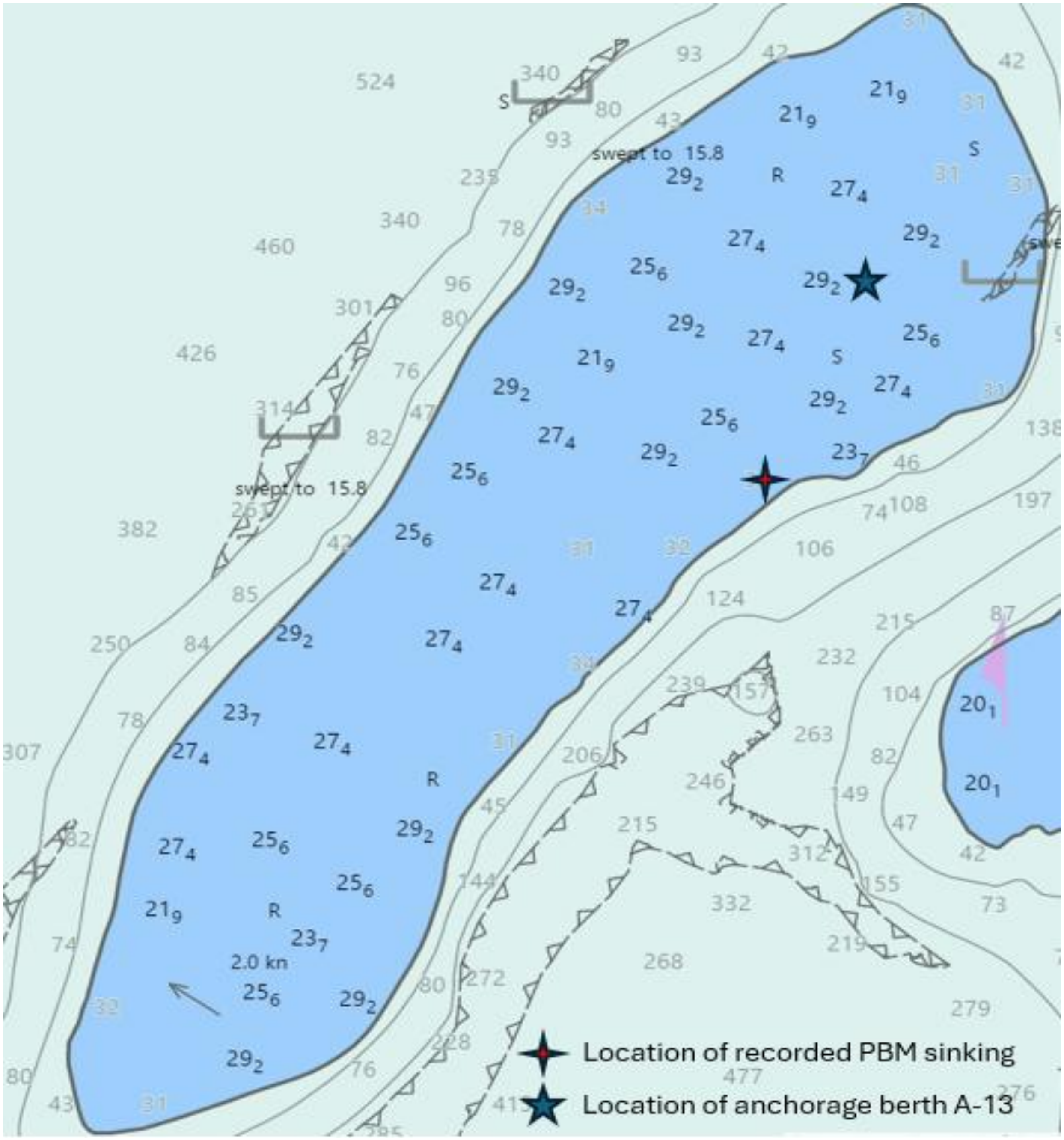


FIGURE 5.3: Reported location of PBM-3D BuNo 48173 and the interpolated location of A-13 anchorage from which *Ballard* conducted seaplane tending operations. Depth is depicted in meters (Image courtesy of author).

5.2. TOW BOARD SURVEY

After Targets 14 and 18 failed to yield PBM-related cultural artifacts, the survey effort shifted to developing a methodological tow-board visual survey informed by archival research. The targeted search area was initially focused upon the sinking location as reported by the U.S. Navy in its aircraft accident report, albeit using the unconverted WGS84 datum during planning. Follow-on efforts were expanded to the assessed location of the anchorage area (A-13) occupied by *Ballard* during its establishment of the original six open ocean seadrome anchorage points. Aleck Tan conducted route planning via ArcGIS in collaboration with the author (FIGURE 5.4). The intent was to maximize the search area so that a tow team could reliably cover it in a single day; this was assessed to be nine 500 m (547 yd.) lanes and planned as such.

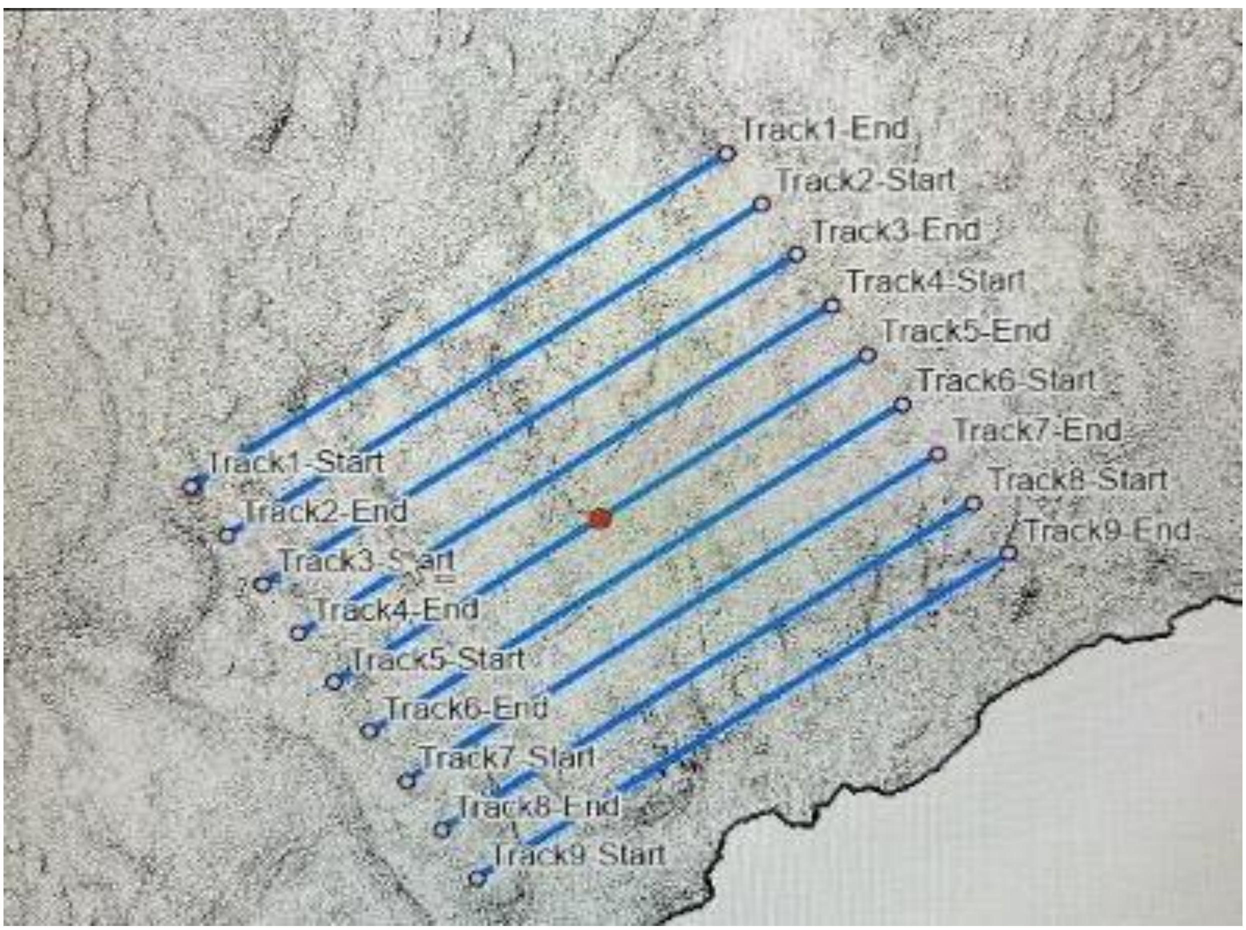


FIGURE 5.4: ArcGIS generated plot track developed by Aleck Tan for the 9 May 2023. The red dot represents the reported location of the sunken PBM and was made the center point of a lineal search extending in all directions around this point (Image courtesy Aleck Tan).

Based upon this consideration, the 9 May 2023 search consisted of a series of nine 500-m (1,640 ft.) search tracks that were laid out using UTM coordinates centered upon the reported sinking location of the PBM, with tow lanes plotted using ArcGIS. These tracks were oriented on a 030°/210° heading to run parallel to the edge of the Saipan Shelf located approximately 300 m 328 ft.) to the southeast, where the water drops precipitously to more than 100 m (328 ft.) deep. Lanes were spaced at 50 m (164 ft.) to provide the tow board team with visual overlap in conditions of an approximate water visibility of 50+ m (164 ft.). These points and associated nine lanes were transferred to a Garmin 64st GPS. All points in the search were given the discrete label of PB xy (where x is a linearly progressive number, and y is A or B associated with the beginning and end point of a single-track line, respectively) to associate them with the PBM search effort. This GPS was the primary navigation tool used by the boat captain. However, it proved suboptimal for maintaining a proper course and assessing overall coverage during the activity.

These searches were conducted via tow board from a small power boat, towing two people in a staggered tandem approximately 25 m (82 ft.) behind the tow boat. Team personnel utilizing masks, snorkels, and fins were towed at an average speed of roughly 2 mi. (3.2 km) per hour. Water temperatures were warm and did not require exposure protection. Initially, each team completed approximately 15-minute, 500 m (1,640 ft.) lane before being swapped out as the boat reset for the next lane due to possible fatigue concerns. Based upon experience gained on the first day, this was excessively conservative, and tow distances were later increased and extended to multiple legs to achieve efficiency without sacrificing effectiveness.

Water visibility was at least 50 m (164 ft.). Generally, it allowed an unobstructed view of the ocean bottom and laterally more than 25 m (82 ft.) on the ocean floor from the center point of the tow track within the search area. This allowed sufficient visibility to ensure proper overlap coverage based on the planned tow routes. In some cases, localized turbidity in the water restricted this overall excellent visibility. Given the size of the primary target (78 ft./24 m long; 118 ft./36 m wingspan), this should not have impeded the detection of the PBM, assuming it remains generally intact as anticipated. However, detecting the secondary targets of a small bowser boat and possible seaplane anchors was undoubtedly negatively impacted. In fact, given the primarily wooden construction of the bowser boat certainly degraded over the previous 80 years and the small size of the anchors, it is unlikely their remains could be reliably detectable with this visual search from the surface.

Upon sighting a cultural object, the towed observer released from the tow board to mark the target. Their partner also dropped off the line to maintain team integrity for safety and to reliably maintain contact with the discovered object. Based upon their assessment, enhanced by free diving to the extent possible to better observe the object, other archaeologists might enter the water as appropriate to evaluate it more reliably. The cultural features were also marked with an onboard Garmin 64st GPS, and its location recorded. Depending upon the characterization of the object and its potential association with the PBM Mariner wreckage, consideration was given to returning to allow a deep dive team to survey it at the end of the day.

Task Force Dagger (TFD) Special Operations Foundation, a collaborating partner with Ships of Discovery and ECU in this search, had two rebreather divers on standby in the boat. The dive plan involved the most promising targets detected being subjected to deep diver survey, photo documentation, and possible photogrammetry modeling via GoPro 10s. Nicole Grinnan from Florida Public Archaeology Network (FPAN) was also on board as a dedicated photographer should a consequential archaeological find be made to assure professional quality photographs. Grinnan employed a Sony ILCE-6000 camera body, an E 10-18mm F4 OSS lens, and a Nauticam underwater housing with an 8” dome. Her photos were captured in RAW format, processed in Adobe Lightroom, and exported in .jpg format.

Due to the depths involved and the fact that decompression requirements restrict a single deep water dive team aboard, only a single photographic survey dive could be made daily. Consequently, the entire search area was surveyed by tow board, and the deep dive team revisited the most promising daily cultural find for survey. Given the volume of potentially significant cultural artifacts discovered daily, this was a significant limiting factor.

The search commenced with PB 5 through PB 9 to search from the epicenter of the reported loss to the edge of the Saipan Shelf. At the time of the PBMs sinking, the tide was going in with the probable effect of pulling the seaplane to the southwest toward the beach, so it was prudent to begin the search in that direction. The PB 9 line was adjacent to the limit of the Saipan Shelf, and any effort further to the southeast was fruitless due to the sudden drop off from the shelf and increased depth beyond visual search limits. No culturally significant items were found in this area.

The tow board teams shifted to the PB 4 to PB 1 lines to the northwest. During the PB 4 a suspected landing craft, with tracks, was observed. Based upon the size and appearance of this object, it was initially assessed to be a potential Landing Vehicle, Tracked (LVT). Unfortunately, due to a camera malfunction, no images of this artifact were taken (McKinnon et al. 2024:99). A full site survey is recommended to verify this initial assessment. No other items of interest were identified.

On 10 May 2023, the search parameters were extended to include four additional tracks parallel and to the northwest of the PB 1 line run. This expanded the search area by 200 m (656 ft.) in that direction. Concurrently, four perpendicular lines (120°/300°) were established to the northeast and southwest, each measuring 600 m (1967 ft.). This provided a symmetrical 800 x 600 m (2625 x 1967 ft.) rectangle search area around the assumed PMB location, assuring continuity in the search. No additional tracks were established to the southeast due to the prohibitive depth of the channel beyond the Saipan Shelf. These tracks, designated PB 10 to PB 21 were also 500 m (1,640 ft.) long and continued to extend the symmetrical search box around the reported loss location. Although some items, such as chain or steel cable lengths, were observed, nothing that could be definitively associated with the PBM-3D loss or other items of independent significance were found.

On 11 May 2023, attention was shifted to the presumed anchorage location A13, where *Ballard* was located, during the establishment of the open ocean seadrome. As archival information suggests, the PMB anchorage was situated to the southwest of this position, and a search pattern beginning at the assumed center point of anchorage A13 and extending to the southeast was established using legs PB 22 to PB 32. These legs were extended to 750 m (2,460 ft.) in length. They maintained a 030°/210° for continuity, and tow board teams were left in the water for two lanes to gain efficiency based upon demonstrated performance during the two previous days' efforts.

During the search lane (PB 23), the tow team observed cultural objects possibly consistent with a PBM wreck. Specifically, a large oval metal object that could have been a vertical stabilizer and other nearby debris were seen. The position was recorded, and the search continued. There were frequent sightings of metal tubes or pipes throughout the area, and it became clear they were ubiquitous to the area and in such abundance that their presence was not associated with the target PBM. Further discussion and assessment suggest these are large-caliber shell casings due to their size, shape, and often organized stacking characteristics. Given the extensive transfer of ammunition between ships throughout the battle in this area, as well as the transfer of ammunition to landing craft destined for the shoreline, it seems plausible quantities of large caliber ammunition (i.e., ship's 20mm, 40mm, 5in., and 8in. guns; landing force's 37mm, 75mm, 105mm, and 155mm ammunition) created these features.

Upon completion of the routes, the decision was made to return to the site of the oval metal object and put deep water divers on target to assess and document it. Once on location, this team determined that this object was more consistent with a landing craft ramp and was adjacent to a block of machinery assessed as an engine. These were determined to be a marine inline engine and associated drive shaft (McKinnon et al. 2024:100). These artifacts were photo documented by TFD divers (FIGURE 5.5, 5.6 & 5.7). Although efforts were also made to create a photogrammetric model, the GoPro10 photographs were insufficient. Still, until definitively identified there is a potential that these artifacts could be associated with the bowser boat sunk accidentally by *Ballard* accidentally in a collision as the tender was evading Japanese air attack Given its proximate location near the seaplane tender's anchorage location, a full survey should be conducted to definitively determine the identity of this object.

TFD divers confirmed significant quantities of unexploded ordnance (UXO) were present in the area in the form of unexpended 40mm anti-aircraft ammunition, much of it still inside magazines (McKinnon et al. 2024:100). This reinforced the assessment that the "pipes and tubing" observed throughout the area are UXO (FIGURE 5.8).

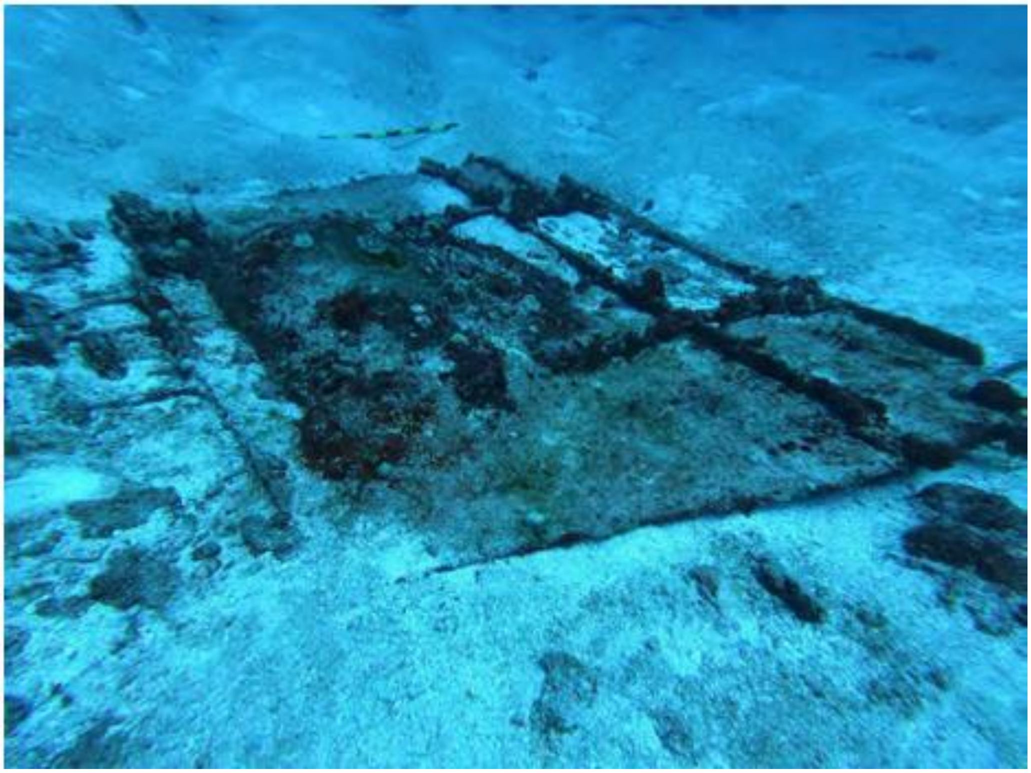


FIGURE 5.5: Landing craft ramp, possibly associated with a LCVP (Image courtesy of Ships of Discovery).

FIGURE 5.6: Marine inline engine (Image courtesy of Ships of Discovery).

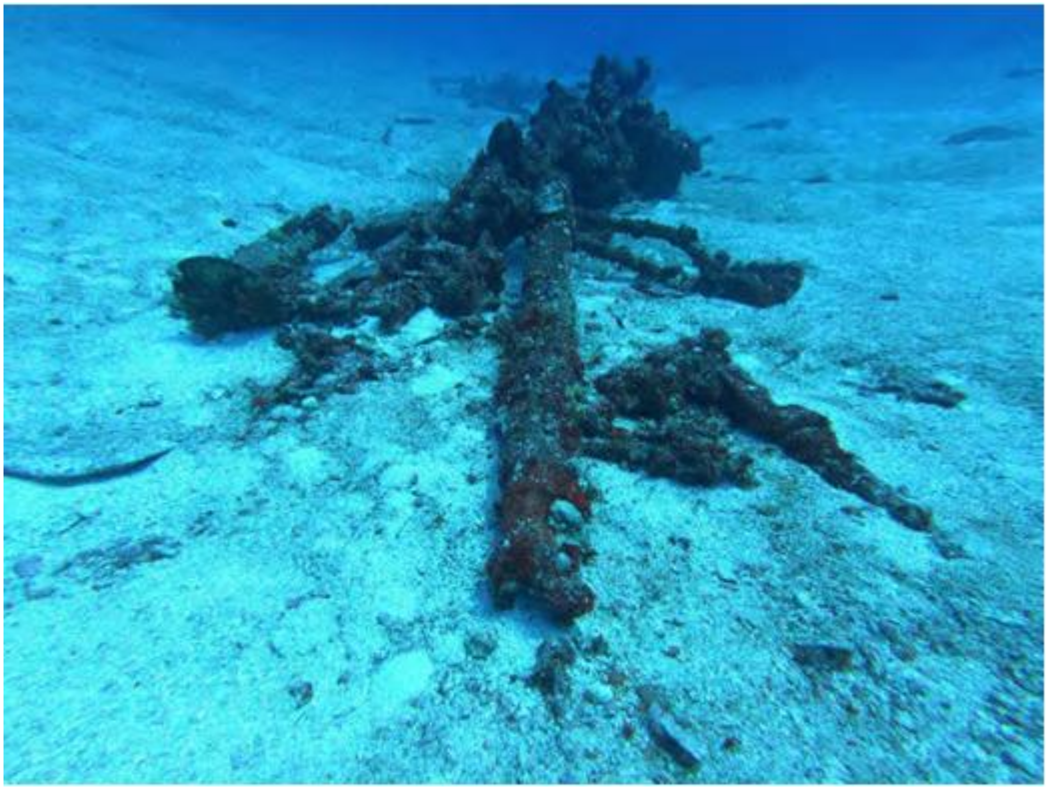


FIGURE 5.7: Drive shaft associated with the marine inline engine (Image courtesy of Ships of Discovery).


FIGURE 5.8: UXO, such as this, was prolific throughout the site (Image courtesy of Ships of Discovery).

Unfortunately, the search pattern was improperly executed for reasons not entirely determined (FIGURE 5.9). A primary cause was likely the use of the handheld GPS and the inability to visually observe a display concurrently showing the current and previous tracks. Regardless of the reason, this survey activity should not be considered a thorough search; much was likely left unobserved. A duplicate effort should be made when resurveying this location properly. Given the available resources, three visual search days identified at least two prospective targets for follow-up survey efforts and validated the presence of copious amounts of other cultural artifacts. This search did not determine the location of the missing PBM-3D Mariner, which is unsurprising given the limited search area using purely visual means and the limited time for the survey. Yet it still validated the abundance of probable cultural artifacts that would significantly enhance our understanding of the events in Transport Area 3 on the Saipan Shelf during Operation FORAGER.

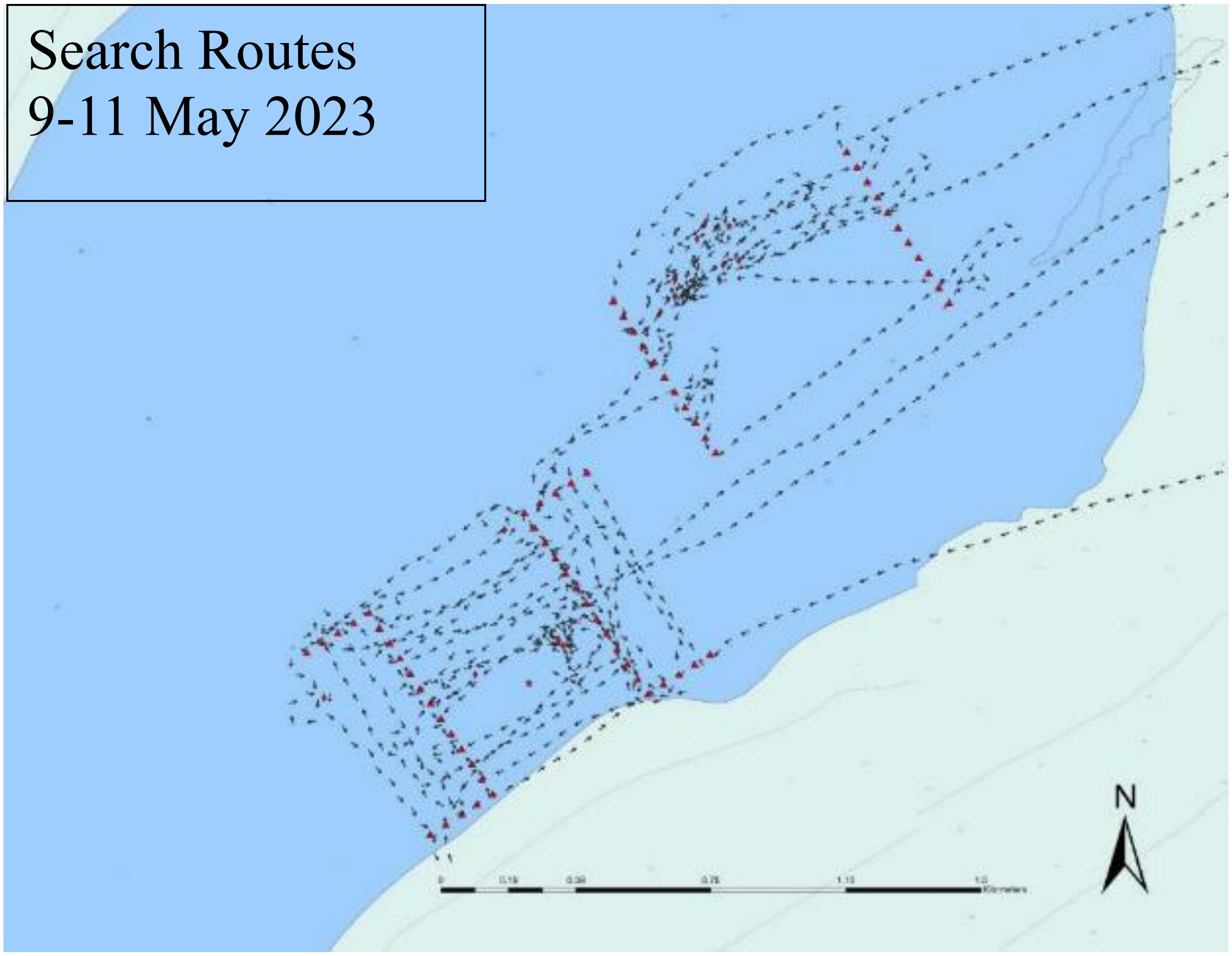


FIGURE 5.9: Actual tow board search tracks 9–11 May 2024 (Image courtesy of author).

5.3. IDENTIFICATION METHODOLOGY

Regrettably, this survey did not locate the wreckage of BuNo 48173. Ideally, if the aircraft had been located during this initial effort, the remaining effort could have shifted to positively identifying the PBM. Typically, once discovered, an aircraft is subjected to a rigorous analysis to try and determine its identity.

> "The first half of the identification question, "what type?" is typically answered with archaeology. Archaeologists survey and record a site, look for specific features that match types and tease out the details of aerials, hatches or turret types and configurations to narrow in on the model. Conversely, the latter half of the identification question, "which one?" (Pruitt and McKinnon 2016:45)

This is often easier said than done. Despite an extensive archaeological survey by Adamson (2020), the exact identity of the PBM Mariner situated in Tanapag Lagoon remains indeterminant.

This process should be more straightforward for the Mariner lost on the Saipan Shelf. Though it is the only documented type/model/series aircraft loss in this location, confirming the identity using various means is still necessary. These include any remaining painted markings on the aircraft that may have included BuNo 48173 painted on the vertical stabilizer, P-16-10 on the fuselage, other squadron-specific markings, or a pilot’s name beneath the cockpit window. There should be serialized and identifying plates, potentially in good enough condition to read, in the cockpit or engineering spaces. Engine identification tags are another possible source of identification. Although Ensign Culbert was the PPC at its sinking, it is doubtful he was the airplane’s primary PPC; his name was almost certainly not stenciled on the airframe. However, any name discovered could be cross-referenced with VP-16 records for confirmation. As such, any of these markings would be definitive.

Because the aircraft's aluminum construction is not generally prone to concretion, some of these markings may have remained viable indicators of its provenience despite being beneath Pacific waters for 80 years. Much of this could be determined by how the aircraft settled, whether painted surfaces were exposed to sand-scouring actions or were protected by ocean sediment, and the level of corrosion experienced. The level of preservation would also directly inform a site formation database. While robust traditional knowledge of wrecks has been developed, “For submerged aircraft, however, this database is small, yet growing” (Pruitt and McKinnon 2024:685). BuNo 48173 would contribute markedly toward expanding this database.

An equally reliable indicator is the presence or absence of the fatal refueling barge strike damage. When *Pocomoke*'s bowser boat #2 attempted to turn away from the aircraft, its screws cut through the aircraft's port hull at the waterline from the bow hatch aft to the beaching hatch. It made three large gashes in the seaplane's hull at bulkhead #5, frame #91. Additional damage was inflicted after the bowser boat fouled its propellors in the mooring pendant of the anchor buoy, causing the boat to remain alongside the aircraft, doing continuous additional damage until it could free itself (USS *Pokomoke* 1944b:8). These propellor gashes on the port side waterline, and other localized damage from the barge are positive indicators of the aircraft's identity. These should be readily apparent if the fuselage port side is visible.

5.4. FUTURE SURVEY PROPOSAL

This thesis provides a solid basis for further efforts. Given the lessons learned during the research and subsequent 9-11 May 2023 fieldwork, there is a clear path forward by optimally resolving the lingering questions regarding the anchoring plan employed by Fifth Fleet in 1944. There is enough evidence to conduct a thorough, effective, and methodological survey. This issue could be entirely obviated by expanding the search to encompass the whole Saipan Shelf; given the prolific amount of wartime activity and consequent archaeologically significant artifacts there, this would be worthwhile.

In 2008, maritime archaeologists Jason Burns and Michael Krivor with SEARCH, Inc. conducted a remote sensing survey in Saipan (Burns 2008) (FIGURE 5.10). An 823-line km (512 mi.) remote sensor survey with survey lines spaced at 100 ft. (31 m) within the navigable waters of Tanapag and Garapan Lagoons. This survey extended 200 m (656 ft.) outside the western barrier reef (Burns and Krivor 2015:33). The purpose of this search was to "locate and identify high-probability submerged archaeological resources inshore and offshore of Tanapag and

Garapan Lagoons, along the west coast of Saipan" (McKinnon and Carrell 2015:27). Their objective was to build "a baseline inventory for future investigations to build upon and to supplement findings from previous cultural resource investigations…" (McKinnon and Carrell 2015:28). They achieved remarkable results identifying 1,543 magnetic anomalies throughout the surveyed area. Of these, 142 targets were further identified using SCUBA, side scan sonar, or previous knowledge. Important discoveries included landing craft, tanks, aircraft, and other culturally and archaeologically significant artifacts (McKinnon and Carrell 2015:33–34). This model effort should be extended offshore into deeper water to locate and identify additional resources, including BuNo 48173. Appendix B assesses some known losses with consequential archaeological and cultural significance. It effectively demonstrates the abundance of artifacts to be located and documented beyond BuNo 48173. Another survey, similar to the 2008 SEARCH effort, should be undertaken in the waters outside this reef and focused explicitly upon the outer reef shelf in the invasion beach lane area and the Saipan Shelf. Emphasizing these shelf areas constrains the search into an easily achievable survey area, with waters no deeper than 30 m (96 ft.) within non-technical SCUBA diving depth, and with the highest probability of artifact discovery.

FIGURES 5.6, 5.7, 5.8 & 5.9 depict the proposed search areas and planning overlays to emphasize their proximity to invasion activity. This search should include side scan or multibeam sonar and magnetometer technologies. The proposed survey lines have 75-m (246 ft.) spacing intervals, requiring 210 survey line kilometers for the outer reef shelf and 230 survey line km for the Saipan Shelf. This will offer a 100%+ survey and allow completion in approximately a week. Given the nature of the targets, this spacing may be excessive in providing the high level of fidelity needed to locate all possible targets within this area. Survey line intervals should be reduced commensurate with the time available and the fiscal health of the project. Survey intervals of 15-m (49 ft.) may be optimal to maximize effectiveness if time and funding are available.

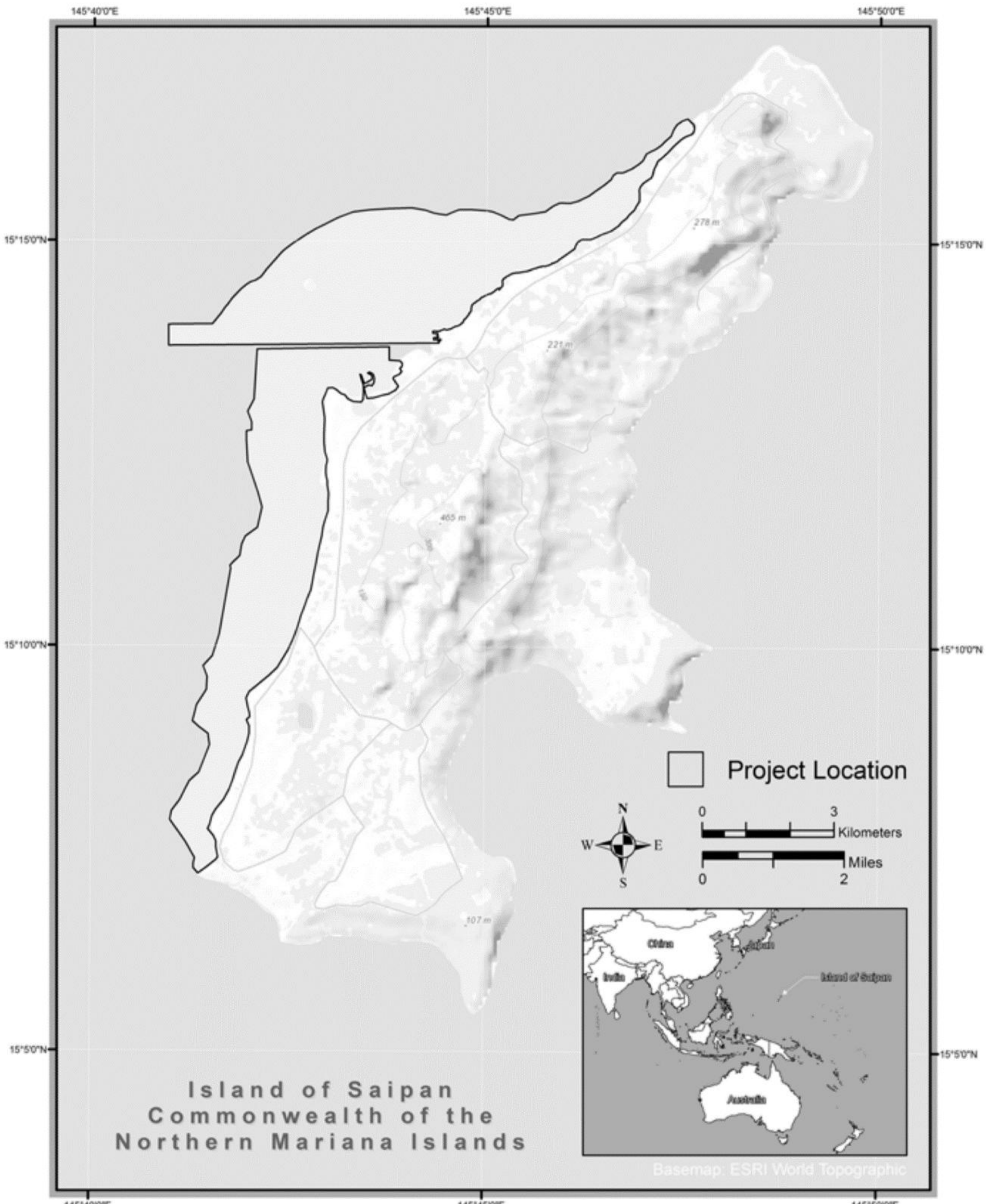
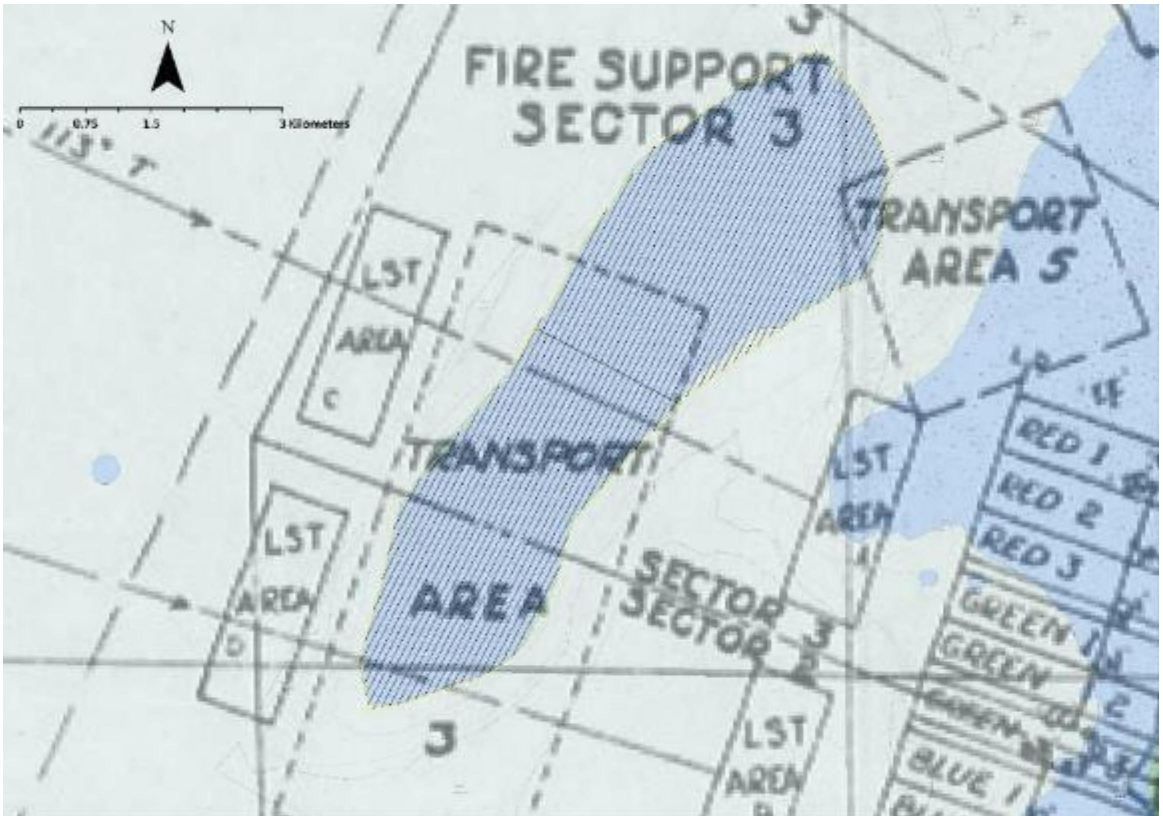


FIGURE 5.10: This image depicts SEARCH's 2008 submerged cultural resource remote sensing survey area (Image courtesy SEARCH).

Although a towed survey would be effective, consideration should be given to using emergent autonomous underwater vehicle (AUV) capabilities. These survey areas are homogenous, with a sandy and generally flat bottom. Coral head protrusions may interfere with survey efforts, but AUV collision avoidance systems, unlike towed systems, can readily mitigate this concern. AUV usage could also dramatically reduce the personnel and time required to conduct this survey, minimizing support activity costs.

This survey proposal is non-prescriptive but merely recommends a possible future effort. Detailed survey planning must be conducted based on the time, funding, and resources available before any later attempt. A thorough survey effort in these areas should locate BuNo 48173 unless it fell or was swept off the Saipan Shelf into much deeper water. This broad survey would obviate the need to search specifically for this airplane and gain efficiency from any survey activity. However, a deliberate survey for this aircraft is warranted given its tremendous archaeological potential and cultural significance.



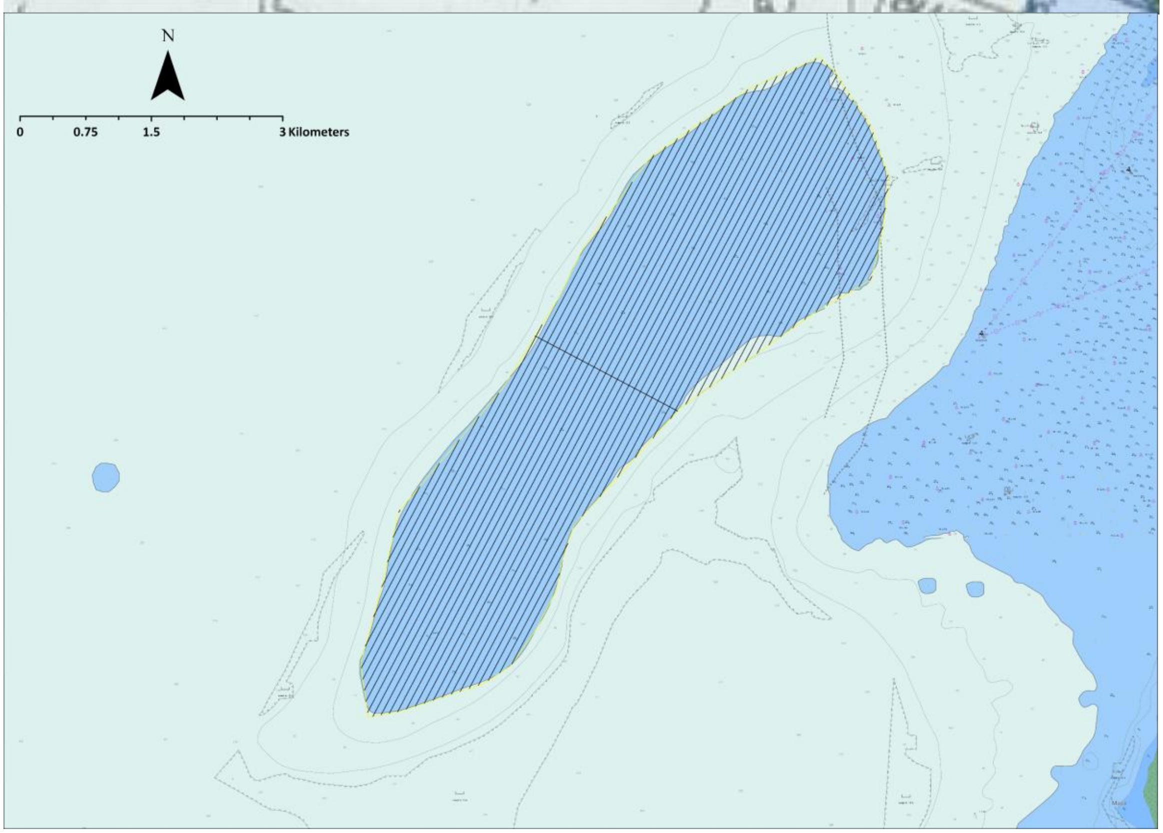
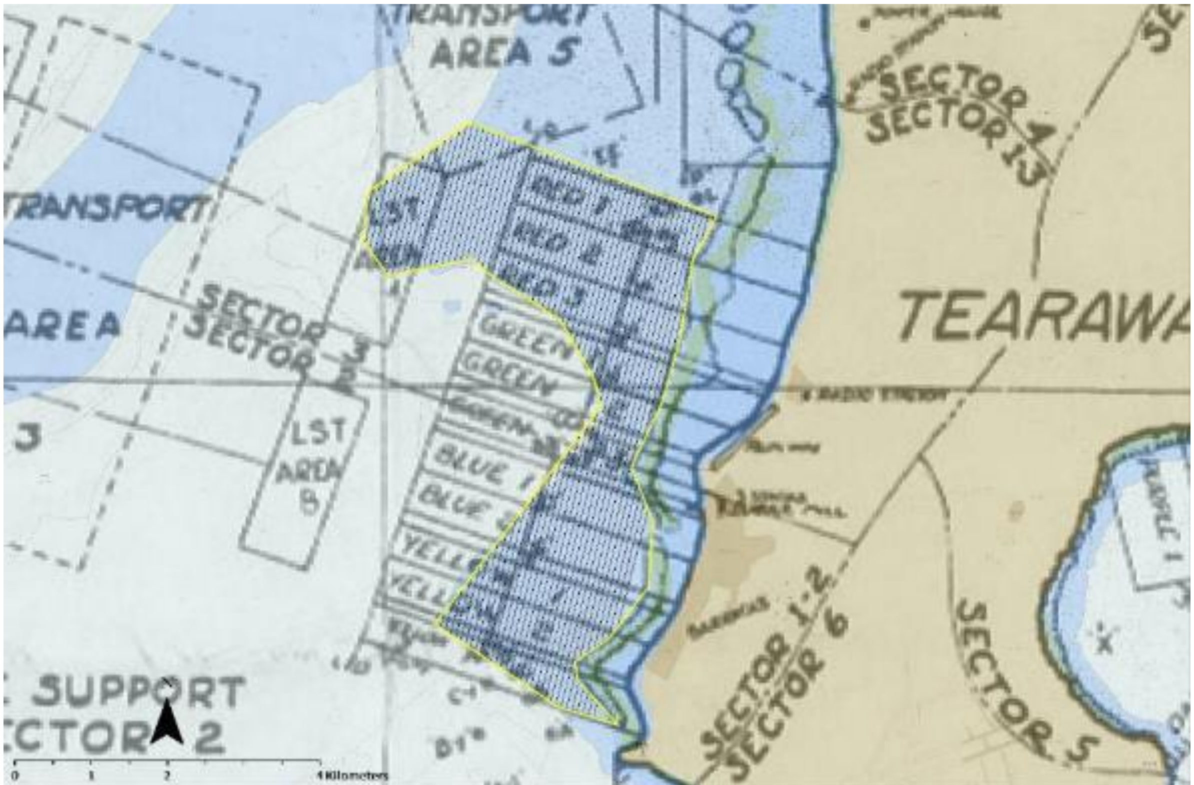


FIGURE 5.11 (top) and FIGURE 5.12 (bottom) depict the proposed Saipan Shelf survey area with 75-m (82 yd.) interval lines superimposed both with and without Operation FORAGER invasion overlays (Images courtesy Mateusz Polakowski).



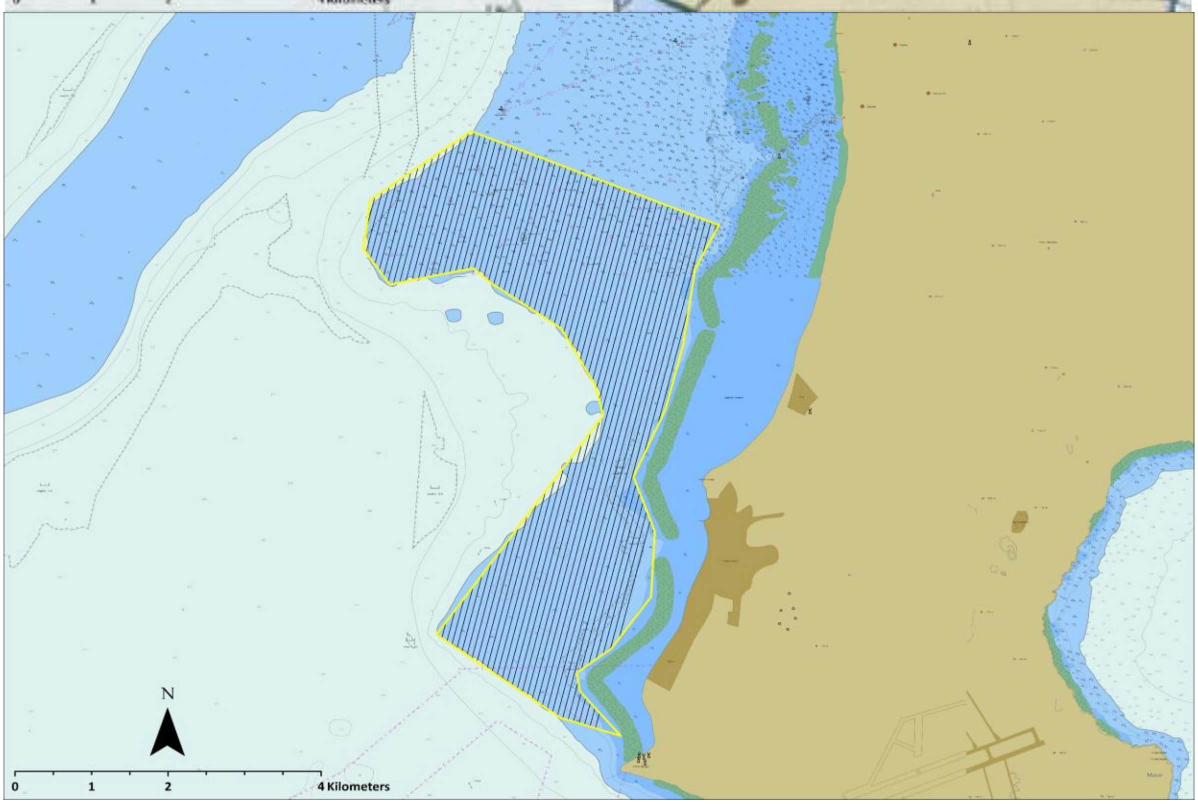


FIGURE 5.13 (top) and FIGURE 5.14 (bottom) depict the proposed Outer Reef Shelf survey area with 75-m (82 yd.) interval lines superimposed both with and without Operation FORAGER invasion overlays (Images courtesy Mateusz Polakowski).

6. DISCUSSION

The primary goals of the thesis are to document the circumstances and conditions that led to the establishment of the inaugural open ocean seadrome; document the scope and scale of its operational contributions during its five-day life-span; assess its contributions to the establishment of future invasion open ocean and roadstead seadromes; document the impact it had concerning its assigned operational tasks and the historical record; evaluate the success or failure of the seaplane tender support provided; and most importantly locate, survey and document the archaeological remains within the open ocean seadrome location. Optimally, this would have included the sunken bowser boat, residual anchorage locations, and, critically, the wreckage of BuNo 48173. The following research questions were evaluated during archival research and the search for the open ocean seadrome. Unfortunately, the failure to locate the wreckage of BuNo 48173 significantly hinders archaeological evaluation and interpretation. Still, much contributory information was learned, adding to the archaeological and historical record.

6.1. PRIMARY RESEARCH QUESTION

1. What conditions and characteristics led to the innovative establishment of the open ocean seadrome, and what contributions did it and the aircraft it supported have to the Battle of the Philippine Sea and the overall war effort?

The open ocean seadrome was born of operational necessity. The Japanese decision to contest the U.S. offensive in the Marianas with the First Mobile Fleet created an urgent need to close the long-range search gap. Although the U.S. possessed a robust submarine picket screen, radio intercept teams, Army long-range aircraft in the distant Admiralty Islands, and carrier-based search aircraft, each had glaring operational limitations. Submarines had a limited search radius and could not keep pace with faster surface contacts. Radio interception was only viable if the enemy chose to break radio silence. The Army's B-24 aircraft to the south could not range the likely corridors from which any Japanese force would approach the Marianas. Finally, U.S. carrier aircraft had a significantly shorter range than their Japanese counterparts, especially given the numerous nearby Japanese airfields. Consequently, U.S. carrier aviation could not be relied upon to make the first detection, which is essential to gain the operational initiative. If a reliable long-range search platform were to be had, it would fall to seaplane patrol aircraft based in the forward area.

The only realistic option to deploy patrol seaplanes to Saipan, given that control of a traditional roadstead anchorage or developed seaplane base had not yet been wrested from the Japanese, was to establish an offshore seadrome. The decision to do so was contrary to every guiding principle in *Tactical Orders and Doctrine, Volume 3: Patrol Aircraft* (1942), the doctrinal bible for seaplane employment. A careful balance had to be struck between the safety of the aircraft in their anchorage and their ability to be correctly maintained and serviced to preserve their ability to execute the mission.

By analyzing Japanese defensive capabilities, hydrographic conditions, the capacity of already present vessels to provide the required support, the impact of continuing amphibious invasion activities on flight operations, and weather — an anchorage in the open ocean afforded none of the desired sheltering characteristics — the decision was made to establish the open ocean Seadrome in Transport Area 3 on the Saipan Shelf. Although sub-optimal, it was the only location that could reasonably provide a safe distance from most Japanese surface fire in a sufficiently shallow area to allow for anchoring. The Marines and soldiers ashore progressively pushed the Japanese away from the ocean, steadily attritting the defender's heavier weapons so the seaplane anchorage could move closer to shore. The necessity to maintain the original open ocean seadrome in its original location lasted only five days before this incremental march toward the shore began. The Battle of the Philippine Sea was by then over, and the crisis had passed. The open ocean seadrome served its purpose well.

This movement toward the shore culminated with the capture of the Japanese Tanapag seaplane base on 9 July 1944, which was quickly repurposed by the U.S. Saipan became a significant seaplane base for the U.S. for the rest of the war (FIGURE 6.1). Support facilities were constructed, the harbor was dredged to remove obstacles, and designated water runways were established, adequately marked, and lighted. Saipan had come a long way from the initial open ocean seadrome upon which the hopes for detecting and destroying the Japanese fleet were hinged for those first five days in June 1944.

FIGURE 6.1: Captain Willard Goodney (left), Commanding Officer USS *Chandeleur* (AV-10), and Captain Edwin Weimer (right) Commanding Officer USS *Pokomoke* (AV-9) on the seaplane ramp at Tanapag harbor supervising the beaching of a VP-216 PBM-3D on 10 July 1944 (Photo courtesy National Archives photo #80-G-265985).

The contributions of the open ocean seadrome to the outcome of the Battle of the Philippine Sea are mixed. On the eve of this potentially decisive battle, a VP-16 Mariner piloted by LT Arle discovered the location of the Japanese fleet, yet their report was not received promptly. Admiral Nimitz's view that had the report been punctually received, it "might have altered the outcome of the Battle of the Philippine Sea and resulted in a much greater destruction of the Japanese Forces" warrants consideration (CINCPAC 1944:130). Doing so requires an understanding of how the battle played out.

The Japanese intended to force a decisive battle, destroying the U.S. carrier with land and carrier-based aircraft; the U.S. improperly perceived the threat as primarily targeting the invasion transports (Dull 1978:303–304). Regardless, the reaction was swift. In addition to VP-16 and additional seaplane tenders (*Onslow* and *Pocomoke*) being directed to move forward to the open ocean seadrome, other vital steps were taken. The still-afloat reserve 27th Infantry Division was ordered to land immediately to expedite Saipan's conquest and remove them from the danger of their transports sinking underneath them. All non-essential invasion ships were ordered away from Saipan and out of danger. Four additional submarines (*Albacore*, *Finback*, *Stingray*, and *Bang*) were directed to take up station 600 mi. (966 km) west of Guam to establish an "invisible trap" to ambush the advancing Japanese. VADM Turner detached his battleships from their invasion fire support roles to VADM Lee, Commander, Battleships, Pacific Fleet, to form a battleline ready to repel any Japanese surface force breaking for the Saipan beachhead. Finally, air support for the embattled Marines and soldiers on Saipan was restricted to the smaller escort carriers. The large fleet and supporting carriers, bolstered by additional screening vessels, were withdrawn to prepare for a showdown with their Japanese counterparts (Lockwood and Adamson 1967:83–87).

How the battle unfolded weighed heavily upon the intelligence collected, the sole purpose of VP-16's forward deployment. The U.S. submarine screen continued to be highly effective in providing contact reports. They continued to track the First Mobile Fleet's eastward movement toward Saipan even after *Flying Fish*'s seminal sighting of the Japanese fleet sallying on 15 June 1944 near the San Bernadino Straits. *Seahorse* sighted a second element of the Japanese fleet the same day near the Philippines' Surigao Strait. *Cavella*, on 17 June 1944, detected Japanese oilers, tracked them, and was rewarded with detecting the Japanese main body as they refueled. It was clear they were willfully remaining out of range of the U.S. Army long-range bombers based at Los Negros Island based upon their chosen track (Prados 995:570; Buell 1974:268–269).

The Japanese fleet broke radio silence on 18 June 1944 to coordinate attacks with the land-based First Air Fleet. An efficient mobile radio intelligence unit operating aboard Task Force 58 detected and localized this transmission. Based on these reports, RADM Marc Mitscher, Commander of Task Force 58, sought to gain the early initiative. He proposed proceeding west to position for an early morning (0500) strike at what was presumed to be the Japanese main body. VADM Spruance, deeply concerned about an end run by a separate Japanese force and understanding his overriding objective was to protect VADM Turner's invasion fleet, promptly rejected RADM Mitscher's proposal (Buell 1974:264).

This was not an unreasonable assumption, as the Japanese had previously habitually employed this multiple-axis of advance tactic. VADM Spruance worried that if Task Force 58 were to proceed west to conduct this first strike, it would find itself out of position to refuse a Japanese "end around" advance against the invasion force and so declined RADM Mitscher's proposal. Task Force 58 proceeded east, away from the enemy, instead. VADM Spruance determined, “We should…remain in air supporting distance of Saipan until the information of enemy requires other action…” (Specter 1985:308). In further justifying his decision, VADM Spruance advised RADM Mitscher “End run by other carrier groups remain possibility and must not be overlooked” (Lockwood and Adamson 1967:90).

This decision yielded the initiative wholly to the Japanese, much to RADM Mitscher and his staff's chagrin. VADM Spruance was playing pure defense. Given that the Fifth Fleet had been able to broadly track the Japanese fleet movements beginning 15 June 1944 through continuous submarine contact reports and was now armed with “huff-duff” — as high-frequency direction finding was colloquially known — reports, he could not escape the notion that other Japanese elements could be present and a direct threat to the invasion force. Had LT Arle’s contact report been received, it would merely have confirmed the presence of at least a portion of the enemy at the huff-duff location that had already been pinpointed. PBM RADAR contacts pointed to approximately 40 enemy vessels. Yet, absent visual identification, there was no way to tell what kind of ships and in what numbers the enemy possessed here (Lockwood and Adamson 1967:90–91). Without this level of fidelity, LT Arle’s report would not have tipped the scales in the mind of a commander wholly committed to the defense of VADM Turner’s invasion fleet, even under the pain of missing the opportunity to engage and destroy the Japanese First Mobile Fleet decisively.

Consequently, this author believes that even if this RADAR contact report had been received, it would not have materially changed the conduct or outcome of the Battle of the Philippine Sea. VADM Spruance’s decisions to withdraw to the east and allow the Japanese the first carrier strikes were firmly entrenched in his mind. A RADAR report confirming his understanding, absent amplifying information, could not have adjusted this calculus. Still, U.S.

material superiority and the high caliber and training of its fighting troops by this stage of the war overcame the initiative deficit. The subsequent evisceration of the Japanese air arm during the Marianas Turkey Shoot delivered a blow from which they never recovered.

RADM Mitscher counterpunched on the evening of 20 June 1944 with the fabled Mission Beyond Darkness, a maximum-range strike against the Japanese. This attack mauled, but did not decisively defeat, the Japanese fleet. Participating aircraft did not return to their vessels from this long-range strike until darkness had fallen. This resulted in high losses from aircraft running out of fuel and dangerous nighttime landings despite the Fifth Fleet breaking every tactical convention by fully illuminating the fleet to guide the aviators home. RADM Mitscher chose not to launch any nighttime carrier aircraft searches, given his aircrew's extraordinary efforts that day, that may have enabled him to make early morning strikes in exchange for allowing his aviators much-needed rest.

This opened a window of opportunity for the Mariners operating from the open ocean seadrome to redeem themselves from the previous night’s failures. Supposing they could detect and shadow the Japanese fleet, this might allow Task Force 58 another opportunity to decisively engage and destroy the First Mobile Fleet with an early morning attack while they were still within range. Despite a dedicated effort with now six aircraft, VP-16 inexplicably failed to find the enemy forces with their night RADAR searches despite knowing their approximate location with high confidence. Had VP-16 detected their foe that night, there is little doubt RADM Mitscher could have completed the destruction with Task Force 58. Instead, this second failure allowed the Japanese to extend from Task Force 58 as they withdrew, extricating themselves evermore from danger.

In a final ironic twist, on the next night, 21 June 1944, a PBM successfully located and shadowed the Japanese fleet's main body. LT Felix "shadowed the enemy group, reporting accurate information on its size, course, and speed, sometimes closing to within three miles and one time close enough to see the wake of one of the enemy ships. With just enough fuel to reach the base, Felix left the fleet after shadowing it for three hours" (VP-16 History 1945:46–47). Acting on this information, early morning strikes consisting of Grumman F6F Hellcats carrying 500-lb. (227 kg) bombs were directed to a range of 300 mi. (483 km) in search of the enemy. Still, they found only open ocean (Y'Blood 1981:197). By then, it was too late. The Battle of the Philippine Sea was over, and most of the Combined Fleet lived to fight another day.

The inability of the open ocean seadrome-based PBMs to effectively perform the mission they were given blunted their impact on the battle. Their communications failure on the eve of the engagement, although invoking the ire of Admiral Nimitz himself, was likely far less consequential than he perceived at the time. Had this report possessed the potential to shift the strategy employed by VADM Spruance, claims of significantly enhanced destruction of the enemy fleet may have been warranted. In truth, it is unlikely this report would have altered either the conduct or outcome of the battle. However, the failure to locate and report on the location of the Japanese fleet the following night, while it was still well within the grasp of Task Force 58's aircraft, undoubtedly saved the Japanese from annihilation. In this sense, Admiral Nimitz's criticism was warranted, but not for the reason he initially conveyed. Unfortunately, VP-16's success in locating and shadowing the enemy fleet on 21 June 1944, although a model of success, did not contribute to the battle.

In conclusion, while establishing the open ocean seadrome might have decisively shifted the balance in favor of the U.S. forces, it failed to do so. This was not because the concept was unsound — it proved to be a viable and effective operational initiative — but because of the challenges of the PBMs in executing their mission. The real contribution the open ocean seadrome made was in validating the proof of concept and demonstrating conclusively that while far from optimal, it was a feasible method for forward deploying seaplanes for a limited period and with limited operating objectives. This informed later amphibious operations, including Iwo Jima and Okinawa, that again advanced sufficiently far to reduce the effectiveness of land-based aircraft support. In this sense, establishing the open ocean seadrome was an unmitigated success. It positively influenced the conduct of the rest of the war, even as it had a minimal impact on the Battle of the Philippine Sea.

6.2. SECONDARY RESEARCH QUESTIONS

1.1. How effective was the seaplane tender support in the open ocean seadrome, and how did it influence future seaplane tender operations?

The seaplane tender support for the open ocean seadrome initially fell exclusively to USS *Ballard*, a small, converted World War I four-stack destroyer. *Ballard* was ill-equipped for this mission. It had been deployed to provide VADM Turner's Northern Invasion Force with a dedicated support vessel to tend to small naval gunfire-spotting seaplanes and was never intended to support large patrol seaplanes like the PBM-3D Mariner. Consequently, it did not possess any spare parts for PBM, such as were instead loaded onto the large seaplane tender *Pocomoke*, nor did it have the necessary fuel and other petroleum products to support these larger patrol planes' gas-guzzling Wright R-2600-22 engines. Its 30,000 gal. (113,562 L) of aviation fuel could only fully refuel the 2,914-gal. (11,031 L) fuel tanks of the PBMs a dozen times. This might suffice for just two days of operations for the intended six aircraft nightly patrols (*Ballard* 1944:10).

FIGURE 6.2: *Pokomoke* received PBM spare parts at Guadalcanal in May 1944 in anticipation of Operation FORAGER. Conversely, *Ballard* had no PBM spare parts aboard (Photo courtesy National Archives #-G-238417).

The high sea state also made refueling operations challenging. Standard procedures and equipment assumed operations could only be conducted in a fully sheltered or roadstead environment. Innovations were required to adapt tactics, techniques, and procedures to operate well offshore in unfavorable weather conditions.

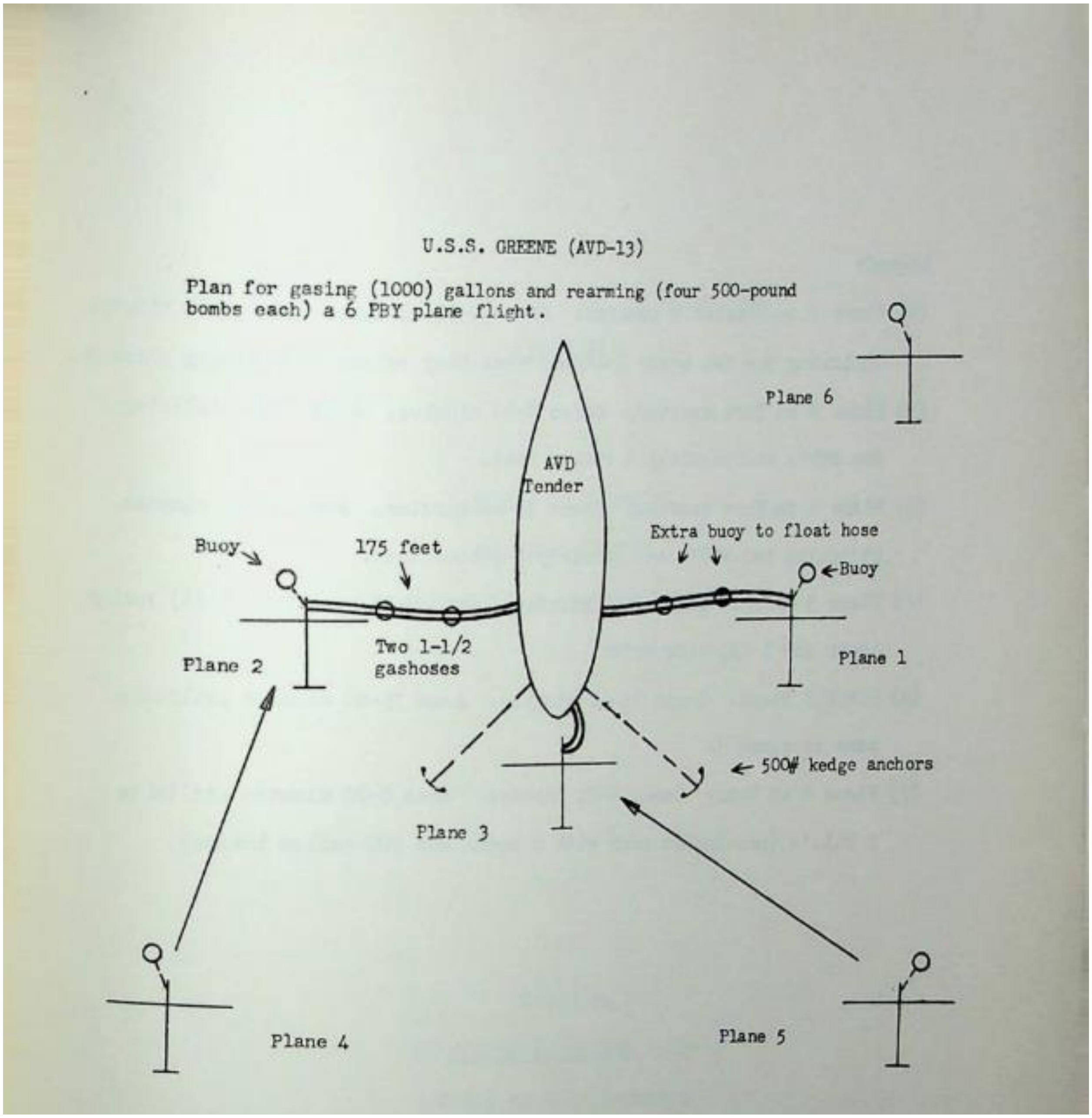


FIGURE 6.3: USS *Green* (AVD-13), the same class vessel as *Ballard*, responding to an Aeronautics Bureau survey on best practice refueling/rearming techniques. This system would be used for smaller PBY aircraft in a mature seadrome environment and does not represent the challenges and conditions faced in the open ocean seadrome (Diagram courtesy of Michael G. Kammen).

These innovations were required due to operational challenges and the overburdening of an ill-equipped tender. *Ballard* had significant shortfalls, given its role. It did not enjoy a dedicated Patrol Aircraft Service Unit (PATSU) committed to providing higher-level maintenance during aircraft maintenance periods. Accordingly, aircrew initially conducted essential maintenance during limited periods when they were not performing their missions, further burdening the limited and already overtasked VP-16 aircrew. It also limited work on specialized equipment, such as the IFF, causing them to fail. LCDR Scarpino later directly attributed the challenges on a non-functional IFF to the friendly fire engagement of LT Blocker's aircraft on 19 June 1944 (VP-16 History 1945:47–48).

Ballard also lacked adequate onboard berthing spaces for the PBM crews, forcing many to remain berthed aboard their aircraft in the heavy seas. This limitation was partially mitigated by the necessity of maintaining both an emergency taxi crew and security watch aboard each aircraft. These were intended to handle emergent issues such as unintentional departure from their anchorage, damage control should they be hit by enemy attack, and even repel Japanese boarders.

Fortunately, the arrival of *Pocomoke* and *Onslow* on 20 June 1944 remedied these deficits after only a couple of days. Together, these three seaplane tenders possessed the required capabilities to comprehensively provide for the operational requirements of these aircraft and the life support needs of their crews. Additional seaplane tenders and squadrons incrementally flowed into the Saipan seadrome as the battle continued until a robust and fully functioning seaplane base was finally established upon the remnants of the captured Japanese base in the protected Tanapag harbor.

The impact of the open ocean seadrome, during its five days of operations, on future campaigns was profound. It had demonstrated conclusively the ability to successfully, albeit temporarily, conduct limited operations from an austere forward operating base absent traditional support requirements. This greatly influenced seaplane support during the battles of Iwo Jima and Okinawa, enabling planners to defy traditional seaplane deployment considerations.

At Iwo Jima, the depth of the water offshore plunges after only 1,000-2,000 yd. (914-1,829 m) off the beach, making anchorages for a seadrome impossible beyond this. Although seaplane tenders arrived the day after the invasion on 20 February 1945, it was four more days until the enemy had been pushed back and sufficiently attrited to begin laying anchoring buoys. Even then, conditions in the anchorage were so hazardous that the seaplanes sometimes taxied up to 10 mi. (16 km) out to sea before attempting takeoff due to battlefield debris in the water nearer the island and the extent to which the anchorage was overcrowded with ships from the invasion fleet. Seaplanes again served as the eyes of the fleet and saviors of downed aircrews until the airfield on Iwo Jima was finally secured on 6 March 1945, allowing the seaplane tenders and their Mariner charges to return to Saipan's Tanapag harbor for refit (Kammen 1958:29–30).

The final stepping stone on the long march to Japan was Okinawa. Here again, there were no proper facilities from which to operate seaplanes, although circumstances favored the establishment of a seadrome more so than at Saipan or Iwo Jima. The Keramas Retto islands are 10–20 mi. (16–32 km) from Okinawa. Captured before the main invasion, they provided a semi-sheltered location to establish a seadrome. Although insulated from the threat of attack from Japanese land-based fire, they still could be subjected to air attack and lacked beaching locations. This latter condition again forced most maintenance and repair work to be conducted while the aircraft were anchored on the water (Kammen 1958:44–49). PBMs operating from there were responsible for detecting the super battleship *Yamato* as it made its suicidal foray to contest the U.S. invasion fleet (Dull 1978:333).

The hard lessons learned at Saipan during the conduct of the inaugural open ocean seadrome heavily influenced and informed future operations. It is reasonable to say that they directly enabled the success of these future operating locations. Had the Saipan open ocean seadrome not been established, similar efforts at Iwo Jima and Okinawa may have occurred. Saipan had flattened the learning curve, saving lives and aircraft during these later operations.

1.2. What archaeological remains, if any, of Saipan's original open ocean seadrome still exist?

Some ambiguity surrounds what archaeological evidence may remain of the open ocean seadrome. PBM BuNo 48173 and the refueling bowser boat are known to have sunk at this location. A series of the six original mooring locations may remain, each comprised of anchors, anchor chains, and rope. Additionally, because four additional VP-16 Mariners arrived on 19 June 1944 after supplementary tenders arrived, at least ten moorings were likely established in the open ocean seadrome by this time. Elements of additional squadrons began to arrive on 20 June 1941, the day before the movement toward shore began, likely necessitating even more anchoring points.

All, or none, of these may still be present depending upon environmental factors, including frequent typhoon activity, expected degradation of a wooden boat and metal corrosion, and heavy military and commercial maritime activity. Although the unknown location of these wrecks shields them from opportunistic salvage, their location in a deep-water anchorage was used extensively both at the time of their sinking and since their sinking exposed them to other cultural site formation factors. The most prominent danger to the site is the large anchors and shifting anchor chains of large deep draft vessels using this site as an anchorage. The only means to determine what remains is to locate and conduct a more deliberate and thorough survey, and once located, evaluate remains in this area.

1.3 What can the archaeological investigation of the bowser boat, anchorages, and PBM Mariner Bureau Number (BuNo) 48173 communicate regarding the operations within the open ocean seadrome?

The discovery and subsequent archaeological investigation of Saipan's open ocean seadrome would be pivotal in analyzing operations within such seadromes. This unplanned and expedient operational evolution can significantly enhance our understanding of the planning and execution of this operation through a detailed assessment of remaining artifacts such as the BuNo 48173 BuNo, lost bowser boat, and any remaining anchors.

USS *Ballard* was neither intended nor equipped to provide for large patrol seaplanes. Identifying and analyzing the locations, types, and setup of any anchors on site would be instructive primarily because no doctrine nor precedence existed for establishing an open ocean seadrome. During *Ballard*'s September 1941 refit, it received new 500-lb. (227 kg) seaplane anchors but determined it could not correctly stow such large anchors in stowage racks and lockers designed for smaller versions. Consequently, it successfully petitioned to retain 150-lb. (68 kg) Danforth and Northill 200-lb. (91 kg) anchors. No records suggest *Ballard* had ever swapped its anchor racks and obtained larger versions. Stopgap-converted destroyers were steadily replaced by the newer purpose-built *Barnegat*-class small seaplane tenders by 1943. Most converted destroyers like *Ballard* were transitioned back to traditional destroyer roles or reconverted to high-speed transports (APDs) and, therefore, were unlikely to have received modifications or upgrades necessary to accommodate larger anchors (Bruhn 2016:20).

Independently, these 150 and 200-lb. (68 and 91 kg) anchors were unsuited to holding a large seaplane such as the Mariner in place — especially in the heavy seas encountered — without dragging. *Ballard* would have had to set multiple anchors to moor the VP-16 aircraft successfully. They may have received more substantial anchors better suited to the task from other vessels, just as *Alhena* provided a refueling bowser. The use of expedient means, such as large machinery parts or broken equipment, which were undoubtedly available in vast quantities several days into the invasion, to firmly embed these moorings is possible. Such improvisation would not be uncommon; for example, 40mm grenade boxes had previously been used as seaplane anchor floats. However, the record is silent on this issue. Only by successfully locating and surveying the remains of the anchorage can these questions be answered.

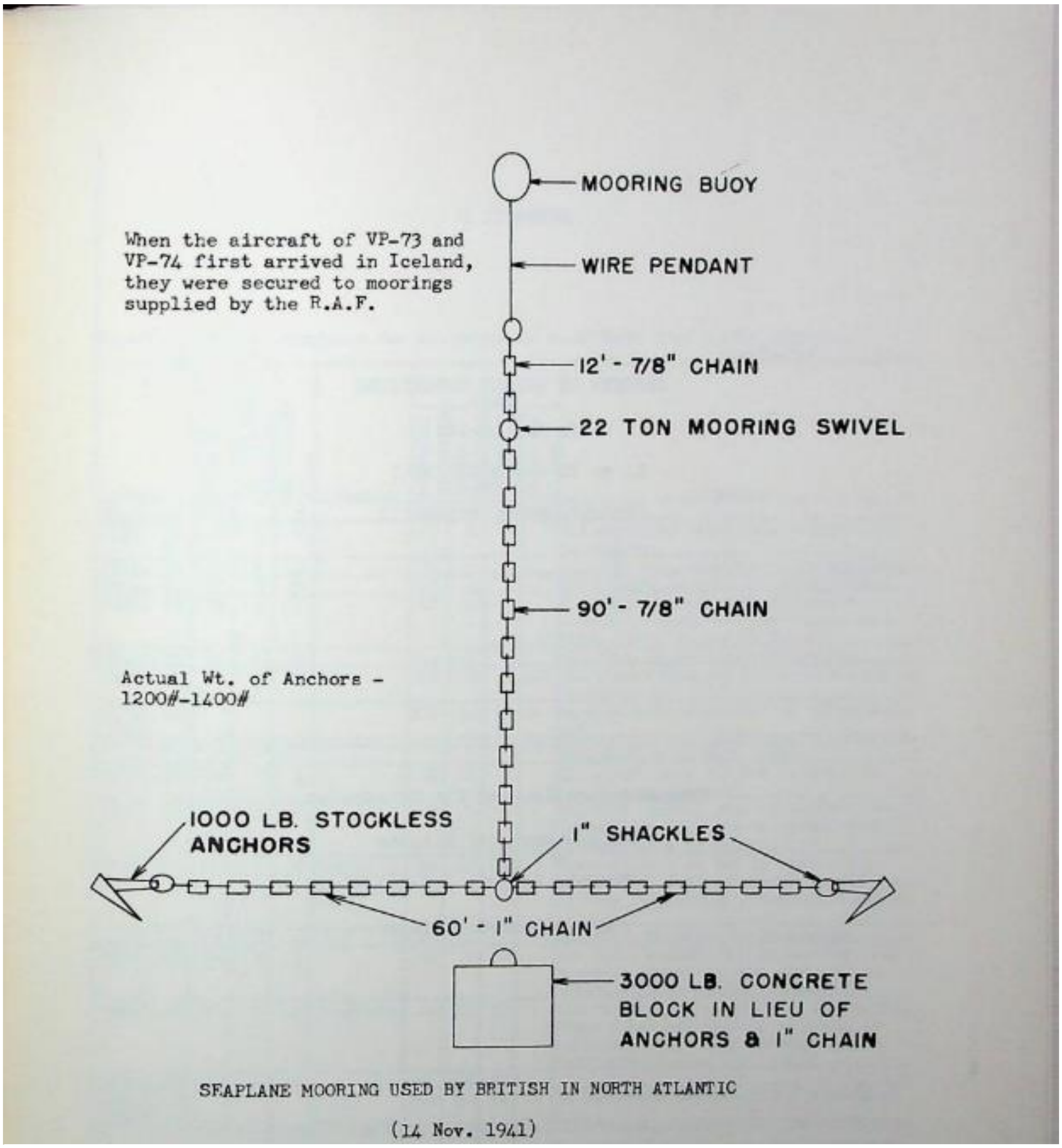


FIGURE 6.4: Anchoring system used U.S. PBMs provided by the British in challenging North Atlantic operating environments. Anchors could be substituted with a 3000-lb. 1361 kg) concrete block. Similar improvisation could have taken place in the open ocean seadrome (Diagram courtesy of Michael G. Kammen).

Similarly, the discovery of the PBM could answer many lingering archaeological questions. It suffered severe but isolated hull damage, and a determined damage control action was undertaken to save this seaplane. This effort required the PBM to stay tethered to avoid drifting and allow a stable point to maneuver around. As the aircraft settled and sank in a nose-down attitude, the forward anchor hatch was certainly already submerged before the decision was made to "abandon ship" and remove damage control teams, potentially eliminating the ability to untether it. Discovering this intact mooring, potentially with BuNo 48173 still attached, would provide evidence and answers regarding the anchorage methodology addressed above.

Another value of discovering this PBM lies in determining what is found aboard and, as importantly, what is not. The three hours it took to sink beneath the waves afforded crew and damage control parties plenty of opportunity to conduct systematic salvage, directly informing the site formation process and providing insight into the salvage priorities for these patrol aircraft, making the information from its discovery and *in situ* survey unique and invaluable. This direct evidence of systematic salvage following the Process of Wrecking described by Bell (2010), and the items removed would specifically communicate what items were deemed most valuable and meaningful by their crews.

Salvaged items likely include charts, maps, logs, code books, and other sensitive documents. The Norden Bombsight, earmarked for recovery or destruction whenever an aircraft was lost to avoid this sensitive technology from falling into the wrong hands, is almost certainly removed. Highly technical and costly equipment such as radios and RADAR or IFF components were probably also high on the list. Finally, the many machine guns onboard, due to their heavy weight and ease of removal, may have been recovered if time and conditions allowed, both to reduce weight during damage control efforts and preserve valuable equipment. Absent equipment and material are as beneficial for archaeological interpretation as is that which is present.

The last known artifact in the open ocean seadrome is a bowser boat inadvertently sunk by collision during evasive maneuvering by *Ballard*. This small vessel sustained significant damage during the sinking event. Due to its wooden construction, it has likely degraded significantly since 1944 and will provide different, yet still valuable, site formation information. *Ballard* was equipped with two converted 30-foot (9 m) motor launches, each retrofitted with a 600-gal. (2,272 L) fuel bladder to facilitate seaplane refueling. *Alhena* provided an additional bowser boat of an unknown type. The type of browser boat sunk is undetermined, but locating this wreckage would affirm the seadrome's location and contribute to the historical and archaeological record.

In conclusion, locating and surveying what remains of the open ocean seadrome is vital to advancing emergent aeronautical site formation theory. The presence of a reasonably intact PBM Mariner, sunk at anchor in deep water without the catastrophic damage associated with a high-speed impact related to an airborne loss and insulated from many typical cultural scrambling activities, provides a vital site formation resource. The value of this aircraft is enhanced by the presence of a second PBM aircraft just miles away that was lost under diametrically opposing circumstances. This second aircraft was lost during takeoff in a high-energy crash or during taxi operations when it struck a reef and suffered debilitating damage (Adamson 2020:93–95). It came to rest in shallow water, where it was systematically and opportunistically salvaged. It was subjected to dredging and other cultural scrambling activities to eliminate it as a hazard to navigation. This long-term opportunistic salvage and scrambling has continued to this day. Comparing and contrasting the site development characteristics of these two identical aircraft lost nearby but undergoing dramatically different environmental and cultural site formation processes could be illuminating.

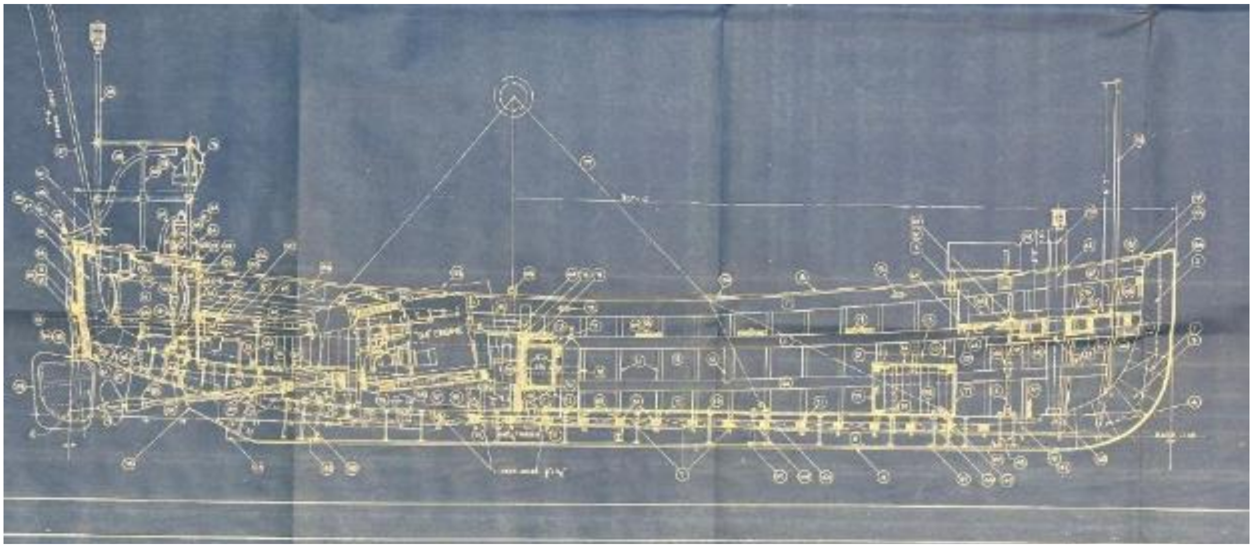
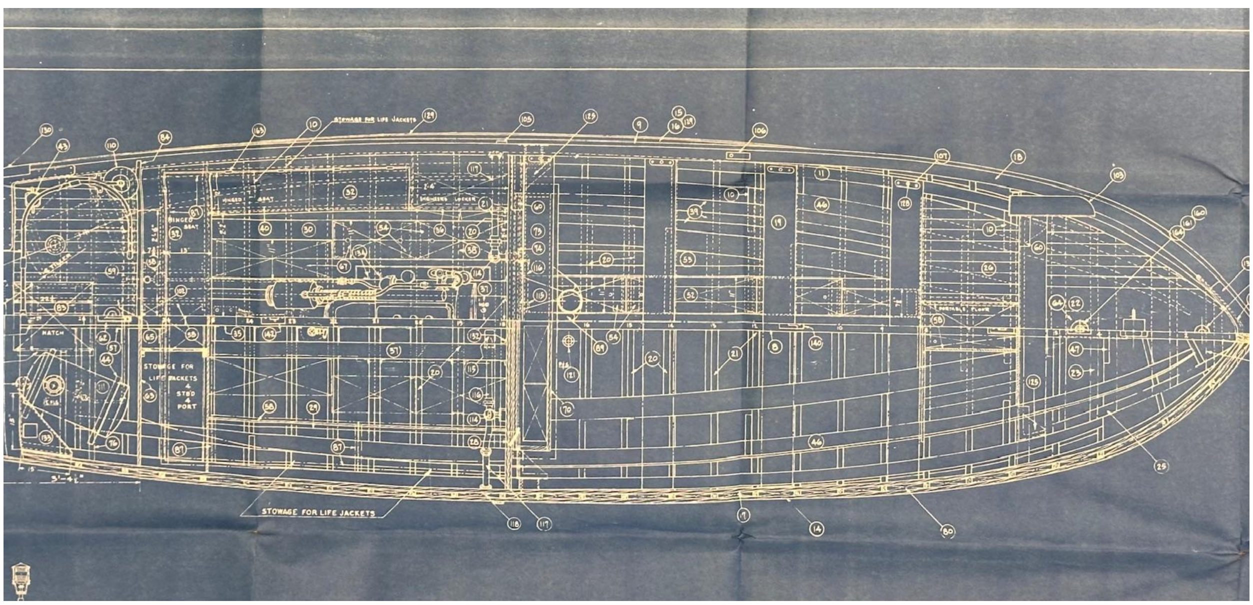


FIGURE 6.5 (above) and FIGURE 6.6 (below): Schematics of a 30-foot U.S. Navy motor launch. *Ballard* was outfitted with two such vessels, each augmented with a 600-gallon (2,272 L) fuel bladder for refueling operations. One launch, acting as a bowser, was struck and sunk during maneuvering by *Ballard* during an air attack in the open seadrome anchorage on 17 June 1944. However, as *Ballard* was augmented with at least one additional bowser boat, from *Alhena* of unknown type, it is uncertain what type may be located (Images courtesy of East Carolina University Digital Collections https://digital.lib.ecu.edu/35635).



1.4 How can site formation studies of the BuNo 48173 deep-water wreck contribute to understanding World War II seaplane operations?

The open ocean seadrome offers a unique case study for aeronautical archaeology. As the inaugural use of a seadrome without the benefits of an established seadrome or roadstead environment, the lessons learned here influenced tactics, techniques, and procedures for the rest of the war. Identifying the location of this seadrome could inform an understanding of the how and why of establishing this key facility but also contextualize it as an integral element of the Battle of the Philippine Sea and Saipan. The decision to develop this facility defied conventional wisdom and doctrinal conventions; it was a revolutionary step in seaplane operations. It served as the stepping stone and foundation upon which all later seaplane-basing decisions were made, enabling successful operations in Iwo Jima and Okinawa. As such, its legacy for both archaeological and historical purposes cannot be overestimated.

Locating and surveying BuNo 48173, the sunken bowser boat, and the residual remains of the seaplane anchorages would allow a site formation study and inform the understanding of World War II seaplane operations. While considerable effort has been applied toward site formation theory (Muckleroy 1978; Ward et al. 1999; Gibbs 2006; and Bell 2010), these theories could be further validated and expanded by surveying this atypical archaeological site.

The open ocean seadrome functionally demonstrated the concept's viability while laying bare the concept’s shortfalls — primarily the inability to properly service the maintenance PBMs at anchor, especially on heavy seas. Another revolutionary step forward, deemed essential after the Saipan open ocean roadstead experience, was the Jet Assisted Take Off (JATO) development. JATO uses small rockets affixed to the airframe to provide additional thrust to assist an overburdened aircraft during the takeoff transition. Used extensively in Iwo Jima and Okinawa, this system allowed Mariners to safely take off in most sea states. Previously underpowered PBMs that often had to make multiple takeoff runs while risking catastrophic damage could now become airborne in as little as five seconds using JATO bottles (Kammen 1958:55–56).

Finally, the open ocean seadrome is integral to the history and culture of Saipan and its Chamorro people. One must remember, “The physical remains of the war — the ships, planes, men and material — are a part of the archaeology of the islands” (Carrell et al. 2009:269).

7. CONCLUSION

Writing an archaeological thesis on the wreckage of a World War II seaplane is made eminently more difficult by the absence of the wreckage of a World War II seaplane. Still, BuNo 48173 is certainly discoverable, barring extraordinary circumstances. Even had it drifted over the eastern edge of the Saipan Shelf into significantly deeper water, it could still be identified if the proper equipment, techniques, and, importantly, time were committed to finding it. It is an archaeological imperative that consideration be made for doing so and conducting a thorough *in situ* non-invasive survey.

Although "unique" is often misunderstood and overused, it is the perfect descriptor for this specific wreck. Given the attention in the past decades to the nascent field of aviation archaeology, few aircraft are as well positioned to advance the discipline as BuNo 48173. It sank under atypical circumstances for an airplane that could highlight the cultural impacts of the wrecking process, given that its crew had hours during its sinking rather than the seconds or minutes normally afforded an aircraft during a typical shoot-down or crashing scenario. It was also spared the typical highly kinetic destruction that most aircraft undergo, providing a contrasting site formation process model to inform the discipline. This point takes on heightened importance given a similar type/model/aircraft that suffered through a highly kinetic crash incident with significant post-wrecking cultural scrambling, against which it can be effectively compared.

Beyond its considerable archeological value, this aircraft's historical value should not be underestimated. At present, it is not known if this is the storied aircraft that made the potentially campaign-changing discovery of the Japanese fleet, and additional research is required to determine this. Regardless, it remains one of a mere handful of aircraft from a groundbreaking patrol squadron deployment that redefined the role of seaplane contributions to future Pacific campaigns. As such, it deserves special consideration in the historical ledger.

The failure to locate and survey BuNo 48173 compelled this thesis to emphasize other aspects of VP-16's storied deployment and heavily weigh theoretical issues. These include the circumstances of the open ocean seadrome's establishment, operations from within, its successes, and its singular, spectacular failure to push through a contact report once a Mariner accomplished its primary mission of locating the Japanese fleet. While searching for this aircraft, fieldwork sought to leverage emergent and experimental archaeological methods, such as the use of LiDAR in locating submerged cultural features, albeit unsuccessfully. It employed existing theoretical site formation concepts to develop a predictive site formation analysis based on the sinking event. It also relates the extraordinary theoretical value of site formation, once discovered, that will inform future site formation theory development.

More importantly for the future, this thesis developed a broad framework and recommendations for additional archaeological efforts for the deeper waters outside of the Tanapag Lagoon and beyond the outer reef. This area is as rich in submerged cultural artifacts as the near-shore areas. Much of this remains within the limits of recreational diving and can be used to extend the existing Saipan Heritage Trail and provide additional outreach to the collective stakeholders of the Battle of Saipan. The recommended methods for surveying this area merely offer a potential framework that must be refined and planned in detail before execution. Doing so is required to continue to expand and interpret the archaeological and historical legacy. All these sites are essential, but perhaps none more than the wreckage of BuNo 48173.

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APPENDIX A: ANATOMY OF A FRIENDLY FIRE ENGAGEMENT

A contemporary study of the Combat Information Center's (CIC) charts from CTG 58.1 reveals that a F6F Hellcat, callsign 'Coke 1' engaged a friendly PBM at 0743 (CIC Plot Chart 1944). The 'Coke' call sign was assigned to Fighter Squadron (VF) 24 aircraft aboard the aircraft carrier light (CVL) USS *Belleau Wood* (CVL-24). On the morning of 19 June 1944, *Belleau Wood* launched two flights of eight Hellcats, divided into two divisions of four aircraft each (FIGURE A.1). The first of these flights launched on a routine CAP mission at 0540. Soon after, enemy air activity was detected over Guam's Orote Airfield, and a division of four F6Fs led by LT Oveland, was vectored to engage these enemy aircraft over the nearby island.

(FIGURE A.1: USS *Belleau Wood* (CVL-24) underway on 22 December 1943. This was the aircraft carrier the VF-24 Hellcats that attacked a VP-16 PBM-3D Mariner were embarked upon (Official U.S. Navy photograph courtesy of the Naval History and Heritage Command #97269).

Arriving at 15,500 ft. (4,724 m), Oveland’s division began a wild melee, expending 2,250 .50 caliber rounds against approximately 20 Japanese Mitsubishi A6M Zeros. Ensign Carl Bennett was the sole U.S. casualty, having sustained nearly a dozen 7.7mm and 12.7mm hits on his aircraft. One round struck his cockpit cover, inflicting minor wounds to the back of his head, although he was able to safely return to the deck of *Belleau Wood* after the engagement. In exchange, the American pilots destroyed three Zeros while damaging three more (VF-24 Aircraft Action Report 1944). This action was one of the opening rounds of the Battle of the Philippine Sea as the U.S. began detecting, attacking, and breaking up land-based Japanese air attacks. These attacks were intended to attrit U.S. air and naval forces in anticipation of the later strikes by Admiral Ozawa’s carrier forces. No mention is made regarding the activities of this flight's second division; consequently, it seems almost certain it did not engage any enemy aircraft.

As the tactical situation developed further, *Belleau Wood* launched a second flight of eight VF-24 Hellcats at 0720. This flight was launched specifically in response to the increasing Japanese activity and was immediately vectored to intercept Japanese aircraft over Guam. Both divisions from this flight were promptly engaged. They were again wildly successful in downing seven Zeros and damaging seven more, having collectively fired 5,700 machine gun rounds during this action while suffering only another minorly damaged Hellcat in return (VF-24 Aircraft Action Report 1944).

Based upon a time-distance analysis, it is doubtful that the second flight, launched at 0720, could have completed the launch of all eight aircraft, formed up, and transited the approximate 60 mi. (97 km) to engage LT Blocker’s PBM just 23 minutes later. They did not arrive at Guam until 0845, 85 minutes after launch. As they were being launched and vectored to intercept Japanese aircraft forming over Guam for an attack on the fleet, it is also improbable that they delayed to attack a low-flying search seaplane that posed no serious threat to an already detected Task Force 58. Furthermore, a direct flight path from *Belleau Wood* at launch to Orate Field, Guam, would also have taken them approximately 15 mi. (24 km) north of the friendly fire location. Although they cannot be ruled definitively out, it seems improbable that they are culpable for the attack on the PBM because of simple physics, visual detection ranges, and the urgency of their intercept mission.

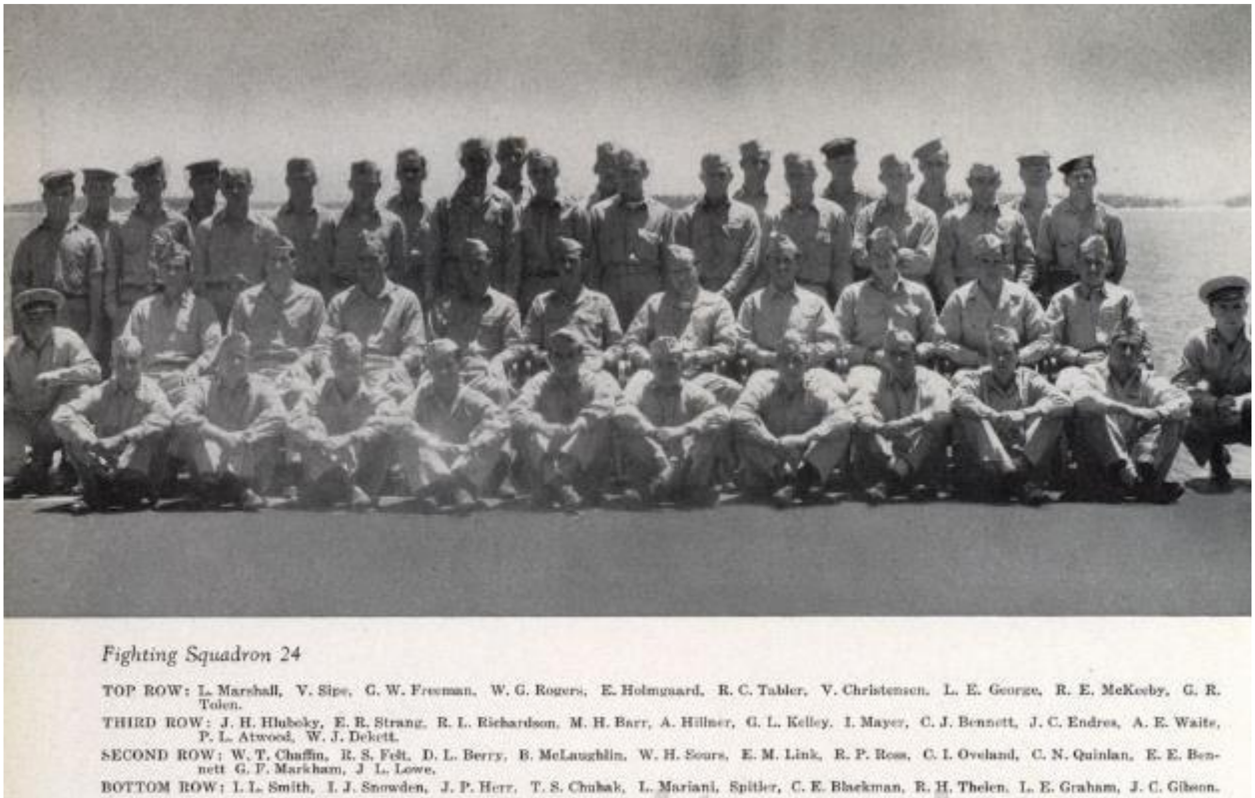
Therefore, the first flight of VF-24 aircraft to launch that day is the leading suspect. One of the two divisions within this flight, led by LT Oveland, launched at 0545 and reported arriving over Guam, 90 mi. (145 km) away, just 15 minutes later at 0600. This is almost certainly incorrect given a Hellcat’s distance and speed calculus, but it demonstrates their urgency to arrive over Guam. Regardless of their arrival, this division became embroiled in their air-to-air engagement over Guam well before LT Blocker’s aircraft was attacked. This flight returned to *Belleau Wood,* landing at 0835 (VF-24 Aircraft Action Report 1944). LT Oveland’s division probably returned directly to the carrier, most likely passing far north of LT Blocker’s PBM position when attacked. However, their return flight's timing could have put them near the PBM at 0743. However, having just engaged in significant combat, likely low on fuel and ammunition, and with a pilot having suffered a head wound, their priority was undoubtedly returning to the carrier.

This leaves the unaccounted-for division that launched with the day's first flight. Assigned to a CAP mission, its mission was prowling the ocean for enemy search and attack aircraft as the two fleets actively probed for the other. Not assigned to investigate or participate in the action unfolding over Guam, it seemed to be held on station by the Fighter Direction Center (FDC) to avoid over-committing to an as yet uncertain and evolving tactical dynamic.

This division is, therefore, the leading candidate to have encountered and engaged the VP-16 Mariner. Engaging an enemy search seaplane would have been consistent with the intent of their CAP mission, and they would likely have been positioned to intercept enemy aircraft launched from Guam toward CTG 58.1, placing them in the proximity of the engagement location and during the timeframe of the action. Moreover, the division callsign of 'Coke 1' would likely have been assigned to the day's first mission, lending more credence to this division as a leading candidate.

As there are no located accounts of this attack in any known VF-24, *Belleau Wood,* or CTG 58.1 records beyond a single annotation on a plot chart, it is unlikely the actual offender will be known with any degree of certainty. It is a curious omission in an otherwise highly detailed accounting of the day's actions. Still, it would hardly be surprising if the command wanted to obscure this transgression from the record. Although this analysis uses the information available to speculate, it is just that — speculative. This is a probabilistic assessment, not a definitive or accurate rendering of the incident. Regardless, such tragedies happen in war, and this unfortunate event should not overshadow the extraordinary job the pilots of VF-24 performed against their enemy that day (FIGURE A.2). Still, this attack set the conditions and put into motion the unfortunate circumstances that led directly to the loss of PBM-3D (BuNo 48173) in the waters off Saipan later that day.

There is still potential for further research to unveil the truth about the attack. Given the often-preventable nature of friendly fire incidents, they were commonly rigorously investigated, when possible, to prevent similar future transgressions. It is conceivable that a detailed post-mortem investigation was conducted and remains in the National or Naval Archives, waiting to be discovered and solve the mystery of the attack on LT Blocker’s Mariner. Regardless, this attack had the unintended consequence of setting the conditions for the sinking of BuNo 48173.



(FIGURE A.2: VF-24 squadron photo taken while embarked aboard USS *Belleau Wood*. LT Oveland, who led the initial attack against Japanese air units over Orate Field on Guam is pictured fifth from the right, third row. Two of the pictured pilots are also likely responsible for the attack on LT Blocker’s PBM-3D. (Photo courtesy USS *Belleau Wood* (CVL-24) from *Flight Quarters* 1946:180).

APPENDIX B: ADDITIONAL ARCHAEOLOGICAL POTENTIAL

While it is known that a PBM-3D from VP-16 and a bowser boat from USS *Ballard* will, barring extraordinary environmental influences, be found in the open ocean seadrome location, a sequential question is “What else of archaeological significance might be located on the Saipan Shelf?” The answer is a very great deal of material.

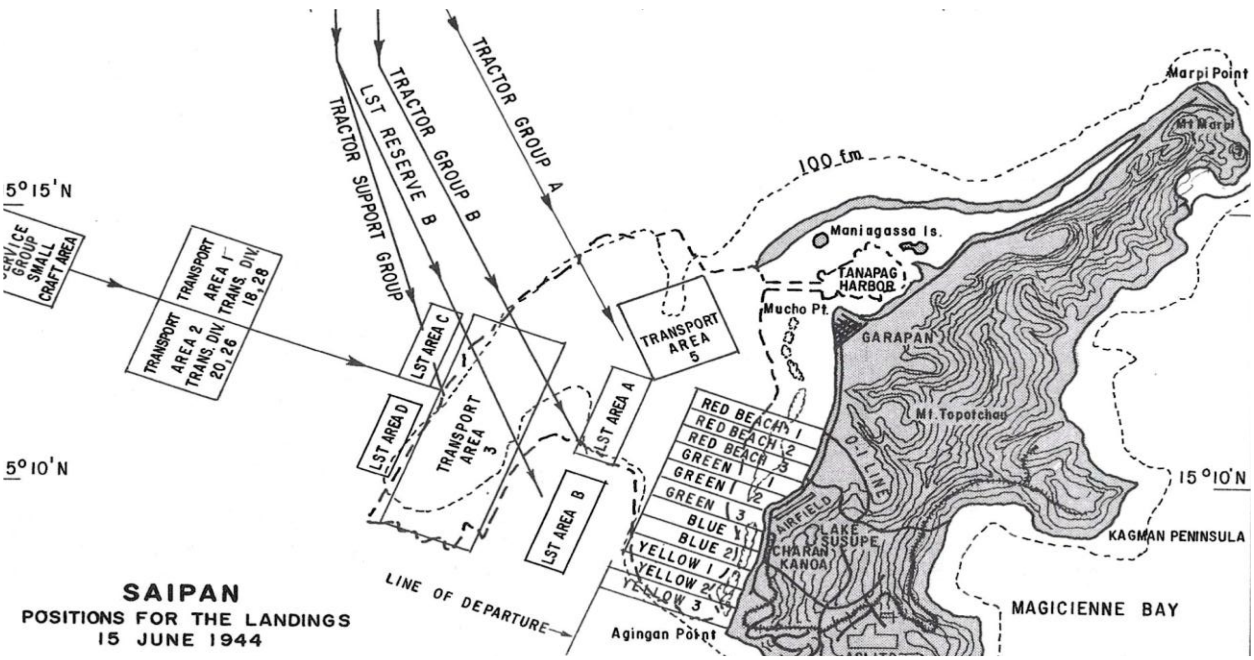


FIGURE B.1.: The Saipan landing plan demonstrates the heavy assault vessel traffic that would pass through Transport Area 3 (Saipan Shelf). All traffic from the beaches would withdraw via Transport Area 3 as well (Dyer 1969: 904).

The number of amphibious craft participating in the assault was staggering (FIGURE B.2). A total of 719 amphibious vehicles, 367 belonging to the Army, with the balance being operated by the Navy and Marines, took part in the attack. In the assault wave alone, there were 393 LVTs and 140 Amphibious Tanks (LVT(A)s) (Gugeler 1945:3). Admiral Turner gave the traditional order of “Land the Landing Force” to commence the invasion at 0542 in the morning. By 0700 a Landing Ship, Tank (LST) flotilla of 34 LSTs arrived 1,250 yd. (1143 m) behind the Line of Departure (LOD) with the assault waves of two Marine divisions. Staged further back were “eight LSTs with both divisions’ artillery, two LSTs with the anti-aircraft artillery, and two

LSTs with XXIV Corps Artillery embarked. Two Landing Ship, Docks (LSD), carrying tanks in LCMs, were in the rear of each division's beach" (Hoffman 1950:41-42).

FIGURE B.2: "D-Day at Saipan" watercolor by Staff Sergeant John Fabion. This artist's rending captures the sheer quantity of amphibious craft involved in the invasion of Saipan (Image courtesy Marine Corps Art Collection).

After disgorging the assault waves of vehicles, all LSTs, save three acting as hospital ships that remained close to the beaches, retired to Transport Area 3 to await the reloading of all LVTs at the end of the day. The LSDs, such as the USS *Belle Grove* (LSD-2), after disembarking its 72 LTVs, joined the movement to rearward (USS *Belle Grove* 1944:6). Concurrently, the APA and AKA ships were active in the outer transport areas 1 and 2. They were sending additional troops forward in Landing Craft, Vehicles, Personnel (LCVP) craft, and other vessels for transfer to LVTs at identified transfer points in the beach lanes to carry them to the shore.

These operations were concluded mainly by mid-morning on 15 June 1944. By 0915, some had already been ordered forward to Transport Area 3, the Saipan Shelf, and all soon followed. From there, they continued providing support, receiving casualties from returning LVTs, loading them with supplies for the return trip, and tending to damaged landing craft (USS *Sumter* 1944:5). Nearly all landing craft would transit through the Saipan Shelf (Transport Area 3) area both on the way to and from the beaches as they continued to provide logistical and evacuation support to the landing forces and be tended to and salvaged (FIGURE B.3).

FIGURE B.3: Salvage of small craft damaged during initial invasion of Saipan, Mariana Islands (Photo courtesy of National Archives #80-G-238430).

Losses of small craft continued unabated in this area, like an LCVP from USS *Leon* (APA-48) that burned and sank in Transport Area 3 after its onboard smoke pots spontaneously combusted (USS *Leon* 1944:3). A great many of these vehicles were lost due to collisions with other landing craft, enemy fire, mechanical failure, and overloading. Still, the preponderance became casualties while crossing the reef line or from being struck by enemy direct fire weapons in the surf line and on the beach. Many more were disabled as they pressed inland to place the Marines ashore well beyond the beach toward the O-1 line, the desired first objective line after the first day of the invasion delineated by a rise of ground that dominated the invasion beaches. The distance inland varied depending upon the line's location but broadly sought to establish a beachhead some 1,000 to 1,500 yd. (914 to 1372 m) inland (Croizat 1989:118). Vehicles pushing inland suffered significant combat casualties and mechanical failures and bogged down due to the harsh terrain (FIGURE B.4). A disproportionate number of losses occurred in shallow water or on terra firma. However, many were described as "lost in deep water."

A review of amphibian tractor battalion losses demonstrates this. The 2d Amphibian Assault Battalion reported seven LVTs lost in deep water; the 5th Amphibian Assault Battalion reported 11 LVTs sunk in deep water, with another missing and presumed sunk. The 10th Amphibious Tractor Battalion also identifies four LVTs sunk in "deep water" but clarifies this as some 2000 yards of the beaches, well inside the LOD and near, but still beyond, the reef, lending ambiguity to what is truly meant by deep water in this reporting (COM GEN 5th PHIB CORPS 1944:1208-1211) Other cases are less ambiguous. In one instance, an LVT ran parallel to LST-222 toward seaward during the retrograde from the beaches. For unknown reasons, the LVT turned 90 degrees across to the bow of the larger ship, where it was promptly struck and sunk with two souls lost (COM LST FLOT 13 1944:3). Other LVTs were seen scattered three to four mi. (5 to 6.5 km) offshore — the approximate distance of the Saipan Shelf from shore — days into the battle, many of which were likely derelict and unrecovered (COM LST FLOT 13 1944:3).

FIGURE B.4: Most LVTs that were lost, like these, were disabled at the water's edge or foundered on the reef. Others were destroyed as they pushed inland, trying to deliver Marines to the O-1 line. Disabled vehicles were collected, salvaged, or refurbished when possible. Some were also lost in deeper water and may be discoverable with a proper survey (Photo courtesy of Naval History and Heritage Command, USMC 88365).

Many landing craft made repeated trips from the beach to Transport Area 3 and back, some disappearing under the waves during this extended transit. Although the casualty rate was significantly lower than expected, the losses were still consequential, given the numbers involved. In total, 719 LVTs were employed, with 184 being operational losses (FIGURE B.5). Most of these, 127 LVTs and 57 LVT(A)s, were lost after the initial assault in follow-on operations (COM GEN 5th PHIB CORPS 1944:1074). The preponderance of LVTs reverted to logistical support, operating as a bridge between the offshore fleet and the landing forces. Consequently, most of their losses are on the water. Due to the sandy bottom and partial floatation of many stranded vessels, they could often be pulled into deeper water by LVTs. This was especially effective for recovering LCVP and LCM vessels that had ventured too close to shore before discharging their loads (COMTRANSDIV 30 1944:A-9). Of the 184 LVTs lost, 74 were recovered and returned to Oahu, leaving the remnants of some 110 on Saipan (COM GEN 5th PHIB CORPS 1944:24).

ORGANIZATION	RETURNED TO OAHU FOR BASE MAINT.	DEMOLISHED BY SHELL FIRE OR SUNK TOTAL LOSS	MISSING PRESUMED SUNK	TOTAL
2dAmphTracBn	9LVT2&4s	12LVT2&4s	1LVT2&4	22LVT 2&4s
5thAmphTracBn	8LVT(4)s	11LVT(4)s	1LVT(4)	20LVT (4)s
10thAmphTrBn	11LVT2&4s	7LVT2&4s	0	18LVT 2&4s
534thAmphTrBn (Army)	4LVT2&4s	19LVT2&4s	0	23LVT 2&4s
715thAmphTrBn (Army)	8LVT2&4s	19LVT2&4s	0	27LVT 2&4s
773rdAmphTrBn (Army)	7LVT(2)s	7LVT(2)s	2LVT(2)	16LVT2
	47LVT2&4s	75LVT2&4s	4LVT2&4	126LVT 2&4s
2dArmdAmphTk Bn(Marine)	11LVTA4s 1LVT(2)	16LVTA4s	0	27LVTA 1LVT(2
708thArmdAmph: TkBn(Army)	15LVTA1&A4s	15LVTA1&A4s	0	30LVTA &A4s
	26LVTA1&A4s 1LVT(2)	31LVTA1&A4s	0	57LVTA &A4s 1LVT(2

FIGURE B.5: 5th Amphibious Corps reporting on LVT losses during the Battle of Saipan (COM GEN 5th PHIB CORPS 1944:1206).

In contrast, the 57 amphibious tanks probably suffered losses ashore as they pushed inland to support the attacking troops. The LVT(A) employed smaller numbers, thereby naturally proportionally reducing numbers lost at sea. Yet the Army's 708th Armored Amphibian Tank Battalion still reported losses in "deep water." A single LVT(A) was sunk by artillery fire in deep water off Beach Blue, while two were similarly sunk in deep water off Beach Yellow (COM GEN 5th PHIB CORPS 1944:1210). Again, an absence of specificity in the reported losses stymies any effort to pinpoint their location with any degree of precision. Small landing craft such as LCMs, 2.5-ton Six-Wheel Amphibious Trucks (DUKW), and especially LVTs also suffered consequential losses. However, the larger amphibious vessels such as LSTs, LSDs, and Landing Craft, Infantry (LCI), although not immune to the attention of Japanese gunners, seemed to have suffered damage but few, if any, actual losses.

There were losses beyond landing craft as well. The 4th Battalion, 14th Marines lost a 105mm artillery tube during the afternoon landing of the artillery well after the assault waves had been put ashore. A DUKW carrying the piece intended to land at Beach Blue 2. While attempting to board an LST to refuel, it slipped off the ramp and plunged itself and its cargo to the bottom (Hoffman 1950:53). LSTs carrying DUKWs loaded with artillery pieces were directed to move forward to the LOD before offloading the DUKWs, so the location of these artifacts could be anticipated to be found in this area (COM 5th PHIBFOR 1944:540). Unfortunately, the water depth at Beach Blue 2 is approximately 285 m (935 ft.). A second 105mm howitzer was lost when another DUKW carrying the gun destined for Beach Yellow 1 experienced engine troubles and sank in rough seas (Hoffman 1950:53). Although it is uncertain what progress this DUKW made before sinking, only 1,000 m (3,281 ft.) from the LOD the water is less than 100 ft. (31 m) deep. It would be easily discoverable in the Beach Yellow 1 lane if it had transited this distance before its demise.

While three Sherman tanks are prominently located a short distance off the invasion beach and already incorporated into the Saipan Heritage Trail, others are potentially left to discover. The M-4 tank was not truly amphibious and could not make its way through deep water despite many being equipped with snorkel kits. Two means of delivering Shermans to the beach were planned. The first was for LCMs with their embarked tanks to proceed through a channel in the coral reef to deposit the tanks directly onto the beach. The second was for the LCMs to disembark them at the reef and let them drive through the shallow water guided by an LVT, but this method failed due to a "lack of communication and coordination" (4TH MAR DIV 1944:577). Instead, a crewmember was forced to travel ahead of the tank, wading and swimming through the water under constant fire to safely guide the tank around shell craters and other hazards until they were safely ashore (Hoffman 1950:51). This method was also found generally unsatisfactory due to the vulnerability of the guide to enemy fire and the fact they often found themselves in water too deep to wade through (MAR 4th DIV 1944:202). Consequently, some tanks were lost on the way to the beach, while others were lost at sea.

In one instance, USS *White Marsh* (LSD-8) disembarked all 18 LCMs when LCM number 19 began taking on water due to faulty ramp gear. Directed to return to the well deck, it was just 20 yd. (18 m) shy of reaching safety when it capsized, sending its embarked Tank number 17 of "B" Company, 4th Tank Battalion, to the deep below. Despite a spirited effort to save the capsized LCM, it followed the tank to a watery grave soon after (USS *White Marsh* 1944:4). As this probably took place near LST Area B, well offshore and in deeper water, it is certain this tank and LCM were unable to be salvaged and now await discovery.

In a similar incident, LCM #10 from the USS *Oak Hill* (LSD-7) also sank with the loss of another M-4 Sherman tank. This LCM also began shipping water soon after it departed its LSD and, despite recovery efforts, capsized to port soon after. As the LCM rolled over to port, a twelve-inch rip in its hull approximately amidships was noted. It was assessed that this damage was done by the fairleads on *Oak Hill*'s dividing gate as the landing craft departed. Unfortunately, this tank is believed to have sunk in 250 ftm. (1,500 ft./457 m) of water and would require a determined effort to locate (USS *Oak Hill* 1944:5).

There are also archeologically significant wrecks in the deep waters off Saipan beyond sunken vessels from the invasion fleet. In an unusual incident on the night of 26 June 1944, USS *Mercury* (AK-42) was anchored south of Garapan in anchorage berth B-46 when it came under a night aerial attack. A twin-engine Mitsubishi G4M "Betty" broke through the protective smoke screen only 200 yd. (183 m) from *Mercury* at an altitude of just 90 ft. (27 m), heading 180° True and completely darkened (USS *Mercury* 1944:3; 1946:5). The bomber instantly released its torpedo, directly impacting *Mercury*. Although unarmed, it still penetrated several compartments of the port side deck house, killing one crewman and leaving remnants of the torpedo scattered on the vessel.

The bomber then failed to clear *Mercury*'s aft starboard boom, impacted the structure, and careened away, crashing into the water just 1,000 yd. (914 m) off the starboard quarter (USS *Mercury* 1946:5) (FIGURE B.6). The USS *Belle Grove* was nearby in berth B-23 and tending to Landing Craft, Control (LCC) and other small boats when this Japanese aircraft struck the water 200 yd. (183 m) off its port bow. It slipped under the waves before a salvage team could arrive. A dead Japanese pilot was recovered by *Mercury* (USS *Belle Grove* 1944:11). The uncertainty regarding Saipan anchorages again impedes the ability to pinpoint this exact location. However, this Betty likely still lies where it crashed unless removed as an impediment to maritime traffic.

FIGURE B.6: Graphic depicting a Japanese torpedo bomber, incorrectly shown here as a single-engine airplane and striking the port bow instead of the starboard aft boom, destroyed by collision with a USS *Mercury* cargo boom. This aircraft likely remains in Saipan's waters. (Image courtesy USS *Mercury*

Less certain due to the dynamic and fast-paced combat experienced during aerial duels are the number of aircraft wrecks that litter the deep-water offshore areas. Given the prolific level of aerial combat associated with the carrier strikes carried out preliminary to the invasion and later during the Battle of the Philippine Sea that pitted the aerial armadas of the Fifth Fleet against a combined Japanese carrier and land-based force, losses on both sides were extreme. Saipan remained a central aerial hub for Japanese land-based aircraft and was also designated as a refueling and rearming point for carrier aircraft after they had struck the U.S. Fleet. The U.S. devoted significant effort to striking Aslito Airfield and heavily engaging enemy aircraft over the island to suppress Japanese air power. It is probable some are in the water within the amphibious areas. Historical and archival research will unlikely be able to pinpoint these aircraft's locations with any specificity. Yet, the potential for opportunistic discovery during a thorough survey cannot be dismissed.

Then, there were the aerial attacks on the invasion fleet themselves. Japanese airstrikes against the amphibious force began on 17 June when five separate attacks consisting of between three and 40 aircraft took place. During the following 20 days, Japanese aircraft utilized Guam and Rota as staging and recovery points. They continued to harry the invasion fleet with 70 separate raids consisting of single attackers and up to a dozen aircraft that continued unabated over the next 20 days (Dyer 1972:911). Most of these attacks occurred at night, and the invasion fleet relied primarily on the passive cover of darkness and thick smokescreens to shield themselves from the aggressors. This reduced the losses suffered by both attacker and defender. Still, a review of anti-aircraft action reports would uncover instances of Japanese planes being shot down, with clues as to their impact points, such as the case of *Mercury*.

The invasion also created environmental impacts on the battlefield, providing archaeological value. Saipan has a significant coral reef ringing the invasion beaches, which posed a substantial obstacle and risk to the invading forces. Underwater Demolition Teams (UDT) were called upon to create breaches of these natural barriers through demolition (FIGURE B.7). On 16 June 1944, a UDT was tasked to blast a channel through Blue Beach 2's coral reef to create an LST ramp to facilitate unloading. This channel was enlarged over the next two days until it was 100 yd. (91 m) wide and 35 yd. (32 m) deep; coral heads throughout the Blue Beach area were also reduced (Underwater Demolition Team No. 7 1944:8). Another UDT conducted a similar activity on White Beach 1 (Underwater Demolition Team No. 6 1944:1). These channels are archaeologically and ecologically instructive and survey candidates.

FIGURE B.7: UDT conducting explosive demolition operations on Saipan's barrier reef (Image courtesy NHHC).

Given the quantities of archaeological and historically significant artifacts that remain unaccounted for, there is a clear need for more archaeological survey efforts in the Saipan amphibious operations area. While considerable effort has been dedicated to known maritime sites, predominantly in the Tanapag lagoon area, there is an unequaled opportunity to make consequential discoveries beyond the outer reef and into the deep water of the beach lanes and Saipan Shelf.

The Saipan Shelf, where the PBM-3D rests, is a primary candidate for additional survey. Given that the transports were predominantly anchored here during the initial phases of the assault, conducting continuous loading and offloading of assault vessels, there are undoubtedly vast quantities of lost or discarded material artifacts. There are also certainly significant numbers of small craft and vessels sunk in this area. Considering the number of LVTs that sank in deep water and are unaccounted for, it is safe to presume that at least some would be in this area. The initial tow board survey is believed to have discovered some of these vessels simply visually, although further survey is required to confirm this assessment. A magnetometer and side scan sonar survey are eminently possible since the bottom average is approximately 100 ft. (31 m) deep throughout this area. Optimally, an AUV would be employed to survey the location more effectively and efficiently. The ability to dive any target located on air or nitrox without rebreather or decompression diving considerations or the use of Remotely Operated Vehicles (ROV) makes this area an attractive option for future exploration.

Special consideration should also be given to the beach invasion lanes outside the barrier reef. Many LVTs are known to have foundered while crossing the reef but given the relatively shallow depth (<10 ft./3 m) here, it is almost certain that the wrecks themselves were salvaged and returned to Oahu for refit. There was a concerted effort to recover and salvage all sunken

LVTs following the battle (COM GEN 5th PHIB CORPS 1944:1211). This salvage effort was likely more limited for LVTs that sank in deeper water beyond the reef. At Beach Red, the water depth does not drop off to more than 75 ft. (23 m) on the LOD. Beach Yellow is similarly favorable, with most of the approaches from the LOD in water depth not exceeding 70 ft. (21 m). Beach Red and Green are less favorable, as the water is not less than 100 ft. (31 m) deep until very close to the reef. The area between the LOD and the reef is 100 ft. (31 m) or less and is likely to produce cultural materials located via traditional survey means.

The deeper waters off Saipan will almost certainly be a treasure trove of consequential archaeological discovery. Some of these discoveries, potentially including LVTs, LVT(A)s, LCVPs, LCMs, M4 Sherman tanks, 105 mm artillery tubes, DUKWs, Japanese ships and barges, and, of course, a relatively intact Martin PBM-3D Mariner, and all manner of other aircraft, have tremendous cultural, historical, and archaeological value. Some would undoubtedly be excellent candidates for inclusion in an expanded Saipan Heritage Trail, while others could further inform the record and understand the battle. All are worthy of discovery, documentation, *in situ* preservation, and interpretation. Based on the information available, further archaeological efforts in Saipan are desirable and should be considered an imperative ongoing effort.