LOST AT SEA:
UTILIZING PHOTOGRAMMETRY TO MONITOR TWO SUBMERGED F8F BEARCATS

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ABSTRACT

LOST AT SEA: UTILIZING PHOTOGRAMMETRY TO MONITOR TWO SUBMERGED F8F BEARCATS

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Naval Air Station (NAS) Pensacola, renowned as the “Cradle of Naval Aviation”, has been a fundamental pilot training facility for the U.S. Navy since its establishment in 1914. World War I ensured aviation would remain an important aspect of U.S. naval warfare and led to an increased influx of prospective aviation cadets at NAS Pensacola. Subsequent decades of training led to hundreds of training accidents and the loss of naval aircraft in the waters off Pensacola, Florida. Two F8F Bearcat wreck sites are discussed here, including the methods involved in aircraft investigation and the historical documents referenced for their identification. Utilizing photogrammetric modeling techniques, the author tests the applicability of photogrammetry as an *in situ* site-monitoring tool.

CHAPTER I: INTRODUCTION

Study Orientation

The examination of aviation cultural resources is evolving from an artifact-centric interest to an anthropological field of study. Museum curators and aviation enthusiasts have been the primary groups concerned with finding aircraft wreck sites. However, archaeologists are now investigating several categories of historic aviation resources such as airfields, hangars, and aircraft wrecks. This study concerns two submerged F8F Bearcats off Pensacola, Florida, that wrecked during naval training exercises after the Second World War (WWII). No previous scientific documentation has occurred on aircraft wrecks in the area; therefore, recognizing environmental and cultural site formation processes that affect them is imperative to the study. Examining these processes may assist in the interpretation of the life history of the aircraft as it evolves from operational to artificial reef. Site formation studies of aircraft are the current standard for initial assessments and *in situ* monitoring projects, as archaeologists expand theoretical knowledge of the resource (Jung 2001; 2007a; 2007b; 2008; 2009; and Bell 2015).

The lack of scientific research on submerged aircraft off the coast of Pensacola is surprising due to the early, lasting presence of naval aviation in the area. The 1914 foundation of Naval Air Station (NAS) Pensacola signified the United States Navy's (hereinafter referred to as Navy) plan to organize a Naval Aeronautic Service. Development of aviation technology and training programs led Pensacola to become a pivotal naval pilot training facility. This effort provided air support for U.S. military action in virtually every major conflict of the 20th century. NAS Pensacola continues to serve as an aviator training facility to this day and is the home of world-famous aerobatic team, the Navy Blue Angels.

The author discovered the presence of submerged naval aircraft in the area through the Pensacola SCUBA diving community. Local divers took an interest in Pensacola's history of naval aviation and spent the last several decades locating submerged aircraft. In 2015, local physician William "Doc" Howe provided the author with the GPS positions of four submerged historic aircraft, two F8F Bearcats and two F6F Hellcats. This information led to an initial site assessment of the aircraft to determine their identities and state of preservation (Whitehead and Mauro 2016) which led to the conception of this thesis.

Research Questions

Aircraft identification is key to forming additional research questions. Naval aircraft can be categorized in three subcategories: 1) Class, 2) Type, 3) Bureau Number (BuNo). It is important to understand that knowing the BuNo of an aircraft also reveals portions of its life history. Upon delivery from naval-contracted manufacturers, the Navy assigned each aircraft a specific serial number, BuNo, to keep track of its movements. This information provides a document trail for researchers, as the BuNo was recorded during any transfer, action, or loss of the aircraft. This documentation offers a wealth of information about both the aircraft and the pilots. Thus, the first research question envelops the following:

- According to historical documents, what are the operational histories of the two submerged F8F Bearcats, and how did they end up on the seafloor?

The study also serves to gather baseline data on unrecorded cultural resources through relatively new data collection methods. Computer-vision photogrammetry is an innovative way to gather both qualitative and quantitative data. The software *Photoscan* (Agisoft, LLC 2014) allows the creation of detailed site plans in the form of 3D photogrammetric models. It is a data collection method utilized by numerous archaeologists in various capacities (McCarthy and

Benjamin 2014; and Balletti et al. 2015). However, the method has not been tested in the waters off Pensacola. In short, the modeling techniques allow archaeologists to deduce broad cultural and environmental impacts of the sites. Accordingly, the second research question inquires the following:

- Utilizing photogrammetric modeling techniques, are cultural and environmental impacts of the F8F Bearcat wreck sites observable through time?

Site Introduction

The Navy chose Pensacola for the development of its first aviation training facility in 1914 for practical reasons such as the warm weather and protected bays. Early aircraft designs provided pilots little protection from the elements, and thus Pensacola's weather provided a longer flying season. As aviation technology and naval strategies developed, the launch and recovery of aircraft off the decks of marine vessels became more common. Pensacola Bay and the Gulf of Mexico offered a large area for early aircraft carrier testing and training missions. The F8F Bearcat wrecks resulted from aircraft carrier qualification training missions post-WWII. Each plane lies in the Gulf of Mexico, approximately fifteen miles outside of Pensacola Pass (Figure 1). They are roughly three miles apart and in about 100 feet of water. Each was assigned a UWF arbitrary designation: F8F Bearcat 1 and F8F Bearcat 2 (Figure 2). They lie partially buried in a fine sandy sediment in similar states of preservation.

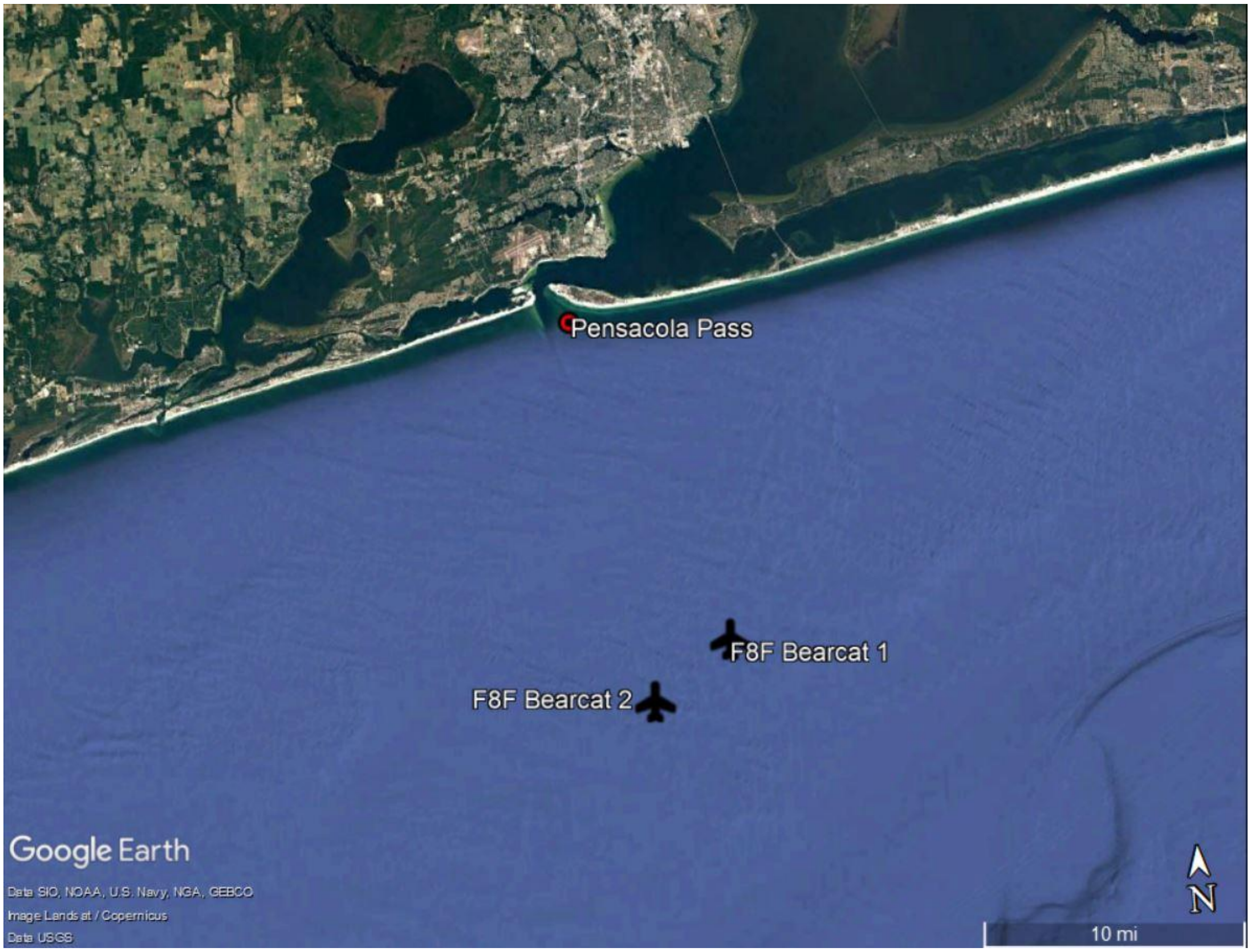

Figure 1. Location of F8F Bearcat Wrecks in Reference to Pensacola Pass (Google Earth)

Previous Work

As mentioned, no scientific documentation has occurred on submerged aircraft in the area prior to Whitehead and Mauro's (2016) initial assessment and subsequent assessments of additional aircraft by the author, and Nicole Mauro's (2018) master's thesis which focused on documenting one of the submerged F6F Hellcats. However, sport divers such as "Doc" Howe discovered and regularly dived on these sites as early as the 1980's. Local dive charter captain and Pensacola native, Douglas Hammock, has spent several decades locating submerged historic aircraft in his spare time. He has generously taken the author to several of these sites and provided the location of many of his discoveries. While several members of the Pensacola dive community are aware of the location of these sites, the information is a tightly guarded secret. Many divers are concerned with protecting the aircraft from looting activities, but the sites are good spearfishing locations. In any case, even though there has not been a systematic or scientific survey of the aviation cultural resources in the area, Pensacola natives have taken it upon themselves to discover their rich cultural heritage underwater.

Figure 2. F8F Bearcat 1 & 2 (Photos taken by author, 2016)

Significance of Study

The findings of this study provide critical baseline data on the tangible remains of historically significant submerged aircraft sites associated with naval aviation training in Pensacola. This study will have not only regional, but potentially global impacts as cultural heritage managers and scholars try to expand and formalize the sub-discipline of aviation archaeology. *In situ* preservation is viewed as the first option regarding the protection of underwater cultural heritage, and thus photogrammetric documentation is perhaps one of the best methods of monitoring archaeological sites. The results of the photogrammetry aspect of this study will add value to the current body of knowledge regarding photogrammetric site monitoring. Lastly, there are few places in the world, if any, where there is a university maritime archaeology program that has such a vast number of submerged historic aircraft in the immediate area. This study will likely spur additional studies into Pensacola's submerged historic aircraft and offer a plethora of comparable data for areas with aircraft in similar environments around the world.

CHAPTER II: LITERATURE REVIEW

Introduction

Aviation archaeology is an evolving academic field of study, as illustrated by numerous theses and dissertations (Capelotti 1996; Goldstein 1997; Ford 2006; Jung 2008; Bell 2010; Burgess 2013; Pruitt 2015; Ortiz 2016). Professional archaeologists now advocate for adequate protection of aviation cultural heritage and the establishment of a standard methodology and theoretical framework. Prior to this advocacy, aviation historical societies, museums, and private individuals were the primary interest groups involved in aircraft salvage and preservation. The following demonstrates the evolution of historic aircraft preservation, salvage, legislation, and archaeological study. Rather than discuss the history of aviation archaeology, this chapter highlights key elements of aviation archaeology and preservation development.

Aircraft Preservation

Historic aircraft preservation in the United States may be attributed to the advent of aviation itself. Relics of early flight, such as the *Wright Flyer*, survive today in the National Air and Space Museum (NASM) collection due to some degree of preservation foresight. Many early historic aircraft are in museum collections because of their association with an historical event or figure. For example, the NASM displays Charles Lindbergh's *Spirit of St. Louis* and Amelia Earhart's Lockheed 5B Vega due to their respective roles in aviation pioneering. However, most historic aircraft have not received such preferential treatment. Surplus aircraft of the World Wars certainly saw mass dispersal and disposal without much consideration of their value as cultural heritage.

After WWI, the U.S. government sold many surplus aircraft, primarily Curtiss JN-4 Jenny's, into the civilian market (Larkins 2005:1). This move encouraged civilian aviation, but also stifled aircraft sales and thus technological innovation. To prevent similar aircraft market saturation at the end of WWII, Congress established the Surplus War Property Administration in February of 1944 (Veronico et al. 2000:12-13). This administration attempted to dispose of over 200,000 surplus aircraft, factories, buildings, and airfields in an "orderly, systematic, and hopefully somewhat profitable manner" (Larkins 2005:2). This task proved daunting, as the U.S. military possessed the largest inventory of surplus aircraft in the world. Some aircraft moved to reserve squadrons, but most became aluminum ingots or simply degraded in derelict airfields. Even newly manufactured aircraft were sometimes pushed off the decks of aircraft carriers or used for target practice (Larkins 2005:18-19). Other aircraft avoided destruction through government sales to other nations or to private individuals. The wholesale salvage, destruction, and dispersal of surplus aircraft, predominantly during WWII, illustrates a key turning point in aircraft preservation ideals.

WWII veterans viewed the widespread disposal of surplus aircraft as destruction of the nation's aviation cultural heritage. Indeed, due to certain government shortsightedness, several aircraft types are not survived by even one example (Hoffman 2001:44). Many WWII pilots were particularly concerned and purchased aircraft for recreational use and numerous aircraft participated in the National Air Races in Cleveland, Ohio (Veronico 2013:12). The races, postponed during WWII, resumed in 1946 and witnessed a surge of interest (Kinert 1968:7). Although, some of these converted racing planes experienced the occasional accident and steady deterioration, various historic aircraft survive today, in part, due to the efforts of those interested in racing war birds.

At the end of the war, Army General “Hap” Arnold, worried about the fate of the nation’s aircraft, instigated a push for legislation in 1946 when President Harry Truman signed a bill founding the Smithsonian’s National Air Museum (Bryan 1988:15). The bill stated that

> Said national air museum shall memorialize the national development of aviation: collect, preserve, and display aeronautical equipment of historical interest and significance; serve as a repository for scientific equipment and data pertaining to the development of aviation; and provide educational material for the historical study of aviation (Public Law 722).

While the Smithsonian Institute’s collection of aircraft truly began at the end of WWI, this bill allowed the institute to accept WWII aircraft into their assemblage (Van der Linden 2010:110-111). It still took several decades for the museum’s first curator, Paul Garber, to secure funding for a permanent museum location. When the museum opened in 1976, the collection had expanded to include space exploration memorials and was aptly renamed the National Air and Space Museum.

Extensive efforts to preserve historic aircraft began in the 1960’s, with the opening of numerous historic aircraft museums, such as the National Museum of Naval Aviation (NMNA) in 1963 (Bédoyère 2001:9). The 1970’s witnessed increased interest in aircraft preservation; however, as more aviation museums opened, there developed a shortage of historic aircraft to display. Increased interest in historic aircraft displays resulted directly in salvage activities (Fix 2011:990). Often, those participating in these operations were concerned with looking for specific aircraft parts for a restoration project or for static museum displays. Most major aviation museums pursued wreck chasing activities to supplement their collections, including the National Air and Space Museum, Air Force Museum, National Museum of Naval Aviation, Royal Air Force Museum, and Imperial War Museum (Veronico 2013:27). Wreck chasing also occurred at a local scale. In one such case, Ron Buxton (1982) remembered witnessing a German Messerscmitt 109 shoot down a British Hawker Hurricane in 1940. Many years after the war, Buxton initiated a salvage operation and recovered the engine of the aircraft. After restoration, the engine was placed on display at a local war memorial museum. This artifact-centric mentality occupied aircraft preservation efforts for the next several decades.

In 1973/74, The Aviation Archaeology Association was founded and in 1978, was renamed the British Aviation Archaeology Council (BAAC). The BAAC "acted as a forum for local aviation archaeological societies across the UK and affiliated with similar bodies worldwide" (Burgess 2013:9). In his master's thesis, Anthony Burgess notes that while the BAAC operated under the title of archaeology, their activities consisted mostly of artifact collecting. Similar interest groups soon formed in the U.S., the largest of which may be The International Group for Historic Aircraft Recovery. Furthermore, collectors began writing guides to locate and recover aircraft, such as Bruce Robertson's (1977) *Aviation Archaeology: A collector's guide to aeronautical relics; airfields, autographs, badges, books, nomenclature, postcards, propellers, records, research, stamps and wrecks*. This title, as well as numerous other books, reflects the enormous public interest in locating and collecting artifacts from historic aircraft wreck sites (Darby 1979; Wotherspoon et al. 2009; Veronico et al. 2011).

Perhaps the first time historic aircraft salvage appeared in a peer-reviewed archaeological journal was Keith Muckelroy's (1978b) review of the Fourth World Congress of Underwater Activities. The meeting consisted of papers on numerous fields of underwater research, including underwater archaeology. Muckelroy referred to a presentation on the recovery of a Blackburn Skua II – L2940 for display at the Fleet Air Arm Museum in England (Linsley 1976:47). The project was consistent with museum salvage operations of the time, yet its inclusion in the conference proceedings indicates a minor shift in the resource's perception. Richard Gould (1983b) may be the first to point out the significance of aviation wreck sites as cultural resources; however, U.S. policy did not reflect his opinion for some time. The numerous entities involved in historic aircraft research and recovery, from aviation museums to private salvers, clearly demonstrated a need for cultural resource management policies. It is probable that various unsanctioned, poorly conducted salvage operations prompted military aircraft protection laws, and as a result, federal agencies were required to consider aviation cultural resources. Consequently, the development of legislative stipulations encouraged archaeologists to begin examining aviation cultural heritage.

Legislation and Management

Legislation regarding aviation cultural heritage in the United States has generally addressed WWII military aircraft. One of the earliest pieces of legislation, Public Law 722, allowed the preservation of significant civilian and military aircraft, yet offered no protection for aircraft wreck sites. As these sites came to the attention of museums and collectors, the Navy and Air Force recognized their role in protecting the property under their purview. According to the National Historic Preservation Act of 1966, each began considering management plans.

Over time, each military branch developed policies for their aviation cultural heritage. The Navy and Air Force formed antipodal management policies; the former claimed complete ownership of its wreck sites, the latter formally abandoned them. On 19 November 1961, an Air Force archive facility was destroyed in a fire; unfortunately, this facility held aircraft accident records. The Air Force relinquished ownership of aircraft that wrecked prior to the1961 fire due to the loss of these records, leaving the sites under the authority of respective landowners (United

States Air Force 1994). However, copies of the Air Force records that were apparently lost can be found in the collection of the Air Force Historical Research Agency (Neyland and Grant 1999:49). The Navy, on the other hand, developed numerous management policies in response to a growing number of salvage requests in the 1980's. As a result, the Naval Historical Center (hereinafter referred to as NHHC) became the forefront of aviation archaeological research.

Prior to the management policies established by NHHC, the Navy already held a stance that U.S. naval ships and aircraft wrecks remained the property of the U.S. government. Aircraft wrecks were "dealt with as surplus equipment and must satisfy the legal requirements for disposal of federal property . . . " (Neyland and Grant 1999:46). The Navy reserved the right to recover, loan, or donate to a qualified institution, or sell such surplus. This policy allowed various salvers and museums to apply for salvage permits. One example was Captain Bob Rasmussen, director of the National Museum of Naval Aviation (NMNA). The director saw potential in the well-preserved aircraft from Lake Michigan for supplementing the museum's collection. He encouraged Congressman Earl Hutto to sponsor legislation allowing military museums to trade historic aircraft in their inventory for aircraft recovery services. This legislation allowed the museum to trade more common historic aircraft for the recovery of rarer types from Lake Michigan and other locations (Neyland 2002:770).

As the NHHC became involved in underwater archaeology, it also became responsible for ensuring Navy salvage operations followed the stipulations of the National Historic Preservation Act (NHPA). World War II aircraft wrecks were becoming potentially eligible as historic properties due to the NHPA's 50-year threshold. This fact, along with mounting numbers of salvage requests, moved the NHHC to develop its own cultural resource management policies. Underwater archaeologist David Cooper (1994) assisted the NHHC in drafting a management plan and in creating a naval wreck database. Federal and state agencies also began considering ACH for nomination to the National Register of Historic Places (Diebold 1993; Foster 1993; Whipple 1995). In 1993, the NHHC recognized the need for evaluation standards specific to historic aircraft and sponsored the development of a National Register Bulletin, *Guidelines for Evaluating and Documenting Historic Aviation Properties* (Milbrooke et al. 1998).

While developing management policies and historic property guidelines, the NHHC also defended its aircraft wrecks from numerous salvage claims. A 1996 court decision became the turning point for naval aircraft preservation. Historic Aircraft Preservation Inc. claimed ownership of a F4F Wildcat salvaged from Lake Washington. The Navy won the suit and thus ownership of the aircraft. Historic aircraft collector, Doug Champlin, maintained an interest in the aircraft and attempted to gain support from Senator John McCain for a proposed Navy Warbird Act. This act would force the Navy to abandon all aircraft wrecks occurring before 19 November 1961. The Navy reviewed the proposed act and found it to be in conflict with the Federal Property Act. The act would have "led to the disturbance of war graves, foster commercial exploitation and the depletion of a finite resource, and harm the public's interest in these historic aircraft" (Neyland and Grant 1999:49).

In 1996, the NHHC formed an Underwater Archaeology Branch (UAB) made responsible for management of the Navy's underwater cultural resources around the world. Perhaps due to the attempted Navy Warbirds Act, the UAB developed policies that eventually became the Sunken Military Craft Act (SMCA). The SMCA expanded and improved existing historic military wreck regulations. The prior rule relied on requirements of the NHPA, which limited protection to the military's cultural resources. Under the SMCA, "all U.S. sunken military craft were covered, regardless of location or time of loss, while all foreign military craft in U.S. waters

. . . are also afforded protection from disturbance by the SMCA" (Naval History and Heritage Command 2004). The regulation also expresses interest in reaching agreements with foreign nations while offering reciprocal treatment.

Perhaps the most significant result of the SMCA is the permitting process it established. Those wishing to "disturb, remove or injure" submerged or terrestrial Department of Navy wrecks are first required to apply for a permit through the NHHC's UAB. Furthermore, the disturbance must advance archaeological, historical, or educational purposes. The listed purpose for such protection of the Navy's wreck sites are as follows: 1) historical significance, 2) protection of war graves and memorials, 3) public safety hazards, such as unexploded ordnance, oil and other materials that may harm the environment, and 4) protection of state secrets and technologies of significance to national security. It is interesting to note that the regulations also offer protection to Coast Guard wreck sites if the Secretary of the pertinent department wishes. The SMCA is the product of several decades of resource management decisions and perhaps the numerous lawsuits that ensued due to those policies. Fortunately, the Navy's policy regarding its ship and aircraft wrecks has always held a distinctive tone: retained ownership of the resources despite the passage of time, or apparent abandonment.

The policy offering specific protection to military aircraft wreck sites is the SMCA. Thus, the Navy has been at the forefront of aviation cultural heritage preservation and aviation archaeology in the United States. In addition, numerous distinctive archaeological studies on aircraft have occurred internationally over the last several decades and assisted in the creation of aviation archaeology as a subfield.

Aviation Archaeology

Archaeologists from numerous organizations, agencies, and universities have contributed to the field of aviation archaeology. Early archaeological studies of aviation cultural heritage in the United States stemmed from compliance requirements and focused on a variety of aviation properties, ranging from historic airfields and hangars to submerged and terrestrial aircraft wreck sites. The resulting archaeological and desktop surveys provide a number of publications and grey literature that support the development of theoretical and methodological framework. The following is a review of contributions, including those from federal and state agencies, universities, and other organizations. Also discussed are those from outside the U.S., primarily Australia and the United Kingdom due to their key development of aviation archaeology as a subfield. Finally, this section highlights several works that examine the value and significance of aircraft as historical and archaeological resources.

Perhaps some of the earliest archaeological projects are the surveys of the Wright-Patterson Air Force Base outside Dayton, Ohio (Butler et al. 1994; Babson et al. 1998). The project consisted of visual, geophysical, and remote-sensing surveys of structures and airfields associated with the Wright Brother's 1910 hangar. The Department of Defense (DoD) Legacy Resource Management Program funded this project. Since the DoD manages nearly 25 million acres of land in the United States, it is likely that similar projects have resulted in abundant grey literature.

In 1995, UAB archaeologist Richard Wills (1996, 1997) documented a Douglas SBD Dauntless recovered from Lake Michigan. He studied the aircraft post-recovery at the National Museum of Naval Aviation and helped develop a standard methodology for aircraft documentation. In 1996, The UAB undertook a joint project in Puerto Rico to conduct site assessments of three potential U.S. military craft (Naval History and Heritage Command 2014). The investigation revealed two aircraft, a USAF B-29 Superfortress, and a Pratt and Whitney engine expected to be associated with a U.S. naval aircraft. The UAB was also involved in a survey for and investigation of a PBJ Mitchell known as the Badin Bomber that crashed in Badin Lake, North Carolina in 1944 (Coble 2014).

In 1994, the National Park Service may have been the first federal agency to co-sponsor, with East Carolina University, an underwater archaeological field school focused on an aircraft wreck site (Rodgers et al. 1998). The project involved a pre-disturbance survey and documentation of a PBY Catalina flying boat submerged in Kaneohe Bay, Hawaii. In 1997, NPS staff searched for a B-29 Superfortress that crashed in Lake Mead, Nevada, in 1948 (Chenoweth et al. 2006). The search was unsuccessful, though the aircraft was later discovered by an individual without a survey permit. The park has since defended the bomber from salvage claims and remains the site's custodian. NOAA also conducts archaeological surveys for underwater cultural heritage, including aircraft wrecks. Within the boundaries of the Monterey Bay National Marine Sanctuary off of California lie the remains of the Navy's rigid dirigible, the USS *Macon*, and four associated F9C-2 Sparrowhawk aircraft that crashed in 1935. NOAA, in a joint expedition, assisted in the archaeological investigation and analysis of the resource. Additionally, outside of the Thunder Bay National Marine Sanctuary, NOAA archaeologists assisted the documentation of two aircraft associated with the Tuskegee Airmen (Haigler et al. 2016).

It should be mentioned that the Joint POW/MIA Accounting Command, now the Defense POW/MIA Accounting Agency (DPAA) has also contributed to aviation archaeology. The agency is responsible for the inventory and recovery of U.S. military casualties of war in foreign countries (Pietruszka 2015). These recoveries occasionally involve excavations of submerged or terrestrial aircraft wrecks. However, the DPAA is focused on recovering and reinterring servicemen remains and devotes much less attention to the wrecks themselves.

State agencies and universities have also initiated studies of aircraft wreck sites. One report of note is an archival survey sponsored by the State of Washington to determine the number of U.S. Navy shipwrecks and submerged aircraft within its borders (Grant et al. 1996). A report submitted to the offices of the California State Parks describes survey fieldwork on a F4U Corsair within park boundaries (Beeker and Smith 2005). Another report, produced by University of Hawaii at Manoa, describes an underwater survey of a submerged P-47 Thunderbolt off Oahu (Petrey et al. 2008). There are likely additional survey reports that are not included, and only a few are noted here.

A focus on aircraft as archaeological resources is not exclusive to the United States. In particular, archaeologists in the United Kingdom, Australia, and Greenland have numerous published studies pertaining to historic aircraft sites detailed below. There are also multiple studies on aircraft off Pacific islands (Spennemann 1992, 1998; Holly 2000a, 2000b; Jeffery 2006, 2007) and English Heritage (EH), custodian of English archaeological sites, produced a guidance document for the management of military aircraft sites (Holyoak and Schofield 2002). English Heritage archaeologist Vince Holyoak (2002), points out the necessity for aircraft site management, due to growing interest in amateur excavations in the 1990's. The private firm Wessex Archaeology has since produced a number of archaeological and desktop survey reports on aircraft wrecks for EH (Wessex Archaeology 2002, 2008; Scott and Gane 2015:75-95).

Australian archaeologists may be the earliest to have studied aircraft as potential historically significant material. Western Australia Museum archaeologist Michael McCarthy (1997) produced a report of the feasibility of locating, raising, and conserving one of the PBY

Catalina flying boats that was scuttled off Rottnest Island. He also notes that the department examined submerged PBY Catalinas in Roebuck Bay several years earlier (McCarthy 1990). Silvano Jung (2007, 2008, 2009) later studied the Catalina wrecks in Roebuck Bay, which were eventually nominated to Australia's Register of Heritage Places (McCarthy et al. 2002). Jung focused on documenting the Catalina wrecks and applying site formation processes concepts. His, and others' contributions, to the development of site formation processes of aircraft wrecks is discussed in the next chapter. Lastly, Australian archaeologists Julie Ford (2006) and Tim Smith (2004) compiled evidence for the potential of submerged WWII aircraft wrecks in Victoria and New South Wales, respectively. These studies provide a preliminary guide for future archaeological surveys.

There are certainly other regions that house historic aircraft wrecks, with archaeologists and cultural resource managers that consider them worthy of study and protection. This chapter highlights several countries that stand out in regard to amount of aviation archaeological studies. The final region considered here is Greenland. Archaeologists Michael Deal (2009, 2013) and Lisa Daly (2015) examined cultural material related to WWII in Gander, Newfoundland, and Labrador. They studied not only aircraft wrecks, and their site formation, but also how aviation culture affected the infrastructure and civilian life of these areas.

Approaches to the management and preservation of historic aircraft, both in archaeological contexts and otherwise, have changed considerably over the years. Early interest of salvers and collectors led the way for early aviation archaeology, until legislation required professional archaeologists to consider historic aircraft as cultural resources. Archaeological studies often limited themselves to archaeological surveys and archival investigations. Now, archaeologists are beginning to ponder the significance of ACH within human existence.

Pennsylvania State University archaeologist Peter Capelotti (1996, 1997, 2007) has produced a number of publications regarding what he refers to as aeronautical remains. However, his (1998) seminal paper calls attention to the many aircraft salvage attempts, and the lack of anthropological inquiry. He notes that the 20th century marks the human species' ambition to explore the air and space above them, and the lack of archaeological studies that attempt to answer the question of "Why?".

Other issues are being considered, such as whether to conserve aircraft wrecks *in situ* or after recovery, and the place and value of aviation archaeology as a subfield of archaeology. The best option for some submerged aircraft is an *in situ* conservation plan, with site formation processes monitoring (McCarthy 2004). Not all aircraft should be recovered; those that are should be done so with an adequate conservation and management plan in place (Schwarz and Fix 2010). Peter Fix (2011) and Anthony Burgess (2013), PhD candidates of Texas A&M University and University of Malta respectively, deliberated the definition and value of aviation archaeology, and both conclude that the field must continue to evolve away from one that is artifact-centric. Burgess posits the disadvantages and benefits of the field being in its earliest stages. Archaeologists lack a cohesive panel to discuss method and theory, but also have the flexibility to determine the field's path (Burgess 2013:2). As such, this is where the field of aviation archaeology stands currently.

In 2014, the Society for Historical Archaeology conference saw its first session pertaining to aviation cultural resources (Society for Historical Archaeology 2014:85-86). The session resulted in several publications in the Advisory Council of Underwater Archaeology Proceedings (Brown 2014; Dagneau 2014; McKinnon and Bell 2014). Since (2018), there have been twenty-two paper presentations on aviation archaeology at the SHA annual conference.

Furthermore, in 2017, the University of Malta and the Flying Heritage and Combat Armor Museum hosted the first International Conference on Aviation Archaeology and Heritage. Aviation specialists, conservators, museum curators, and archaeologists from ten separate countries presented papers at the conference. The proceedings will be published in 2019, and the conference will meet again in 2020 in Seattle. Given these movements, aviation archaeology is developing away from artifact collecting and salvage to a more defined field of study.

Conclusion

Preservation of aviation cultural heritage has evolved in a linear manner; from collection of significant relics, to management and legislation, and finally anthropological study. Archaeologists are only recently deliberating theoretical frameworks necessary for a holistic approach to the subfield. Methodologies pertaining to the study of historic aircraft will certainly differ according to management strategies. Archaeologists, aircraft museum curators, and salvors each maintain individual interests and desires for the resource. The only way to move forward together is to develop standard documentation, conservation, and preservation strategies.

CHAPTER III: UNDERWATER SITE FORMATION PROCESSES

Introduction

During the development of the subfield of aviation archaeology, researchers realized the need for standard methodologies and theoretical frameworks (Fix 2011). Accordingly, many archaeologists began studying site formation processes that affect submerged aircraft (Bell 2010; Jung 2009; Pruitt 2015). Formation processes studies offer baseline data for site interpretation and the development of management strategies. The following is a description of how archaeologists apply site formation processes analyses to submerged aircraft wrecks.

Shipwreck Site Formation Studies

Site formation processes, as defined by Michael Schiffer (1987), are the influences that generate a historic or archaeological record. Perhaps one of the earliest to examine underwater site formation processes, Frédéric Dumas, (1972) examined shipwrecks in the Mediterranean. In his study, Dumas recognized three shipwreck location categories: sandy shores, rocky shores, and shores with submerged cliffs. He concluded that a wreck in the latter category would be most preserved and thus most useful for underwater archaeologists (Dumas 1972:32-33). Keith Muckelroy (1978a) criticized this conclusion and pointed out that Dumas' categories were specific to only particular locations, such as the Mediterranean on which the study was based. His own work in the British Isles helped him further develop Dumas' ideas on underwater site formation processes. He defined two main processes, "extracting filters" and "scrambling devices," to assist in the understanding of the mechanisms and processes that create and affect a shipwreck site (Muckelroy 1978a:165-181).

Muckelroy formulated a lens in which to view a shipwreck's depositional process. His "extracting filters" are mechanisms that take material away from the site including the wrecking process, salvage, and disintegration of perishable items. Due to extracting filters material are no longer present on the site and are therefore not observable in the archaeological record. The "scrambling devices" involve the process of moving artifacts during and after deposition, causing the loss of contextual data. These scrambling processes include the wrecking event and subsequent environmental progressions such as wave action, currents, and marine-life interactions until the ship is a part of the seascape; at which time any further alterations of the wreck become an effect of seabed movement.

Muckelroy's terminology and site formation framework in his seminal work (1978a) has been widely incorporated and "remains the most important single statement of method and theory in the discipline which he dubbed maritime archaeology" (Gibbins and Adams 2001:284). Not only has Muckelroy's shipwreck formation framework been incorporated in many studies, it has been altered and supplemented by archaeologists seeking to explain cultural and environmental factors unexplored previously. Ingrid Ward et al. point out the faults in Muckelroy's findings and assert that his research failed to "effectively link the physical attributes of the wreck site with the processes controlling wreck formation" (Ward et al. 1999:562). Instead of referring to the wrecking event as a single process, Ward et al. assert there are multiple processes that affect a site including physical, biological, and chemical. Martin Gibbs (2006) emphasizes cultural processes that he states have been given less attention than those natural and divides these processes into categories such as the pre-wrecking life history of the ship, immediate salvaging by the crew and modern salvaging and looting events. He further defines a difference between wrecks that were scuttled intentionally and those that were the result of catastrophic events.

Environmental Processes

Muckelroy's extracting filters occur in both the depositional and post-depositional stages of a shipwreck event. As mentioned previously, Ward et al (1999) describe multiple intertwining processes that occur in the life cycle of a shipwreck. They refer to G. F. Caston's (1979) research, which "was the first to explicitly correlate scour marks around wrecks with the prevailing hydrodynamic and sedimentary conditions" (Ward et al. 1999:562). By examining these scouring events and the anticipative resulting preserved stratigraphic record, information regarding the wreck's depositional history may be discovered. Additionally, the biological processes that affect a shipwreck may be detrimental or beneficial to the wreck's preservation. Furthermore, they point out research discussing chemically induced alterations on archaeological materials such as wood, metal, glass, and stone (Weir 1974). From these studies, Weir determined that reactions differ between oxic and anoxic horizons in sediments. Reducing conditions are supported when the rate of organic matter supply and sedimentation exceeds the rate of decomposition by aerobic bacteria (Gautier et al. 1985). Thus, chemical processes rely heavily on oxygen content and the sedimentary processes in which the material lies. All three of these processes may occur correspondingly throughout the life cycle of a shipwreck.

Cultural Processes

Muckelroy (1978a) addresses cultural processes briefly in his site formation processes model; as noted by Gibbs (2006), the majority of focus is on natural processes. Cultural processes may act as extracting filters that take material away from the site, or scrambling devices that reduce archaeological context. Gibbs expands on the cultural factors of jettisoning, salvage, and recreational diver impacts. Richard Gould's (1983a) and Donna Souza's (1998) research examines pre-depositional factors such as the life history of the ship, risk minimization strategies, and precautionary preparation of vessels. These types of cultural factors would have an effect on the depositional process during a catastrophic wrecking event. Alternatively, Gibbs (2006) identifies intentional scuttling as a second type of wrecking event. A scuttled vessel would show a contrasting artifact pattern, since most materials that held any value would have been removed. However, some depositional processes may be fundamentally unchanged.

Examining the deposition of a catastrophic wrecking event, Gibbs utilizes John Leach's (1994) five major wrecking stages: pre-impact, impact, recoil, rescue, post-trauma. These stages supplement an understanding of the activities aboard the ship during the wrecking incident and the resulting formation of the wreck's assemblage. Under applicable conditions, some wrecks may be salvaged before they reach a depositional state and become a part of the seascape. During this process, either an opportunistic or a systematic salvage effort may be employed. A third cultural factor is modern salvage or recreational diver impacts. These activities may be systematic or opportunistic, although in either case, the removal of some or all of the materials illustrates filtering and scrambling progressions.

Aircraft Wreck Formation Studies

Within the relatively young field of maritime archaeology, submerged aircraft have only recently come of interest to professional archaeologists. Due to a previous lack of attention, archaeologists are left with the task of developing method and theory concerning the site formation of a submerged aircraft. By utilizing Muckelroy's shipwreck site formation model, it may be possible to cultivate a submerged aircraft specific model (Bell 2015). Dissimilarities are present, chiefly owing to depositional differences between a watercraft that belongs on the water and an aircraft that belongs in the air. In addition, materials present on each site will affect the respective degradation rates. Yet despite these differences, some site formation post-depositional factors will be similar. Cultural factors such as looting and salvaging will persist on any accessible site, as will environmental factors that affect the physical, biological, and chemical nature of a ship or aircraft wreck site.

The United Nations Educational, Scientific and Cultural Organization's (UNESCO) Manual for activities directed at Underwater Cultural Heritage considers *in situ* preservation as the first option to manage a site's integrity (Maarleveld et al. 2013:20). Thus, archaeologists employ site formation studies to determine a wreck's preservation state and degradation rate.

As Michael McCarthy (2004) points out, site formation studies allow a better understanding of human activity. Many have engaged in site formation studies of terrestrial and submerged sites (Wildesen 1982, Murphy 1990, O'Shea 2002, Quinn 2006); however, this has not always been the case for aircraft wrecks.

Silvano Jung's (1996, 2001, 2007a, 2007b, 2008, 2009) *in situ* research in Australia set a standard for the study of historic aircraft wrecks. Jung developed a survey method called "defabrication", which involves altering historical aircraft line drawings to match the aircraft's current condition (Jung 2007a:26). He later determined a distinct depositional process, which he coined "wing inversion"(Jung 2009). The process, specific to PBY Catalinas sunk at mooring, describes the manner in which the aircraft's wings break apart and invert. His conclusions may be applied to not only PBY Catalinas, but also other flying boats and other types of aircraft.

Focusing on the pre-deposition, deposition, and post-depositional stages may reveal the relationship between wreck formation and the archaeological signature. One key difference between shipwrecks and aircraft wrecks is the wrecking event itself. Although scuttling events do occur, most aircraft sank due to catastrophic wrecking events. In this case, the pre-deposition process does not start in the water, but in the air. There are two types of catastrophic failures:

those over which the pilot has some degree of control, and those of which the pilot does not. These two types of events may be the result of warfare activities, training accidents, mechanical issues, or weather-related mishaps; but the degree of control the pilot has over the aircraft affects the level of impact. For example, harder impacts may see wider dispersal of an aircraft's components over the seafloor when compared to softer landings that allow the aircraft to remain intact.

Once the aircraft reaches the seafloor, similar extracting filters and scrambling devices that affect shipwrecks exist. Samantha Bell (2010) applied shipwreck site formation theories to aircraft, and determined it is possible to apply a shipwreck model with minor alterations, and created an aircraft-specific site formation model (Bell 2010:124). She compared differences between aircraft wrecks in high and low energy environments. The former is more "susceptible to physically dominated deterioration and high level of coral growth," while the latter is "subject to chemically and biologically dominated deterioration" (Bell 2015:57). At the chemical level, aircraft are enormously dissimilar to shipwrecks due to the differing material composition. For example, site formation studies have largely focused on wood degradation; and not the aluminum frames of aircraft. To minimize this gap archaeologists and conservators have commenced studies on corrosion rates of aluminum and other metal alloys that make up an aircraft's composition (MacLeod 2006; Richards and Carpenter 2015).

Aside from environmental processes, the cultural processes that affect aircraft are fundamentally similar to shipwrecks. Minor differences exist though, such as the quantity or lack of artifacts on submerged aircraft sites. Pilots and crew took few personal belongings on board, so the main artifact assemblage consists of aircraft components and ammunitions. Systematic salvage operations possibly happened as soon as the aircraft was lost or in subsequent years.

More probable is the opportunistic salvage by recreational divers who may take easily accessible aircraft components.

Conclusion

Keith Muckelroy's well-founded site formation model for shipwrecks can effectively be utilized for the study of submerged aircraft site formation. The innate differences between aircraft and ships are minimal when considering the depositional and post-depositional stages. An additional pre-depositional stage that reflects the period between the initiation of the wrecking event and the water collision is crucial. Essentially, an aircraft will have multiple forces impacting the frame prior to the seafloor. Another key difference lies with the material composition of wooden or steel ships compared to aluminum-framed aircraft. In addition, site dispersal, i.e. debris fields of aircraft wrecks might be widespread depending on the collision type. These differences necessitate aluminum degradation studies and debris field analysis for a fuller interpretation of the processes that impact the wreck site.

CHAPTER IV: HISTORICAL BACKGROUND

Introduction

Pensacola, known as the 'Cradle of Naval Aviation,' has a long and rich naval heritage. The United States Navy established a naval station in Pensacola in 1824, but by 1910, the Navy Yard closed due to governmental neglect. Four years later, the Navy established a naval aviation training facility in Pensacola that is still utilized today.

Advent of Aviation

Long before the Wright brothers' famous first flight at Kitty Hawk, inventors such as Leonardo da Vinci conceptualized flying machines. Early notions of human flight include da Vinci's ornithopter, which attempted to emulate the flapping motion of a bird's wings. Though surely not the first attempt, the earliest recorded ornithopter tests were those of Robert Hooke in 1655 (Gibbs-Smith 1985:10). Numerous inventors developed variations of the ornithopter, but it was not until 1890 that Octave Chanute suggested a reason for their failures. He proceeded (1894) to synthesize past research with his own in his *Progress in Flying Machines*, which influenced later aviation inventors.

The combined successes and failures of early aviation pioneers led to a more scientific approach in an attempt to conquer the sky. Chanute argued that the successful development of the airplane, like other scientific endeavors, would be attained through a study of past experimenters' successes and failures (Chanute 1976). Components of the airplane tested individually, such as the cambered wing, propeller, internal combustible engine, and movable controls, only needed to be combined for controlled flight to succeed (Cooke 1958:31). On the verge of technological enlightenment, Samuel Langley created steam-powered models, which he called *Aerodromes,* that effectively flew three complete circles in 1896, and thus proved mechanical flight was possible. Langley's accomplishments were acknowledged by the U.S. Congress, who awarded him $50,000 for the creation of a flying machine that would be capable of carrying humans (Turnbull and Lord 1949:2). In the end, Langley was unable to overcome this threshold, and the Wright brothers, Orville and Wilbur, claimed the first powered flight to carry humans.

The U.S. Navy's Interest in Aviation

The Navy became interested in aircraft as early as 1898, but when Samuel Langley's flying machine failed, interest stalled. On December 17, 1903, the Wright brothers achieved what so many other inventors had attempted before: powered, man-operated flight. This accomplishment, along with the Wright brothers' public demonstrations, reignited the interest of several high-ranking naval officers. During the next several years, the Navy kept a watchful eye on aviation development, and in 1909 Lt. George C. Sweet became the first U.S. naval officer to fly (U.S. Department of the Navy 1958:14). By 1910, Capt. Washington Irving Chambers was appointed to view all correspondence concerning aviation. Chambers then approached Glenn Curtiss, an aircraft manufacturer, with the prospect of flying aircraft off the decks of warships. Later that year Curtiss appointed his employee, Eugene Ely, to conduct the first test flight off the U.S.S. *Birmingham* in Chesapeake Bay (U.S. Department of the Navy 1958:14). During two additional flight tests in 1911, Ely landed on a platform on the U.S.S. *Pennsylvania* in San Francisco Bay and flew back to shore successfully (Figure 3). The same year, Curtiss demonstrated the ability to land a hydroplane near a ship, and for the airplane to be hoisted on and off board for take offs or landings. These demonstrations piqued the Navy's interest, which resulted in the request of $25,000 to be allocated to the development of naval aviation (U.S. Department of the Navy 1958:15).

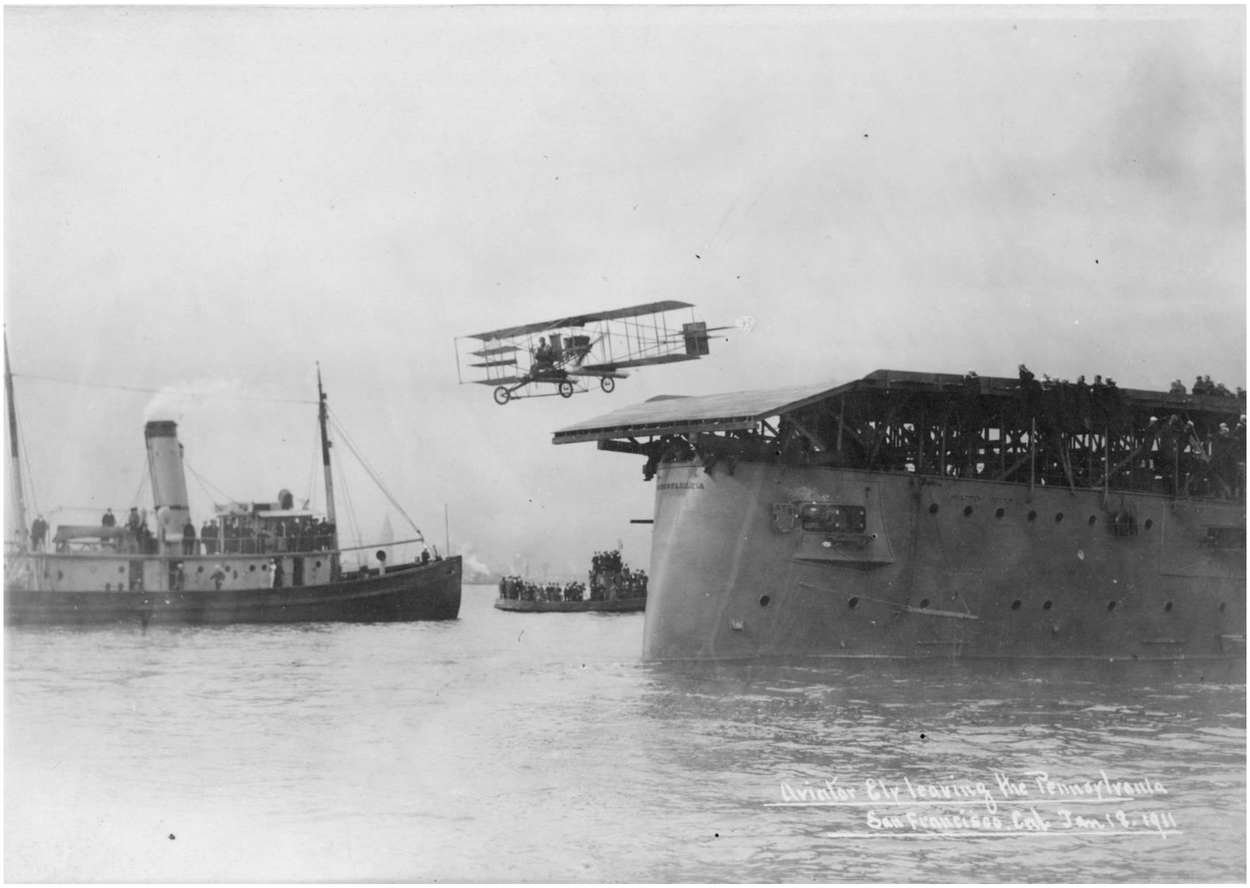

Figure 3. Eugene Ely taking off from the U.S.S. Pennsylvania (2012.004.054; Courtesy the Emil Buehler Library)

Soon to become the Navy's first aviator, Lt. T. G. Ellyson studied under Curtiss where he learned to fly and design airplanes. With new budget allocations, the U.S. Navy purchased two aircraft from Curtiss and one from the Wright brothers and set up a preliminary air station at Greenbury Point, near Annapolis, Maryland. The next few years saw further development of naval aviation, including the first successful launching of an airplane by a catapult, piloted by Ellyson in November of 1912 (Grossnick 1997:10). In 1913, the entire aviation element of the Navy relocated to Guantanamo Bay, Cuba to generate aviation interest among the fleet stationed there. Naval aviators took more than a hundred fleet personnel on flights to demonstrate an aircraft's utilities including: scouting, detecting submarines and mines, and aerial photography (Grossnick 1997:10-11). The demonstrations were a success, and Secretary of the Navy, Josephus Daniels appointed a Board of Aeronautics in October of 1913. The Navy purchased additional aircraft, and in 1914 established the Naval Aeronautical Station for training in Pensacola (Grossnick 1997:12-13)

NAS Pensacola

The new Naval Aeronautical Station in Pensacola developed gradually, with increased growth during the two World Wars. January of 1914 marked the arrival of the aviation unit in Pensacola from Annapolis. Arriving onboard the battleship USS *Mississippi* and collier USS *Orion*, the unit consisted of nine officers, twenty-three enlisted men, seven aircraft, portable hangars and other gear (Pearce 1980:132). Lt. John Towers commanded the aviation-training unit, while Lt. Commander Henry C. Muster directed the USS *Mississippi* and the station. The officers took swift action in preparing the dilapidated Navy Yard for aviation use. They hired locals to clear the beach for seaplane use and hangar installation (Figure 4), and by 2 February, Lt. Towers and Ensign Godfrey Chevalier made the first flight from the station. Tragedy struck shortly after when, on 15 February, Lt. James Murray crashed his Burgess D-1 flying boat into Pensacola Bay and drowned (Pearce 1980). This accident marked the first of many aviation related accidents at NAS Pensacola over the next several decades.

Figure 4. Canvas Seaplane Hangars at NAS Pensacola about 1914-1915 (1993.320.006; Courtesty the Emil Buehler Library)

The first detachment of a naval aviation unit for warfare activities occurred on 21 April 1914, when President Woodrow Wilson ordered the Navy to occupy Veracruz, Mexico in response to a breakdown in U.S. and Mexico relations known as the Tampico Affair. The detachment, aboard the USS *Mississippi,* included: one pilot, three student pilots, and two aircraft (Pearce 1980:135). Lt. Patrick Bellinger piloted an AH-3 flying boat on scouting missions for 43 consecutive days until June when the USS *Mississippi* headed back to Pensacola (Figure 5). It was during one of these missions that the first naval aircraft incurred battle damage; a mechanic found bullet holes in the wing of Lt. Bellinger's aircraft upon landing (Pearce 1980:135). The naval aviators' role in reconnaissance during the incident further proved the importance of aviation to the Navy, which in July established the Office of Naval Aeronautics.

At this time the station was officially designated Pensacola Naval Aeronautical Station (Grossnick 1997:15).

Figure 5. Lt. Bellinger at Controls of AH-3 (U.S. Navy Photograph; Courtesy of Emil Buehler Library)

Upon the U.S. entry into WWI, 6 April 1917, naval aviators had little battle experience and naval aviation was not allocated enough funding to expand at any great rate. At that time, the Navy had 38 qualified pilots, 163 aviation enlisted men, and 54 airplanes. By the conclusion of the war, this number expanded to 2,049 pilots, 43,452 enlisted men, and 2,107 airplanes. The station in Pensacola also saw development of over 100 additional buildings, including hangars and barracks for the increased number of aircraft and personnel. The station continued to supply elementary and advanced flight training to potential naval aviators until May 1918 when the Secretary of the Navy ordered its reorganization. The reorganization included the allowance for aircraft testing facilities and transferred elementary flight to other training facilities. Thus, Pensacola became the first advanced flight training facility (U.S. Department of the Navy 1958:17).

By the end of the war, Naval Air Station (NAS) Pensacola was not the only air station but was certainly the largest station of its kind. Flight training included aerial gunnery, bombing, navigation, photography, signaling, radio, aircraft rigging, and orientation in plane and engine structure. While in 1918, there were 45,632 enlisted men in naval aviation units, by 1920 this number fell to 7,000 (Pearce 1980:162). Approximately 5,000 of those enlisted men were discharged from NAS Pensacola. Flight-school classes were small during the 1920's and early 1930's, the latter partially due to the Great Depression. The impending U.S. entry into WWII restored the naval aviation-training program and pushed the limits of existing Naval Air Stations.

President Franklin Roosevelt began expanding the U.S. military in the mid 1930's due to German and Japanese aggression. For the Navy, the expansion meant utilizing aircraft aboard aircraft carriers, and increased training of naval pilots. The War Department approached the Navy about starting a training program, under the Naval Aviation Cadet Act, and the first class of aviation cadets began their training in July 1935. Due to the large number of students, NAS Pensacola was unable to sustain the training program and similar programs were installed at NAS Corpus Christi and NAS Jacksonville. This program produced a substantial number of naval aviators; and when the U.S. entered the war on 7 December 1941, the Navy counted 5,900 pilots to fly its 5,233 planes. The need for more pilots was clear, and by the end of the war NAS Pensacola's program produced over 28,000 naval aviators (Wynne and Moorhead 2010:98-99).

The level of growth that WWII initiated at NAS Pensacola certainly surpassed that of WWI. Prior to World War II, the Navy constructed and utilized Chevalier (formerly Station Field), Corry, and Saufley Fields for training exercises. In 1941, to assist the war-incurred increase of flight students, Ellyson Field was constructed, followed by Bronson and Barin Fields in 1942, and Whiting Field in 1943 (Figure 6). The air station served as a primary headquarters for a network of auxiliary airfields known as Naval Air Training Center Pensacola (Goodspeed 2014:48). The Navy utilized these fields for various training exercises including, though not limited to, navigation, night flying, and carrier landing qualifications.

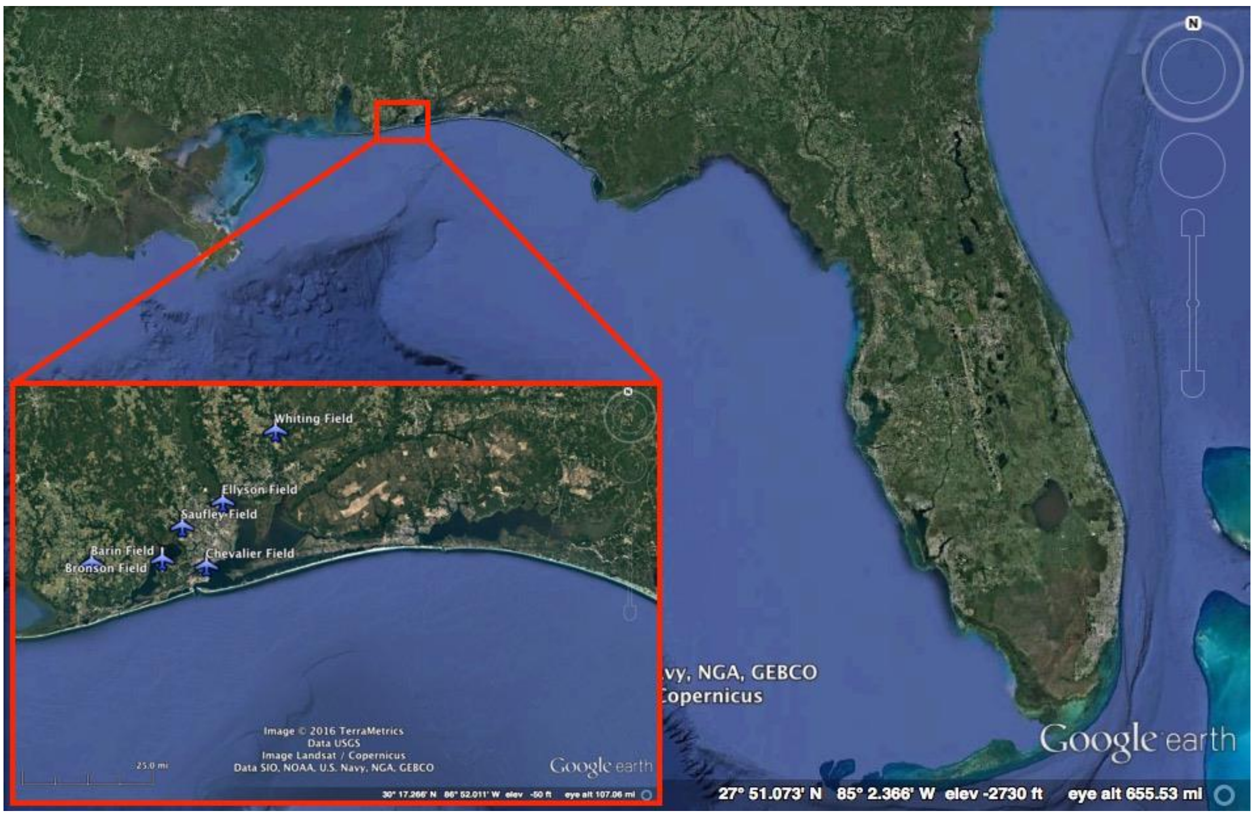

Figure 6. Pensacola Naval Air Station Fields During WWII (Google Earth)

During the war, and certainly after, naval aviation training changed drastically to fit respective needs. NAS Pensacola, since implementation of the Naval Aviation Cadet Act, served as the Navy’s principle flight school. WWII caused significant reorganization when Pensacola was only capable of training a small fraction of necessary naval aviators. To permit increased production, primary flight training moved to various Naval Reserve Air Bases, and pilot training bases in Florida specialized in a particular type of aircraft (Wynne and Moorhead 2010:109). The reorganization marked the birth of the production line method of training, which allowed the Navy to meet war demands for pilots without a reduction in quality.

In 1942, NAS Pensacola was the administrative headquarters of the Naval Air Training Center and Naval Air Intermediate Training Center, though by 1943 the latter moved to NAS Corpus Christi. Through a series of changes, aviation training was systematized by a Chief of Naval Air Training who was in charge of three commands: Primary Training, Intermediate Training, and Operational Training (Emil Buehler Library [1960-1970a]) The various commands were necessary due to new aviation specializations, where one pilot became specialized in carrier-based aircraft, while another in multi-engine aircraft, and so on.

Following the war, naval aviation faced demobilization and organizational readjustment. NAS Pensacola remained headquarters of the Naval Air Training Command, although the cadet-training program was disbanded, which forced the deactivation of Ellyson and Barin Fields, and drastic changes in the work load of others. By 1948, the headquarters of the Naval Air Basic Training Command transferred from NAS Corpus Christi to NAS Pensacola. The Naval Air Training Base at Corpus Christi was disbanded; subsequently the Naval Air Basic Training Subordinate Command was established there. During this time, and leading up to the Korean War, various levels of flight training occurred at NAS Pensacola including carrier qualification training aboard the USS *Ranger* (CV 4), USS *Saipan* (CVL 48), USS *Wright* (CVL 49), USS *Cabot* (CVL 28), and USS *Monterey* (CVL 26) (U.S. Department of the Navy 1950a, 1950b, 1951, 1952).

Carrier Qualification Training

Since naval aviation's inception, it was clear that naval aircraft would be utilized as a weapon of warfare at sea, whether a carrier-based attack bomber or a long-range seaplane. Eugene Ely's demonstration that an aircraft could land and take off from a seagoing vessel sparked an early notion of carrier-based aviation operations. WWI further made it clear to naval officers that aviation would eventually hold a more important place in naval strategy, and thus aircraft carriers were needed. Consequently, in 1919, the Department of the Navy authorized the conversion of the collier USS *Jupiter* into an experimental carrier, the USS *Langley* (U.S. Navy 1958:19). The Navy conducted several successful tests in Pensacola in 1923, allowing for technological advancements such as takeoff and landing techniques with newly developed arresting and launching devices. These successes provided a precedence that permitted the conversion of the USS *Saratoga* and USS *Lexington* into carriers, but also led to the creation of a fleet of aircraft carriers that would serve in WWII and after (Polmar 2006:50).

The Navy's first carrier, built from the keel up, was the USS *Ranger,* commissioned in 1934, which was seen by many as unfit for carrier-based aviation activities due to its small size and lack of adequate capabilities (Graff 2008:10). The USS *Ranger* never saw warfare in the Pacific during WWII but was instead utilized for carrier qualification training and arrived in Pensacola for that purpose in 1945. Seven months later in 1946, the USS *Saipan* arrived to relieve the USS *Ranger* in carrier qualification duties until 1947. The USS *Saipan* again served in Pensacola from 1955 to 1957. The USS *Wright,* USS *Cabot,* and USS *Monterey* filled the role of carrier qualification training duties in the years between (U.S. Department of the Navy 1950a, 1950b, 1951, 1952).

During WWII, the bulk of carrier qualification training occurred in Lake Michigan off NAS Glenview, aboard the USS *Wolverine* and USS *Sable*. In late 1945, this unit moved to Pensacola where it formed the basic carrier qualification training unit of the Navy: squadron VN-6. The instructors of this unit taught basic flight in SNJs and carrier qualification in SNJ-Cs. Part of this training consisted of mock field carrier landings, followed by landing and taking off of an actual aircraft carrier. Two years later, Carrier Qualification Training Unit 4 (CQTU-4) formed as the advanced squadron; this unit utilized the F6F Hellcat, SBD Dauntless, TBM Avenger, and F4U Corsair. (Taylor 2015:39) By 1950, the F8F Bearcat served as the Navy's primary advanced qualification trainer, if only for a short time, before jets became the predominant carrier fighter (Figure 7).

Figure 7. F8F Bearcat sinking after failed carrier approach (U.S. Navy Photograph, Courtesy the Emil Buehler Library)

History of the Grumman F8F Bearcat

The Grumman Aircraft and Engineering Corporation, later renamed Grumman Aerospace Corporation, opened in 1930 and quickly became a leading aircraft contractor with the Navy. Grumman's first aircraft design contract with the Navy was in 1931, when the company began developing the XFF-1 (Thruelsen 1976). Navy aircraft designations, for standardization and continuity, had specific meanings for each letter and number. The X stands for experimental, the F for fighter, the second F is the manufacturer code for Grumman, and the -1 is the variant of aircraft (Campbell 2012:7-9). Once an aircraft was put into production, the designation lost the X, and subsequent variants were sequential: -1, -2, -3, etc. Grumman continued to design and produce aircraft for the Navy in a rather evolutionary fashion. The Grumman design, especially from the F4F Wildcat, the F6F Hellcat, and the F8F Bearcat, maintained a distinct bumblebee shape not seen in other aircraft prior (Thruelsen 1976). Of note, Grumman requested the family name of 'cats' for their future aircraft, just as Douglas Aircraft Company requested 'sky' for theirs (Cagle 1963).

The F4F Wildcat and F6F Hellcat served the Navy well during WWII, although Navy planners as well as Grumman employees tried to stay one step ahead of Japanese aircraft designs. Therefore, in the summer of 1943, Grumman submitted the designs for a lighter and more maneuverable aircraft: the F8F Bearcat. The Bearcat design encompassed the same Pratt & Whitney R-2800 Double Wasp engine as the F6F Hellcat, and the Vought F4U Corsair (Mondey 2002). The new designs also had improvements such as a bubble canopy, allowing for a better field of view, and revolutionary breakaway wing tips. This concept allowed the aircraft to reach 9Gs of force without requiring the weight of previous designs. Once the aircraft reached 9Gs the wing tips would automatically break off, potentially allowing for a safe return home (Aerodata

International 1987:100). The Navy was impressed and ordered two XF8F-1 prototypes in November 1943 (Figure 8). After successful flight demonstrations, the Navy ordered 2023 F8F-1 Bearcats in October 1944. Due to wartime demands, it was common for aircraft companies to subcontract their designs, therefore the Navy ordered 1876 F3M-1 (F8F-1) Bearcats from General Motors in February 1945 (Mondey 2002).

Grumman quickly began production of the F8F-1, and the Navy's carrier qualification training began soon after. The first Bearcat squadron, VF-19, was formed at NAS Santa Rosa in May 1945 and was soon headed to the Pacific theater onboard the USS *Langley* (Maloney 1969). Before arrival, VJ day transpired and the F8F Bearcat never saw combat. The Navy reduced Grumman's Bearcat contract to 770 planes and General Motors' was cancelled altogether. The Bearcat did play a role in the Navy's postwar plans, although limited due to incoming jet technology. A delay in jet production allowed F8F Bearcats to serve in nine squadrons by the end of 1946. In the same year, Grumman tested the XF8F-2, with changes such as a new R-2800 engine variant and an enlarged vertical stabilizer.

Figure 8. XF8F-1 in Flight 1944-1945 (U.S. Navy Photograph; Courtesy the Emil Buehler Library)

Other variants of the F8F Bearcat included the F8F-1B, F8F-1N, F8F-2N, and F8F-2P (for production quantities see Table 1 in Chapter VI). By 1949, the F8F Bearcat flew in 28 squadrons, but was soon phased into the Naval Air Reserve and by June 1950 the F8F-1 replaced the F6F Hellcat as the Navy's principle advanced trainer fighter (Aerodata International 1987). The Naval Air Reserve retained 282 Bearcats by 1953, though these were all replaced by 1954 (Emil Buehler [1960-1970b) While the Bearcat primarily served as a carrier qualification trainer, it did see combat when the Navy gave 100 F8F-1s and F8F-1Bs to the French Aeronavale during the French Indochina War.

Conclusion

The Navy began developing a Naval Aeronautical Station at Pensacola only eleven years after the Kitty Hawk flight. Four decades later, the Navy commissioned the creation of the F8F Bearcat, the ultimate piston-engine carrier fighter (Figure 9). Understanding the congruent and systemic development of aviation, NAS Pensacola, and the Grumman F8F Bearcat is crucial to this research in order to understand the tangible remains of these submerged historic naval aircraft.

Figure 9. F8F-2 Bearcat on Display at the National Naval Aviation Museum, Pensacola, Florida (Photo taken by author, 2016)

CHAPTER V: METHODS

Introduction

Before this study, submerged aircraft in the Pensacola region had not been examined scientifically. Local sport divers, having discovered and tentatively identified several aircraft over several decades, provided UWF archaeologists with the locations of numerous sites. The sport divers' assistance resulted in an initial site assessment study of two F8F Bearcats and two F6F Hellcats (Whitehead and Mauro 2016). Divers documented each site through photographs and video. Key elements of each wreck site illustrated the aircraft type when compared to a plethora of aircraft identification literature (Mondey 2002; Rendall 1996). Upon confirmation of aircraft type, UWF archaeologists constructed three phases of research: 1) archival inquiry, 2) non-intrusive archaeological investigation, and 3) post-processing of imagery for the creation of 3D photogrammetric models.

Archival Research

The first step in the archival research process identified the numerous repositories that held pertinent documents. Archaeologists, James Pruitt and Jennifer McKinnon (2016), provided basic research methods, i.e. what documents are fundamental to naval aircraft research and where to find them. They point out that aircraft identification is a crucial starting point to the anthropological study. Without an understanding of the aircraft's identity, its historical background is lost to the researcher.

Perhaps the most vital document pertaining to this research is the Aircraft Accident Report (AAR). This document contains the contemporary analysis of individual aircraft accidents, ranging from minor propeller strikes to complete losses. These reports detail the pilot's name, aircraft model and Bureau Number (BuNo), date of accident, analysis of event, and other crucial data. Each individual aircraft is represented by a Navy BuNo. This serial number is key to tracing an aircraft's origin, movement from squadron to squadron, and occasionally its demise. The NHHC archive, in Washington D.C., holds copies of AARs from 1920 to 1973. Records of the losses prior to WWII are held on five microfilm reels, covering the years from 1920 to 1941. AARs from 1941 to 1952 are located on twenty-nine reels of microfilm. This collection is conveniently listed by aircraft type and date of accident. The reports after 1952 are not located on microfilm and must be requested individually through the Freedom of Information Act. Additionally, the Naval Safety Center holds any report after 1973, which are not accessible to the general public.

Pertinent historical documents necessary for naval aircraft research are held in numerous facilities, requiring the examination and cross-referencing of many sources (Pruitt and McKinnon 2016:46). The result of an initial AAR search dictates the next step in archival research. AARs provide BuNos, which are primary reference points in other reports and documents. The NHHC holds microfilm copies of Aircraft History Cards, which are useful to discover date of production, squadron assignments, maintenance, and when/if an aircraft is stricken from Navy inventory. AARs also sometimes indicate general coordinates of the accident, and in this research, the aircraft carrier to which the aircraft was assigned. The next step in research took place at the National Archives and Records Administration (NARA) repository in College Park, Maryland. The NARA contains the aircraft carrier Deck Logs, which consist of chronological entries of daily activities aboard the vessel. When these entries are cross-referenced to the events described in AARs, they sometimes provide locational information of aircraft wrecking events. A further analysis of this cross-examination of documents is described in Chapter VI.

Additional relevant historical documents are located at NARA College Park, such as the original copies of AARs and some pilot flight logbooks. Furthermore, the NARA facilities in Washington, D.C. and Atlanta, Georgia revealed documents that added to the historical background, though none contained crucial locational data. Archival research in the University Archives and West Florida History Center, and the Emil Buehler Library of the National Naval Aviation Museum provided documents such as photographs, newspapers, etc. that facilitated the creation of a historical context of NAS Pensacola from its foundation in the early 1900's and throughout the century.

Archaeological Fieldwork

One goal of this project was to identify the photogrammetric methods necessary to observe changes on each Bearcat site through time; e.g. degradation, marine growth, sediment movement, etc. Divers conducted four site visits on each site, over the span of a year, to test video collection methods. Due to SMCA regulations, further data collection consisted of non-disturbance methods such as taking basic measurements, extensive notes, and creating underwater sketches (Figure 10) Video collection remained the primary objective, however, and other data collection occurred sporadically throughout the year.

Figure 10. Austin Burkhard taking notes on cockpit features (Photo taken by author, 2017)

The diving activities involved in this project followed the protocols set forth in the UWF Standards for Scientific Diving approved by the UWF Diving Control Board. Due to the water depths (98-106 ft.) involved in this project, UWF Dive Safety Officer, Fritz Sharar supervised all diving activities. To maximize bottom time, divers employed an 32% nitrox gas mix and followed the Scuba Diving International Dive Tables. Standards also require each diver to have a time keeping device or dive computer. The minimum number of divers for any UWF scientific diving operation is four: a buddy-team of two divers, a topside supervisor, and a safety diver. Before divers enter the water, the topside supervisor reads a dive safety brief and ensures the divers are prepared. Each buddy-team was limited to two dives per day, with a minimum of a one-hour surface interval.

Each site is about fifteen miles from Pensacola Pass, requiring a sufficient dive vessel for operations. Fortunately, the UWF Marine Service Center (MSC) recently acquired a Grady

White, outfitted for offshore research. The vessel offered appropriate deck space, adequate for four divers, as well as a fish finder and GPS system. The day prior to field work, researchers prepared the necessary field gear: GoPro cameras, pencils, slates, measuring tape reels, etc. Prior to leaving for the boat ramp, the field crew met at MSC to load gear and conduct boat safety checks (Figure 11).

Figure 11. Field crew after diving operations, Hunter Whitehead, Austin Burkard, and Andrew Van Slyke.

When arriving on site the DSO and acting boat driver, Fritz Sharar, watched the bottom machine for signs of relief on the sea floor. These aircraft sites have only 3-4 ft. of relief, making them very difficult to see on the screen of the fish finder. As a result, Sharar preferred to pass over the site several times to guarantee we were in the correct proximity. Upon confirmation, a crewmember released the anchor from the bow, allowing an adequate amount of scope out before cleating the line. The crewmember always dropped the anchor 30-40 ft. away from the site to ensure there was no damage to the aircraft wrecks. Dropping the anchor away from the site required the first team of divers to conduct a circle search in low visibility circumstances, though the divers were generally able to see the aircraft on their way down the anchor line. This team of divers' goal was to run a reel to the aircraft wreck from the anchor line so that the next team of divers could begin work immediately.

If the first team found the aircraft quickly, they also completed assorted tasks such as taking basic measurements, notes, photographs, and sketches. It was also the first team's task to eliminate the invasive lionfish (*Pterois volitans*) from the site (Figure 12). The invasive species has quickly taken over many artificial reefs in this region of the Gulf of Mexico, making it difficult to gather suitable video data. To mitigate this problem, the first team of divers eliminated any lionfish, sometimes as many as twenty, on the wreck with a pole spear and a lionfish containment device (Figure 13). The second team also completed these tasks if necessary, though their primary goal was to collect video data for the creation of photogrammetric models.

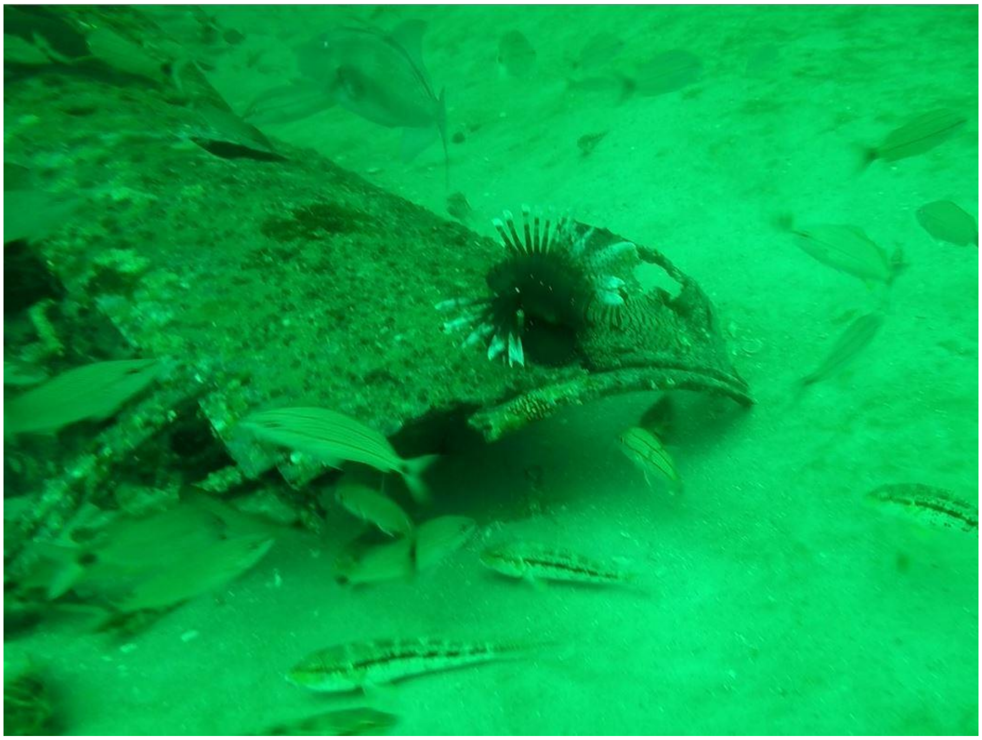

Figure 12. Example of a Lionfish on F8F Bearcat 2 (Photo taken by author, 2015)

Figure 13. Dive Safety Officer, Fritz Sharar, with Lionfish Spear and Containment Device (Photo taken by author, 2017)

As pointed out by archaeologist, Kotaro Yamafune (2016), data collection is the first and most important task for photogrammetric modeling. Without good video collection, the post-processing phase of this project is rendered useless. The second group of divers consisted of a videographer to collect data for photogrammetry, and a photographer to collect additional images. Each diver utilized a GoPro Hero 4 Silver to collect this data, and once finished, collected additional notes and measurements as time allowed.

Photoscan-generated targets provide a unique signature, and when placed into a measured grid system, allow the *Photoscan* software to align photos more precisely. Adapting Yamafune's data collection methods, the codes were printed on sheets of mylar and attached to white tiles to provide a flat weighted surface. Unfortunately, placing the coded targets around the Bearcat sites enticed triggerfish (family *Balistidae*) which immediately picked them up and moved them. This method was abandoned to save the limited bottom time available. The array of marine life caused several problems in relation to video data collection.

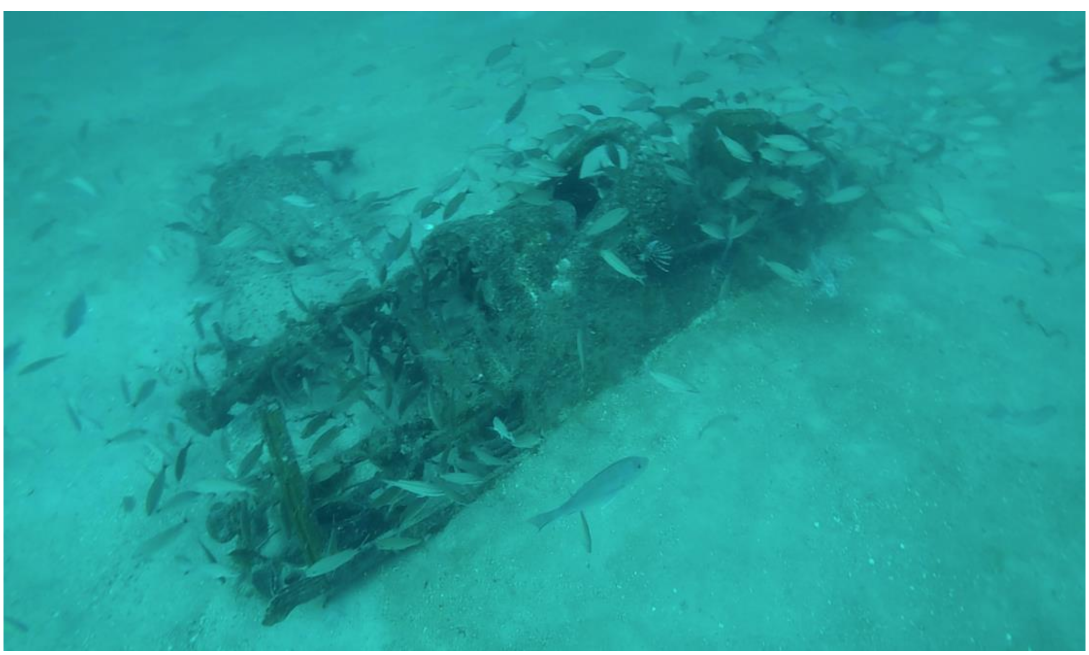

Figure 14. Illustation of the Vast Quantity of Marine Life on F8F Bearcat 1 (Photo taken by author, 2016)

Yamafune suggests an estimated photo overlap of 80% to create a quality model. In this case, due to the high volume of marine life (Figure 14) additional overlap was necessary. To do so, the diver took video along ‘survey lanes’ around the wreck, capturing as many angles as possible (Figure 15). Although video did not produce the same resolution quality as photo stills, the limited time SCUBA allows on deep sites required a quicker field method. The videographer made slow and deliberate movements to reduce the number of blurry photos in post-processing. Once complete, the divers gathered their tools, and reeled in the spool on the way back to the anchor and surface. If time and weather permitted, the crew repeated this process on the second site, just a few miles away. At the end of the day crew cleaned the gear and boat, and copied all field documents, imagery, and other data to the MSC computer for processing and analysis.

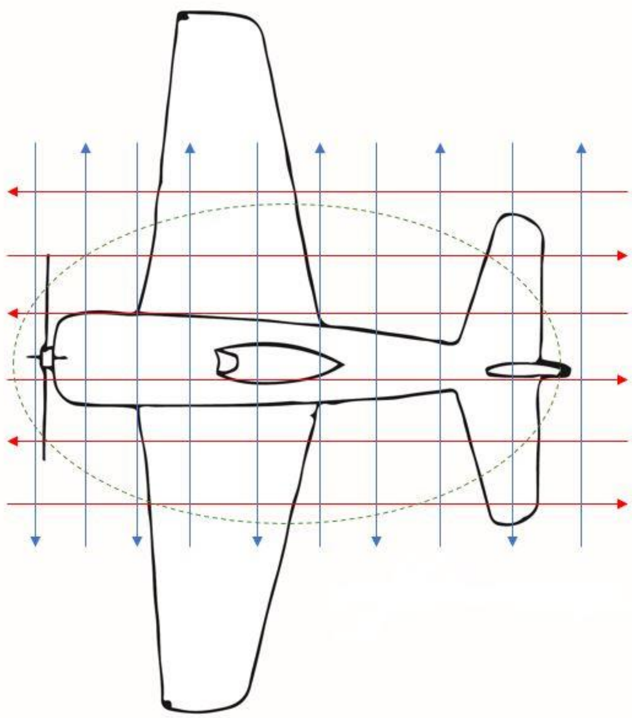

Figure 15. Example of Video-Collection 'Flight-Path' (Image created by author)

Post-Processing

In 2014, Kotaro Yamafune visited UWF to teach his photogrammetric post-processing methods to assorted graduate students in the anthropology department. The author adapted these methods, altering them slightly to fit the research. This project certainly would not have been visualized without Yamafune's assistance. Upon completion of diver investigations, the author processed photographic and video data for the creation of photogrammetric models. This process involved three broad steps: 1) video to photo-still conversion, 2) image corrections in Adobe *Photoshop* (Adobe Inc. 2016), and 3) photogrammetric processing in *Photoscan*. The following post-processing steps are simplified, and many, such as the image corrections in *Photoshop*, required a certain artistic license. For further explanation of these methods, see Yamafune's (2016) dissertation.

Video to Image Converter

Several video-to-image software options are available; the author chose the open source, *Adapter (Macroplant, LLC 2014)*, due to its accessibility. This software allows a user to extract still images from video at a designated frame rate. To reduce the number of blurry images, the product of quick videographer movements, the frame rate was set at three images per second. The resulting blurry images were then deleted from the sequence. It is recommended to use less than 1,000 images to limit the already lengthy processing time of *Photoscan*.

Batch-Processing

Processing 1,000 images individually can be time consuming. Fortunately, *Photoshop*'s Droplet feature allows image corrections to a batch of images. Essentially, the user records the changes made to one image in the image sequence, and then applies those changes to the whole image folder. Depending on the number of images, this process may take several minutes, or only a few seconds, either of which is undoubtedly less time than processing each image individually.

<u>Image Corrections</u>

As alluded to previously, there are numerous image correction techniques within *Photoshop*. Thus, the following methods demonstrate only one way to reach an accurate illustration of the wreck sites. *Photoshop* methods included various filtering and adjusting processes applied to images to reduce bluish-green tones of the water and to reproduce the natural colors of the subject. Given the variety of options, experimentation is necessary to produce the desired quality. Below is a simplified description of the *Photoshop* steps utilized during this project.

To ensure that all filters applied to an image may later be altered, the user should utilize the smart filters function. When utilizing images created with a GoPro camera, the Lens Correction feature removes lens distortion from the fisheye effect. Filters may need to be applied multiple times for desired effect. The author utilized Yamafune's suggested adjustments tools: Color Balance, Curves, Levels, and Vibrance. "Curves adjustment enhances the contrast in an image while Levels adjustment enhances color-distributions of the image. Color Balance adjustment restores original colors by reducing greenish and bluish tones in the water, and the Vibrance adjustment enhances the natural colors of the subjects in the images" (Yamafune 2016:90). Altering the pixel-data too much will result in an inaccurate photogrammetric model. Thus, the author created a color corrected photogrammetric model, and one uncorrected model, so that the two models could be compared for discrepancies.

Photogrammetric Processing

Once the desired image quality was achieved, the images were input into *Photoscan. Photoscan*, in simplest terms, requires four steps to create photogrammetric models. The software first aligns the sequence of photos and proceeds to build a point cloud, an overlaying mesh, and the finalizing texture. Before beginning these steps, however, it is necessary to utilize the software's Estimate Image Quality function to delete any remaining low-quality images. The software defines image quality on a scale of 0.00 to 1.0, the latter being perfect quality. In this case, the author defined low quality as 0.45 and less. Eliminating these less-than-optimal images greatly reduced *Photoscan*'s long processing times.

Each of the main software processing tools allow for low, medium, and high settings, which again required experimentation to achieve the desired model quality. Processing times can range from two hours to more than twelve hours. To best utilize time, the author first processed each model on the lowest settings to ensure the model was feasible. If a point cloud resembling the site was created on lower settings, higher settings were utilized to further refine the model. Another unique feature of *Photoscan* the author implemented during this project was the creation of an Orthophoto.

An Orthophoto is essentially a photomosaic of the site created from a photogrammetric model. The author created a sketch-like illustration in *Photoshop* from an Orthophoto. The resulting illustration was then compared to Navy and Grumman-produced scaled aircraft line drawings. The comparisons provided a better understanding of what remained of the aircraft, as well as its level of degradation. To further illustrate the archaeological sites compared to what the original aircraft resembled, the author layered scaled line drawings over the Orthophoto sketch in *Photoshop*. In the case that line drawings are available of any archaeological site, this process is a valuable comparative tool.

Data Management

The photogrammetric process creates a vast amount of digital data including original video, still images, color-corrected still images, *Photoscan* files, and any orthophotos generated. It is necessary to prepare for the long-term storage and accessibility of these data. In *Caring for Digital Data in Archaeology: A Guide to Good Practice* the author suggested that the goals for digital archiving include: "1) Ensuring the long-term preservation of digital data so that it remains useable in the future, and 2) Permitting easy, wide, and appropriate access to digital data. Furthermore, photogrammetric methods and techniques are quickly evolving" (Brin 2013:9). The preservation of all original data allows future archaeologists to replicate this study and potentially improve the quality of the models generated. Thus, all digital data, and scans of field documentation, are stored on the network drive at the Archaeology Institute at the University of West Florida.

Conclusion

This study serves as a baseline for future research of naval aircraft in the area, and thus the methods described above may be replicated and/or expanded. The archival investigation revealed several primary sources that, when cross-examined, revealed key identification and locational details. Identification was the first step for aircraft-wreck investigations and led to site-specific research questions. The non-intrusive archaeological investigations, primarily video and basic measurement documentation, allowed for a better grasp of the features of the Bearcat wreck sites. An analysis of the photogrammetric models generated from the results of these investigations provided insights into the wrecking event and subsequent processes affecting these sites.

CHAPTER VI: RESULTS

Introduction

The stories of the two F8F Bearcats mentioned in these chapters come alive through archaeological and historical research. The combination of historical documents with analysis of the physical remains of the aircraft gives archaeologists insights into the life history of the aircraft, but also the wrecking events. Photogrammetric documentation of the sites proved to be an exceptional method for site analyses, as it provided qualitative virtual visualization. Having an accurate model of the two sites allowed archaeologists to examine the potential cultural and environmental processes affecting them through time. As future archaeologists create subsequent models during site assessments, the photogrammetric process will be a key monitoring tool.

Prior to field work, the author conducted a desktop study and reached out to the NHHC to determine which documents would provide historical insights. Once recognizing the main archival repositories, the author systematically surveyed documents pertinent to NAS Pensacola, and the F8F Bearcats stationed there. The second phase of research consisted of four visits to each of the sites to achieve various tasks such as taking notes and basic measurements, but primarily collecting video for photogrammetric modeling. The final phase consisted of photogrammetric post-processing and analysis of the resulting models. The following represents the results of each phase of this research.

Desktop Study Results

During the inception of this study, prior to reaching out to the NHHC, the author discovered secondary sources that discuss historic aircraft wrecks in Florida. Douglas Campbell’s (2012) extensive dictionary of WWII wrecks, *BuNos! Disposition of World War II USN, USMC and USCG Aircraft Listed by Bureau Number*, proved to be a crucial resource.

Campbell's work consists of a compilation of the Aircraft History Cards held by the NHHC. However, in the forward, he notes that this work is only a "snapshot in time" as more documents are filtered to the NHHC from other repositories. Campbell listed four F8F Bearcats (BuNos 94901, 95134, 95495, 95496) as wrecking in Pensacola, though this was only discovered after determining which aircraft carriers operated there (Campbell 2012:576-582). Robert Widner's (2009) *Aircraft Accidents in Florida: From Pearl Harbor to Hiroshima* assembled a list of aircraft accidents as reported in local newspapers. This source did not reveal information specific to F8F Bearcats off Pensacola, yet it did provide an understanding of Florida's instrumental role in WWII.

Next, the author deemed it necessary to determine the significance and rarity of F8F Bearcats. The Navy accepted 1,263 F8F Bearcats (Table 1) from 1944 to 1949, a small allotment compared to the 12,275 F6F Hellcats accepted (NHHC 2015:66). The NHHC Underwater Archaeology Branch (UAB) aircraft wreck database has only three known F8F Bearcat wreck sites on record (personal communication, Agustin Ortiz 2018). These include a potential XF8F Bearcat in the Patuxent River, Maryland and two F8F Bearcats in the Pacific Ocean. There are certainly more F8F Bearcat wrecks around the world; however, these are yet unknown to the UAB. There is only one F8F Bearcat in the Navy museum system, being an F8F-2, BuNo 121710 on display at the National Naval Aviation Museum in Pensacola. John Chapman et al.'s (1989) *Warbirds Worldwide Directory* consists of a survey of warbirds in both museums and private hands. The survey lists 39 known F8F Bearcats, some of which are listed as 'crashed'. Of the 1,263 F8F Bearcats accepted by the Navy, the number that still exist is unknown. The UAB's aircraft wreck database does note that there are about 1,200 aircraft wrecks in Florida. Thus, the

F8F Bearcat may be a rarer type, but there are certainly numerous aircraft wrecks on land and submerged in the state.

Table 1. F8F Production Quantities (NHHC 2015)

Quantity of F8F Bearcats Manufactured	***Model***	***Mission/Purpose***
2	XF8F-1	Prototype
765	F8F-1	Production Model
100	F8F-1B	Heavy Armament Fighter
2	XF8F-1N	Night Fighter Prototype
36	F8F-1N	Night Fighter
2	XF8F-2	Prototype
293	F8F-2	Carrier Fighter
12	F8F-2N	Night Fighter
60	F8F-2P	Photo-Recon Aircraft

Archival Research Results

Conversations with NHHC staff led the author to several archival repositories, most of which required travel to Washington, D.C. and the surrounding area. The first archival trip coincided with the Society for Historical and Underwater Archaeology conference that was held in Washington, D.C. in January of 2016. The author made an additional trip in April the same year, and again for an internship with the NHHC from July to August. Numerous trips allowed for a greater understanding of the historical documents pertaining to naval aviation research. The National Archives in Atlanta serves as the repository for NAS Pensacola records. Additionally, historic newspapers and other documents are held at the Emil Buehler Library at the National

Naval Aviation Museum, and the University Archives and West Florida History Center. Ample time at these archives revealed several relevant documents and photographs that helped build an understanding of NAS Pensacola's historical background.

<u>Aircraft Accident Reports and History Cards</u>

Aircraft accident reports (AAR) are the focal point of archival research for naval aviation wreck studies. The information contained within consists of factual data, i.e. date, time, location of crash, but also witness reports and analyses of the accident. In the NHHC AAR microfilm collection, the author discovered four AARs (U.S. Bureau of Naval Aeronautics 1950a, 1950b, 1951, 1952) indicating F8F-1 Bearcats that were 'Lost at Sea' in Pensacola. These reports indicated aircraft with BuNos 95495, 95496, 94901, and 95134 (Table 2). The National Archives facility at College Park, Maryland retains hard copies of only two of these, BuNos 95495 and 95496 (U.S. Bureau of Naval Aeronautics 1950c, 1950d).

The years of the accidents ranged from 1950 to 1952 and occurred during carrier qualification training on three different aircraft carriers: USS *Cabot*, USS *Monterey*, and USS *Wright*. Each pilot and aircraft was attached to the Carrier Qualification Training Unit 4 at Corry Field. Each accident occurred during landing procedures, suggesting the difficulty of this maneuver. Lester L. Shade and Stanley Milton Spaeth, pilots of BuNos 95496 and 95134 respectively, were both 'Lost at Sea.' The two surviving pilots, Leland S. Hosemann and Francis J. Gulshen, reported making over-corrections at the time of crash when they believed their aircraft to be stalled (U.S. Navy Bureau of Aeronautics 1950a, 1951). The AARs for BuNos 94901 and 95134 contained general latitude and longitude coordinates, which were used to identify the known wreck sites. To gain data on the other BuNos' locations, the deck logs of corresponding aircraft carriers were referenced.

Table 2. F8F Bearcat Accidents in the Gulf of Mexico off Pensacola (Aircraft Accident Report Microfilm Collection, NHHC)

Date of Accident	***Aircraft Model***	***BuNo***	***Accident Location***	***Pilot's Name***	***Pilot Recovered (Y/N)***
2/13/1950	F8F-1	95495	USS *Cabot*	Leland S. Hosemann	Yes
11/7/1950	F8F-1	95496	USS *Wright*	Lester L. Shade	No
4/18/1951	F8F-1	94901	USS *Monterey*	Francis J. Gulshen	Yes
4/21/1952	F8F-1	95134	USS *Cabot*	Stanley M. Spaeth	Yes

Aircraft history cards serve as a logistical reference of each naval aircraft and provide information such as acceptance date, squadron transfer dates, and eventually when and if the aircraft is stricken from Navy inventory. The NHHC archives retains a microfilm collection of these records, including BuNos 95495, 95496, 94901, and 95134 (U.S. Navy Bureau of Aeronautics 1945, 1946, 1947a, 1947b). Both 95495 and 95496 were accepted in August 1947, though they appear to have served in different squadrons and locations through their life as trainers. Each of the four cards does not contain squadron or location information past 1948; however, the strike dates correspond with the wrecking events.

Aircraft Carrier Deck Logs

By cross-referencing the dates of aircraft accidents with aircraft carrier deck log entries, research revealed some locational data. The deck logs (U.S. Department of the Navy 1950a, 1950b, 1951, 1952) exposed coordinates for the two BuNos lacking coordinates on the AARs; 95495 and 95496. The deck log's locational information for BuNo 95134 corresponded with the AAR, but for BuNo 94901, the deck log entry created some confusion. The coordinate data on the 94901 AAR and deck log entry did not coincide. The latitudinal coordinates on each document have a difference of roughly 31 minutes, a wide error. This difference likely is a result of contemporary clerical errors. The deck log is recorded as events happen aboard the ship, and the AAR is recorded after an analysis of the event is complete. Unfortunately, one cannot be sure which information is correct; therefore, both coordinates should be considered.

Cross-Referencing Documents for Site Identification

The author plotted the latitude and longitude coordinates from the assorted documents into Google Earth to determine their proximity to the known Bearcat sites (Figure 16 and Figure 17). The black aircraft symbols indicate the two known Bearcats, labeled F8F Bearcat 1 and F8F Bearcat 2. The red aircraft symbols indicate the coordinates found in the deck logs (DL) and Aircraft Accident Reports (AAR). Because some coordinates lacked 'seconds', the minimum and maximum values were substituted and are indicated in the figure by a -1 or a -2 respectively. For example, a latitudinal coordinate labeled 30 06' N would be substituted by 30 6.00 N and 30 6.59 N. One second is equal to 101 feet, so 59 seconds difference would be a range of just under 1 nautical mile, therefore the difference between the -1 and -2 values is relatively minimal.

The known Bearcat sites correlate most closely with the locational data from BuNos 95495 and 95496, although it may be difficult to discern one site from the other due to their close proximity. It is interesting that the identities of each site relate to the sequential BuNos of 95495 and 95496; though, the squadron likely received aircraft in consecutive lots. The deck log referencing BuNo 94901 indicated that the crash occurred roughly 18 miles inland, and thus may be disregarded as a potential submerged site. BuNos 94901 and 95134, as shown by the deck logs and AARs, plot too far away from the wreck sites to be considered likely candidates; they are located roughly 12 and 25 miles away, respectively. Therefore, the use of historical documents allowed for a process of elimination and narrowed the possible aircraft identities to two BuNos. The proximity of the two sites, roughly 3.5 miles apart, combined with the vague coordinates, caused further identification to be difficult, if not impossible.

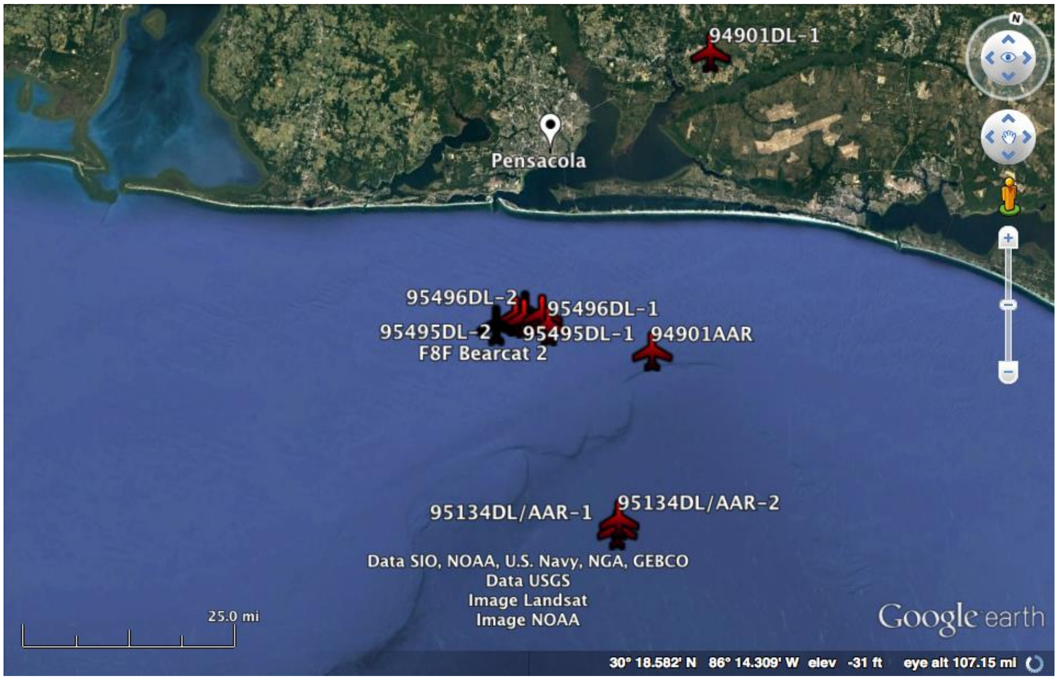

Figure 16. Plotted coordinates from Deck Logs, and Aircraft Accident Reports compared with wreck sites (Google Earth)

Figure 17. Plotted coordinates from BuNos 95495 and 95496 Decklogs compared with wreck sites (Google Earth)

Additional Archival Material

Several additional archival repositories provided numerous documents for the preparation of this thesis. The National Archives at Atlanta, Georgia holds the Records of the Naval Air Training Command, Pensacola. After several research inquiries into these archives, it was evident there was no material specific to this study's goals. However, the repository holds correspondence, historical reports, logistical analyses, etc. and should be considered as a key resource for future research. The author also visited the Steven F. Udvar Hazy Center of the National Air and Space Museum in Chantilly, Virginia. The archives at this facility hold numerous technical drawings and aircraft parts manuals, including those of the F8F Bearcat. One such technical drawing was adapted for use in this thesis through ink tracing and then vector tracing in *Illustrator* (Adobe Inc. 2019) (Figure 28 and Figure 29).

The relative locations of the other mentioned archival repositories to Pensacola allowed the author to visit more frequently. The Emil Buehler Library is the archival repository of the National Naval Aviation Museum. The author spent numerous days perusing this collection and discovered historical photographs of F8F Bearcats, detailed manuscripts of NAS Pensacola history, and an F8F Pilot's Handbook. The collection also holds detailed accounting documents called Location of Navy Aircraft, and Aircraft Allowances of the Navy. The University Archives and West Florida History Center retains the largest collection of historical documents pertaining to West Florida. Historian, George F. Pearce's collection of naval documents and research resides here. It also preserves the NAS Pensacola's historical newspaper *Gosport*, as well as a microfilm collection of the *Pensacola News Journal*.

Historic news articles did not disclose locational data but added brief background information that may be utilized for future analyses of the pilots. Only the accidents pertaining to pilots' deaths appeared in the journal (*Pensacola News Journal* 1950, 1952). This may be due to Navy disclosure, and likely because of the large amount of aircraft losses during training. Lester L. Shade had only reported to duty in Pensacola in 1949 for flight training before his death in 1950 (U.S. Navy Bureau of Aeronautics 1950b). The other reported accident did not include the pilot's name pending notification of next of kin but corresponds with Stanley Milton Spaeth's accident resulting in his death. While the articles do not add to the locational analyses of the accidents, they provided important background information on the importance of the Navy's presence to Pensacola, and key information on the pilots.

The abovementioned documents pertaining to location of naval aircraft allowed an insight into the *terminus post quem* and *terminus ante quem* of NAS Pensacola's utilization of F8F Bearcats. The first indication of the F8F Bearcat's presence in Pensacola was in November of 1948 and the last was November 1952 (Office of the Chief of Naval Operations 1948, 1952). The aircraft type apparently served at NAS Pensacola for about four years. The fewest the station had at one time was 6 and the most was 28, for an average allotment of 17 F8F Bearcats. The amount varies over these years perhaps because of changes in squadron configurations and aircraft losses. It should be mentioned that these reports are sparse, and it is possible that the Emil Buehler Library does not hold every record in the collection.

Archaeological Fieldwork Results

As mentioned, the archaeological aspect of this study consists of non-intrusive recording methods due to the stipulations of the Sunken Military Craft Act (SMCA). Listed here are the general observations made during site visits over the course of the 2016 and 2017 field seasons. Each site lies roughly 15 miles south of the Pensacola Pass, and are located about 3.5 miles apart. While the exact locations of these wreck sites are not disclosed due to NHHC guidelines, Figure

1 illustrates the close proximity of the two sites. Each plane resides in about 100 ft. of water in a sandy environment and are in similar states of degradation. Portions of a fuselage and vertical stabilizer are the main components remaining. Also, each has apparently been stripped of numerous cockpit gauges and other instruments. Aside from the obvious cultural impacts on these sites, each illustrates similar environmental factors affecting them such as aluminum degradation and marine growth.

The F8F Bearcat 1 site is in 96 ft. (29m) of water and consists of a fuselage, broken starboard wing, and buried tail with portion of the vertical stabilizer sticking out of the sand (Figure 18). The fuselage is oriented towards 320°NW. The distance from the vertical stabilizer to the forward most portion of the fuselage is 21 ft. 9 in. (6.64m), and what remains of the wingspan is 10 ft. 5 in. (3.2m). The engine and one blade of the propeller lay 19 ft. 10 in. (6.05m) away from the port side of the aircraft, which is mostly buried (Figure 19). The cockpit is open, allowing for numerous varieties of marine calcifiers to rest in the sand there. The center control stick that would have allowed the pilot to control the aircraft rudder is still visible above the sand. There are also some instruments remaining on each side of the pilot's seat. In this aircraft, the entire main instrument panel is missing. There are rumors that divers in the community have collected items from these wreck sites. Finally, it is important to note the BuNo plate that would be inside the cockpit behind the pilot seat is missing.

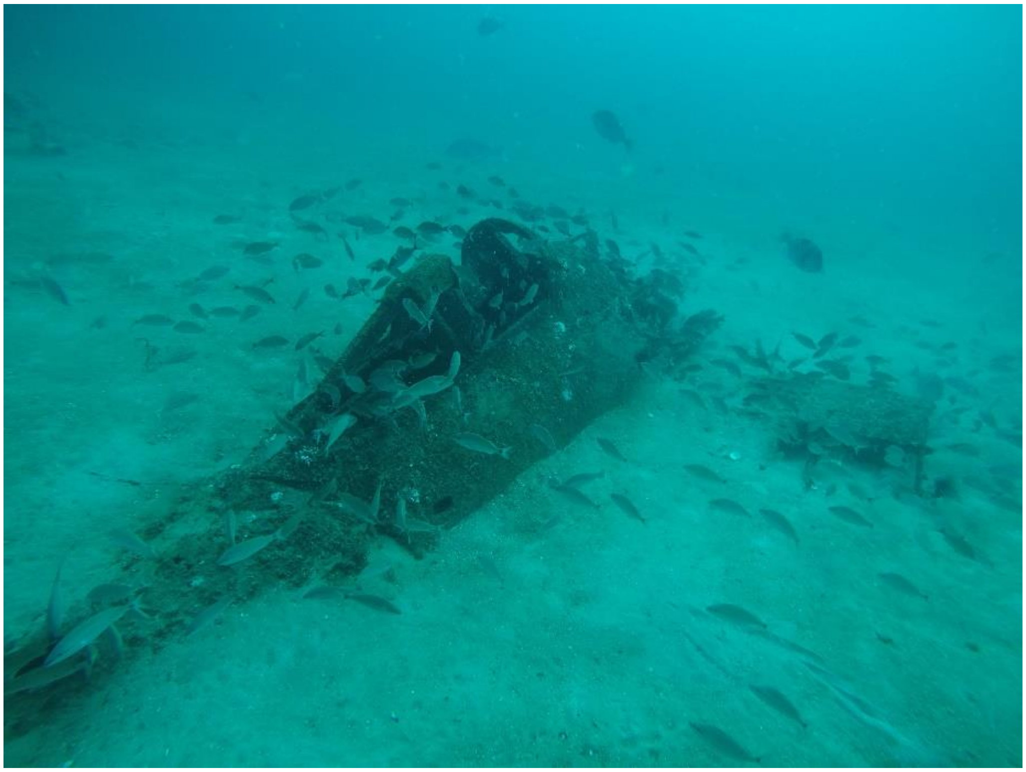

Figure 18. F8F Bearcat 1 fuselage and starboard wing (Photo taken by author, 2017)

Figure 19. F8F Bearcat 1 engine with attached propeller (Photo taken by author, 2017)

Video footage provided by a local dive shop, MBT Divers, shows the state of this wreck site in the 1990s (Figure 20). This footage shows a much different site than what remains today. For example, a complete starboard wing, and deployed landing gear sticks out of the sand. Also, portions of the engine mount and cowling remain on the fuselage, and the rudders remain on the tail. Early photographs and video provide key comparative data to determine the site's state of preservation then and now, but also demonstrates how divers have interacted with the wrecks. In this footage, whether intentional or not, the divers' boat is anchored to the tail of the aircraft. Over time diver visits may have caused damage to the aircraft.

Figure 20. F8F Bearcat in the 1990's (Photograph courtesy MBT Divers)

The F8F Bearcat 2 site, lying in 107 ft. (32m) of water, is in a worse state of preservation than the former (Figure 21). The site consists of a fuselage with a buried tail portion, a broken vertical stabilizer sticking out of the sediment, and the engine and portion of landing gear lying nearby. The forward section of the fuselage to the aft section of the vertical stabilizer is 22 ft. 4 in. (6.82m) long and is oriented towards 280°W. The engine with portions of the cowling lies 75 ft. 1 in. (22.9m) at 10°N from the port side forward most portion of the fuselage. Divers discovered this component on the third site visit due to its remoteness. The landing gear still retains a tire and lies 42 ft. 3 in. (12.89m) on the port aft side of the fuselage. The initial site visit in 2015 did not reveal this component, yet lionfish were attracted to the area. Like F8F Bearcat 1, the cockpit is open and contains the main control stick, and various gauges on the side of the pilot's seat. The main instrument panel is still present; however, a majority of gauges are missing (Figure 22). The missing gauges are likely due to sport diver activities. Also, the BuNo plate was not discovered during site investigations.

Figure 21. Hunter Whitehead investigating cockpit of F8F Bearcat 2 (Photo taken by Austin Burkhard)


Figure 22. Instrument panel inside cockpit of F8F Bearcat 2 (Photo taken by author)

There is a heavy presence of marine life on the wrecks including several species of fish, calcifiers, and even shark on occasion. There is obvious marine growth and some sea fans on the fuselage. Aluminum degradation is obvious throughout the aircraft, especially when comparing the current state of F8F Bearcat 1 to the 1990s footage. Furthermore, there are definite sediment movement, accumulation, and scouring events. According to NOAA Historical Hurricane Tracks there have been 27 named hurricanes through Pensacola since 1953 (National Oceanic and Atmospheric Administration 2018). These, and smaller storm events, have likely impacted the wreck sites. During a site extent investigation, divers discovered several cinderblocks near F8F Bearcat 1; illustrating the use of the site by fishermen as well as divers. The majority of the aircraft are covered by sand, requiring more intrusive measures to determine what remains.

Photogrammetric Post-Processing

The creation of 3D photogrammetric models was particularly challenging during this study. The challenges were in part due to the vast quantity of marine life in the water column surrounding the wrecks. Also, the water depth limited dive times, and thus limited the amount of data collected during each site visit. To alleviate the latter issue, divers collected video rather than photographs. The author attempted to create 3D photogrammetric models of each site's components after each of the four site visits.

Post-processing of video data resulted in limited success during this project, though a principle outcome of collecting video for photogrammetric modeling is the vast amount of visual data. The author used this data to seek features that may have been missed during diving operations, and future analyses of the data may reveal more information about the wrecks. While a primary focus of each site visit was to collect video for photogrammetric modeling, only two visits resulted in a visually appealing model. Successful models of the fuselage of each site were created; unfortunately, the engine component models were unsuccessful.

The first successful model served as the prototype on which all subsequent models were based. Figure 23 depicts the first model of F8F Bearcat 1 which proved the potential for photogrammetry on sites in the Gulf of Mexico, even when densely populated with fish. As the author became more familiar with *Photoshop* and *Photoscan*, models improved considerably. After the initial site visit, subsequent post-processing efforts did not result in recognizable photogrammetric models. Also, video data of the engine with propeller to the port side of the fuselage proved to be unrenderable.

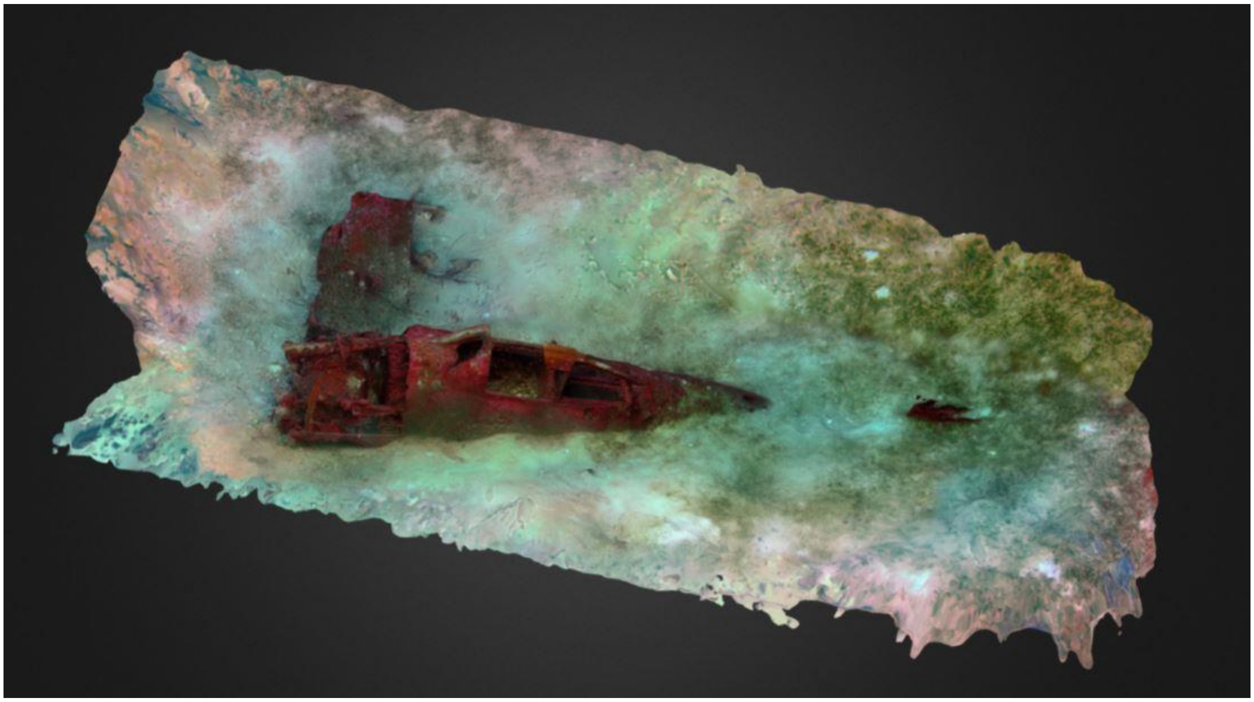

Figure 23. 3D photogrammetric model of F8F Bearcat 1 (Model created by author, 2016)

A model of F8F Bearcat 2 did not materialize until post-processing video from the final site visit, even though the author utilized the same techniques throughout the study (Figure 24). Again, the failure is likely due to the dense population of fish around the wreck. One team of divers utilized the last site visit to gather video of the engine for photogrammetry. This video resulted in a 3D model, though an imperfect one as components of the engine are only just recognizable. Video of the landing gear resulted in a 3D model of much higher quality (Figure 25). The author utilized the products of this process to analyze and illustrate what remains of these aircraft.

Photoscan can export an orthophoto of 3D models, which is essentially a scale corrected image. With Yamafune's (2016) methods, orthophotos allowed the author to create images similar to technical drawings of each wreck component (Figure 26 and Figure 27). The author then used the scaled outline adapted from the technical line drawings of the F8F-1 Bearcat to illustrate what is left of each wreck. By overlaying this outline over the orthophotos, one can see that very little of the aircraft remain, and what may be left lies underneath sediment (Figure 28 and Figure 29) Filled-in outlines of the orthophotos further prove this point (Figure 30 and Figure 31).

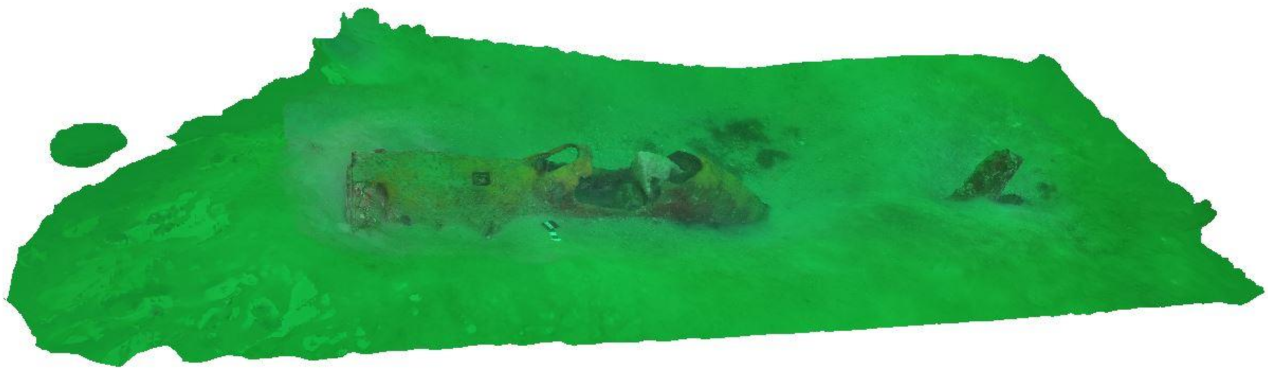

Figure 24. 3D photogrammetric model of F8F Bearcat 2 (Model created by author, 2016)

Figure 25. Orthophoto of F8F Bearcat 2 landing gear component (Image created by author)

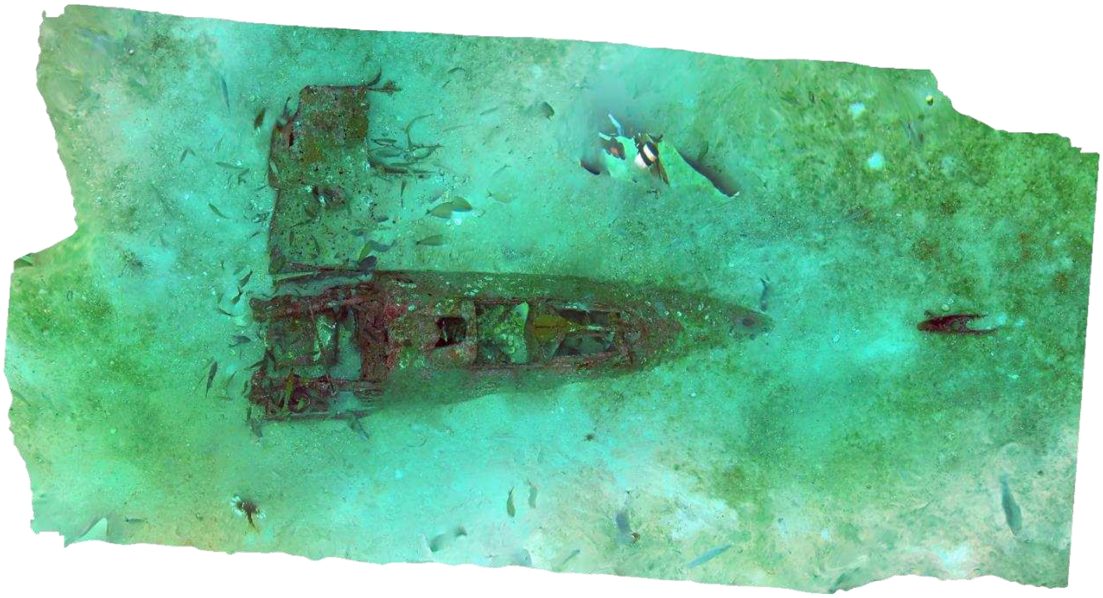

Figure 26. Orthophoto of F8F Bearcat 1 (Image created by author)

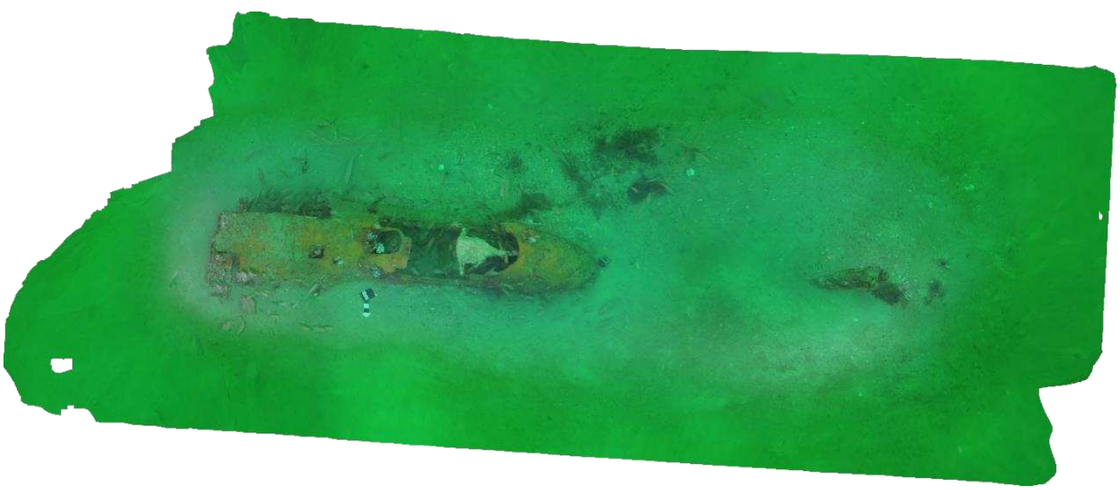

Figure 27. Orthophoto of F8F Bearcat 2 (Image created by author)

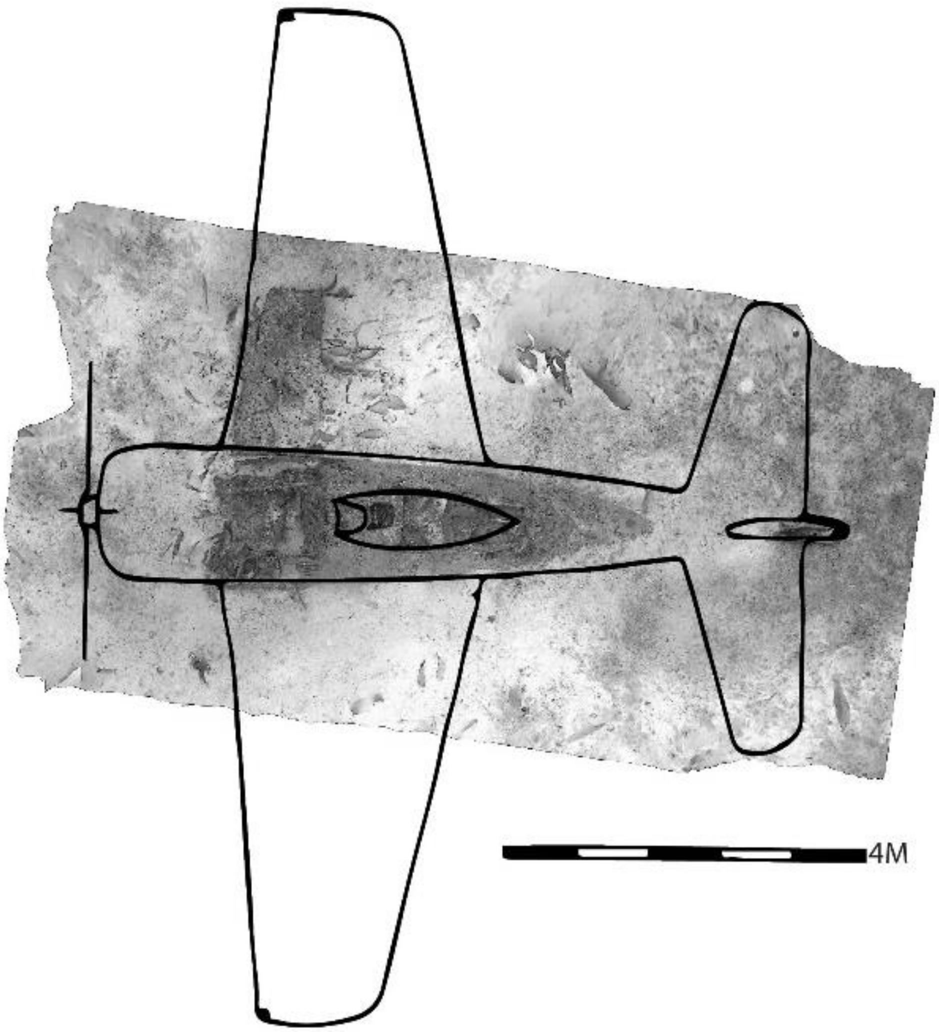

Figure 28. Orthophoto of F8F Bearcat 1 with F8F Linedrawings overlay (Image created by author)

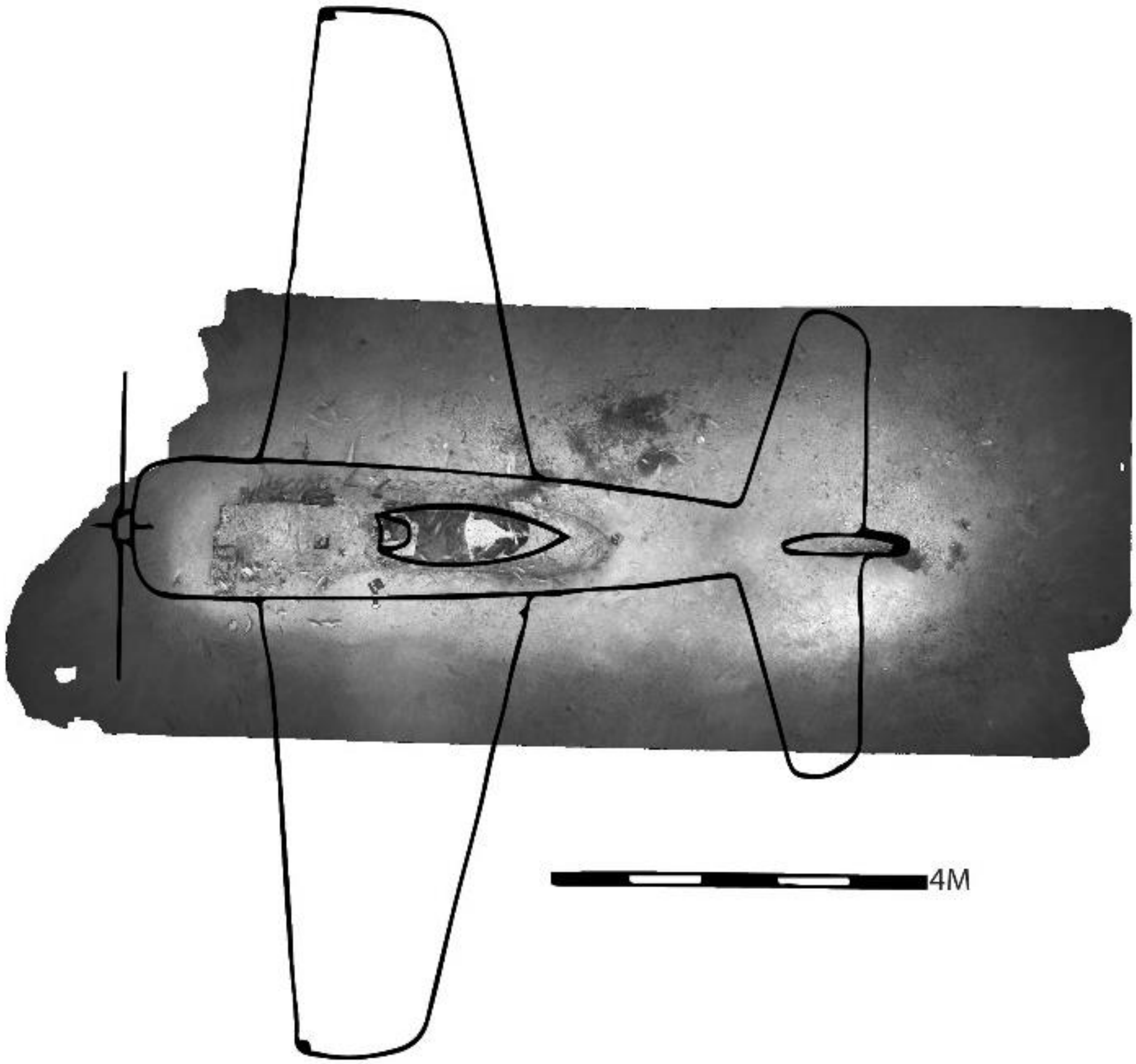

Figure 29. Orthophoto of F8F Bearcat 2 with F8F Linedrawings overlay (Image created by author)

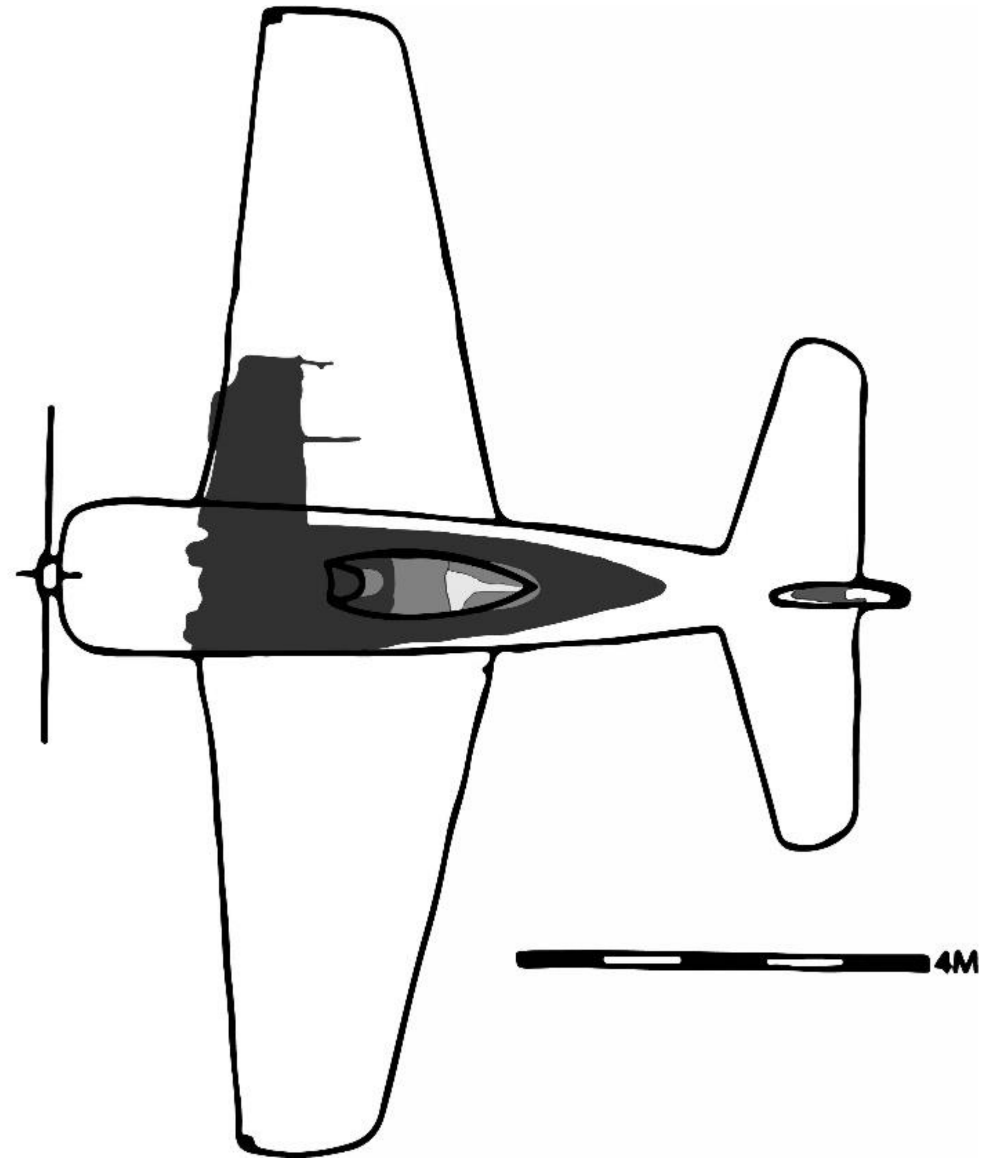

Figure 30. Depiction of what remains of F8F Bearcat 1 with F8F Linedrawings overlay (Image created by author)

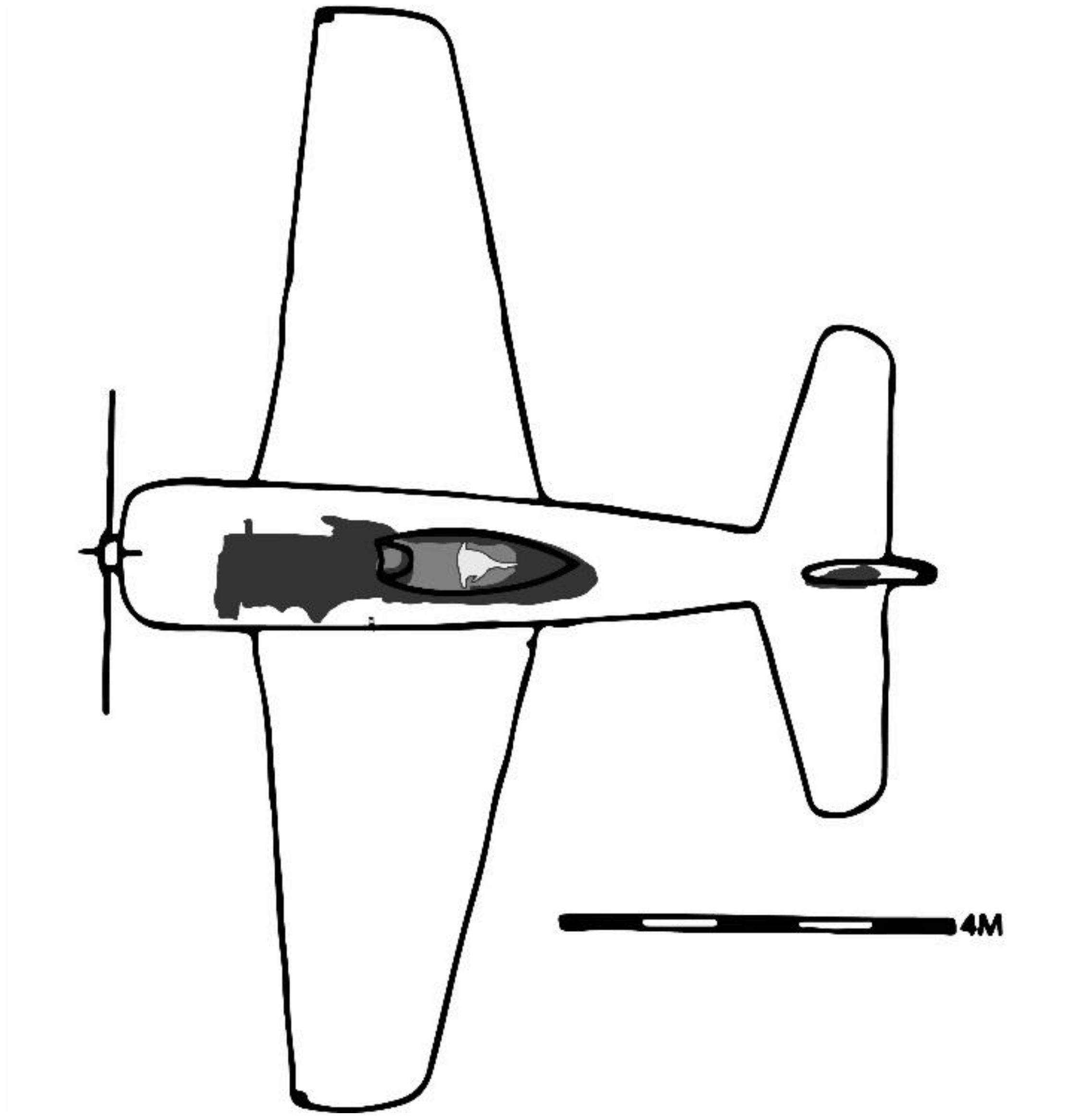

Figure 31. Depiction of what remains of F8F Bearcat 2 with F8F Linedrawings overlay (Image created by author)

Results Analysis

The results of the archival, archaeological, and photogrammetric post-processing phases contributed to the overall understanding of the two F8F Bearcat wreck sites. Archival research revealed the operational history of the aircraft and placed them in a historical context. The archaeological investigations provided data from which the depositional and post-depositional processes could be posited. The post-processing of photogrammetric data allowed for visual representations for site analysis.

From 1950 to 1952 four F8F Bearcats wrecked in the Gulf of Mexico off Pensacola, Florida during carrier qualification training missions. Two of these aircraft, BuNo 95495 piloted by Midshipman Leland S. Hosemann and BuNo 95496 piloted by Lieutenant Lester L. Shade, correspond with the wreck sites. The Navy accepted these sequentially numbered aircraft in August of 1947 and each wrecked in 1950, marking only about three years of service. Each pilot was attempting a carrier landing and apparently stalled and crashed into the water. Midshipman Hosemann's aircraft went nose down into the water, while Lieutenant Shade's aircraft inverted before water collision. The plane guard USS *Corry* picked up Midshipman Hosemann, but sadly Lieutenant Shade's aircraft sank immediately before he was recovered. While there are no obvious remains on either of the wreck sites, the author took this fact into careful consideration during archaeological investigations.

Due to SMCA regulations, the site investigation consisted of a non-disturbance diver survey as described in Chapter V. Video data from each site visit revealed environmental changes over the course of this study. Primarily, there is a high sediment movement rate which can be seen by the scouring and accumulation processes around the fuselages of each wreck, but also by the appearance of the landing gear feature on F8F Bearcat 2. Video provide by MBT Divers demonstrated the state of preservation of F8F Bearcat 1 in the 1990s and the vast differences from its state now. The most obvious difference is the complete starboard wing sticking out of the sand with its landing gear extended. The position of the landing gear corresponds with historical documents describing the failed carrier landing. Interestingly, neither aircraft is inverted as described in the accident report of BuNo 95496. Either the aircraft righted itself on the way down, or possibly a storm event overturned it on the ocean floor.

Cultural impacts are obvious on each wreck site, as numerous divers have likely visited the site over the past several decades. The most obvious is the missing gauges in the cockpits. The entire main instrument panel is missing in F8F Bearcat 1, perhaps from environmental causes. In F8F Bearcat 2, however only individual gauges are missing including the Gyro Horizon Altimeter, Rate of Climb Indicator, Compass Indicator, Directional Gyro (Figure 32 and Figure 33) Divers could also not discover the Bureau Number plates that should be in the cockpit. These numbers would have been especially helpful in identification; however, they were constructed of aluminum and may not have survived in the salt environment. Lastly, there is the possibility that there may be personal belongings of the pilot remaining in the cockpits. However, without the proper permits and invasive investigations this remains unknown.

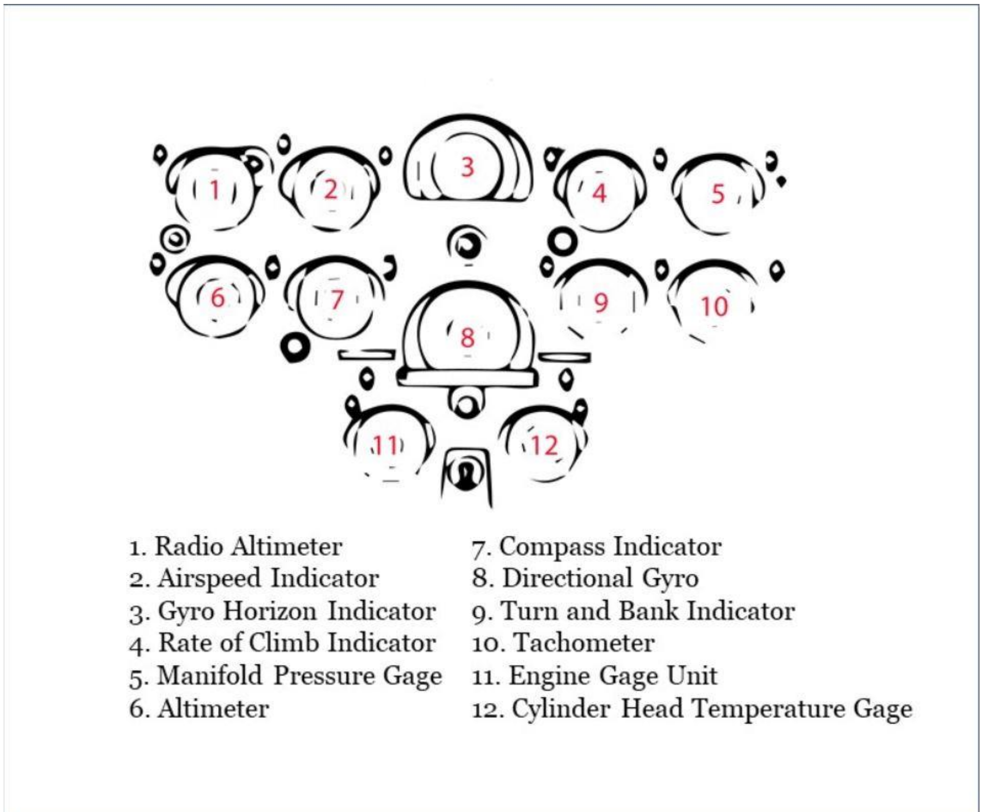

Figure 32. Diagram of F8F Bearcat Instrument Panel (Image created by author)

Figure 33. Instrument panel of F8F-2 Bearcat at the National Naval Aviation Museum (Image courtesy of Michael Boitnott).

Post-processing of the video data proved to be difficult with the limitation of dive times and the quantity of marine life present. Eventually, the author generated quality 3D models of the F8F Bearcat 1 fuselage and the F8F Bearcat 2 fuselage and landing gear components. Perhaps due to structural complexity and the presence of marine life, the engines remain unmodeled. The resulting 3D models provided great insights into the structural remains of the aircraft wrecks. Furthermore, the orthophotos and further processed technical drawings provided a way to determine what remains of the aircraft when overlaid with line plans of an F8F Bearcat. Combined with video provided by MBT Divers, these illustrations provide baseline data on contemporary states of preservation. The visual representations will allow future archaeologists to determine how quickly the aircraft are degrading.

CHAPTER VII: CONCLUSIONS AND RECOMMENDATIONS

Introduction

Site formation studies are necessary for understanding depositional and post-depositional processes which influence submerged historic aircraft over time. Chapter II demonstrated the evolution of aviation archaeology as a sub-discipline, and Chapter III illustrated that site formation studies have propelled to the forefront in submerged aircraft investigations. This thesis provides a method in which to study post-depositional cultural and environmental factors through photogrammetric methods. The research questions are reemphasized here:

- According to historical documents, what are the operational histories of the two submerged F8F Bearcats, and how did they end up on the seafloor?
- Utilizing photogrammetric modeling techniques, are cultural and environmental impacts of the F8F Bearcat wreck sites observable through time?

Identification

Aircraft identification is a preliminary and crucial step to determining site significance and when forming additional research questions. A combination of archival and archaeological examination was necessary to identify the F8F Bearcats. Naval aircraft can be categorized in three subcategories: 1) Class, 2) Type, 3) Bureau Number (BuNo). In this case, the Class and Type categories did not involve much investigation. The aircraft clearly had a single radial engine with a cockpit meant for one pilot; upon referencing site photographs with historic aircraft literature, the sites were undoubtedly F8F Bearcats. Diver-collected measurements confirmed structure specifications.

As detailed in Chapter VI, four F8F Bearcats were lost to the Gulf of Mexico from 1950 to 1952. Through cross-referencing historical documents, two BuNos were identified as the most likely to be associated with the wreck sites: BuNos 95495 and 95496. Although, the near vicinity of each wreck made further identifications improbable. On two separate dates in 1950, Midshipman Hosemann and Lieutenant Shade crashed into the Gulf of Mexico during carrier landings. It is curious that each aircraft lies upright when the BuNo 95496 aircraft accident report indicates that Lieutenant Shade's aircraft landed in the water inverted. Whether the aircraft righted itself on the way to the seafloor or was flipped upright during heavy storms is unknown. According to local divers the aircraft have not changed orientation, aside from sand accumulation, since they began diving on them in the 1980s.

Site Monitoring

Long-term in situ studies require consistent methods of monitoring site conditions and states of preservation. Photogrammetry is an instrumental tool in site monitoring applications and proved to be a useful means of gathering baseline visual data for comparisons during subsequent site visits. Unfortunately, due to complications of model rendering, the author was unable to determine changes in the site over time through photogrammetric methods as planned. Only one 3D model of each site, primarily the fuselages, was created successful. While the same collection methods were utilized each site visit, the amount of marine life surrounding the aircraft proved to be too noisy for Photoscan to process.

However, the successful models of each site provided baseline visual data to compare for future assessments. Additionally, the four site visits allowed the author to understand site stabilization or changes within the year. For example, the second site visit of F8F Bearcat 2 revealed a portion of a detached landing gear, which had previously been covered in sediment. Accumulation and scouring event impacts were noticeable throughout the year. Marine growth, aluminum corrosion, and underwater currents are the most apparent environmental factors which have affected the aircraft's preservation. Cultural factors include marine debris, such as the cinder blocks dropped on site to supplement marine ecosystems for fishing activities, as well as the occasional soda can. Opportunistic looting is also prevalent as many of the cockpit gauges have disappeared.

In reference to historical documentation, it is unclear what impacts may have occurred during the depositional wrecking event. One might assume that during a carrier landing failure, the landing gear would have torn away as a result of the tremendous force of hitting the water. It may also be assumed that the engine and attached propeller may also tear free. While both engines on site are detached from the engine mounts, it is uncertain whether this was the result of depositional or post-depositional events. The engines could have certainly torn free during large storm events many years after the accident. Large storm events have destroyed and rearranged portions of the wrecks since the 1990s, as demonstrated in the images provided by MBT Divers.

Implications for Aviation Archaeology

As archaeologists make strides toward standard methodologies in the aviation archaeology sub-discipline, further submerged historic aircraft studies provide for a larger data set to extrapolate from. The cultural and environmental processes affecting the two F8F Bearcats are perhaps unique to the specific region, or type of coastal setting. More so, the type of aircraft accidents, in this case carrier landings gone wrong, yields different pre-depositional and depositional characteristics than for example, an aircraft shot out of the sky with little to no control of the water impact. To go even further, other aircraft types most certainly break apart in varied ways resulting in a dissimilar dispersal of components. In short, aircraft wreck types have yet to be categorized descriptively by accident type. This study provides an example of one such category which may be built upon: failed carrier landings.

Utilizing photogrammetry in underwater archaeology is certainly not a new documentation method. Since this study began, there have been numerous studies involving photogrammetric modeling of shipwrecks and underwater structures. The National Park Service Submerged Resources Center has even uploaded 3D models of aircraft in Waikiki, Hawaii and Midway to their sketchfab account (https://sketchfab.com/submerged). This study attempted to generate a model from each site visit to determine replicability and comparability for minute site changes. Unfortunately, the methods, equipment, and software used in this study did not yield replicable results. With altered methods, and better camera equipment or software, photogrammetry is still considered an ideal site monitoring tool. Since most resource managers are more likely to study submerged historic aircraft *in situ*, photogrammetry provides a management tool, but also a way to share the site publicly.

Recommendations for Future Research

There are an unknown number of submerged historic aircraft off the coast of Pensacola and surrounding region. With the assistance of the diving community, the author has personally visited ten of these sites to date. To the author's knowledge, Pensacola has the largest concentration of submerged historic aircraft have undergone at least initial archaeological assessments. Most studies involve an isolated wrecking event, and yet in Pensacola there is potential to study an entire aviation training landscape. To truly understand the vast number of aircraft wrecks in the region, a systematic remote-sensing survey is necessary. First, a side-scan sonar combined with a multi-beam echo sounder survey would provide an overview of the potentially related debris in the vicinity. Upon verification of site extents, other sensors such as a magnetometer and sub-bottom profiler would offer data on the unique remote-sensing signatures of submerged aircraft.

Aside from an inventory of sites in the region, it is vital to continue contributing to the body of knowledge regarding submerged aircraft site formation. Studies of debris analysis and aluminum corrosion are instrumental in current methodologies and Pensacola has a wealth of submerged aircraft for potential comparative studies. For example, Vicki Richards and Jonathan Carpenter (2015) commenced aluminum degradation studies on five aircraft in Saipan. A similar study would be beneficial to understanding degradation rates of aircraft in the Pensacola region, but could also be used for global comparisons on sites in different environments (i.e. freshwater, deep water, anoxic, etc.).

Finally, to comprehend how naval aviation has influenced Pensacola's cultural and natural environment, a detailed archival survey would be prudent. The author discovered over seventy aircraft accident reports of naval aircraft crashing into the Gulf of Mexico off Pensacola. There was also an abundance of accidents on land that resulted in the losses of aircraft. This survey alone would provide a vast amount of data for several master's thesis.

The University of West Florida is in an ideal position to become a leader in the sub-discipline of aviation archaeology. The university's access to aviation cultural resources just off the coast of Pensacola is rivaled by no other archaeology program. It is the author's hope that others continue the research the author has established here.

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APPENDIX A

DOCUMENT TRANSCRIPTIONS

The Pensacola Journal

1950 The Pensacola Journal, *Gulf Crash Fatal for Navy Pilot*, 8 November. University of West Florida John C. Pace Library Microfilm Collection, Pensacola, Florida.

The Pensacola Journal

Fifty Fifth Year – No. 312 Pensacola Florida. Wednesday Morning, November 8, 1950

Front Page: Gulf Crash Fatal For Navy Pilot

Lt. Shade Dies Flying Off Carrier

Lt. (jg) Lester L. Shade, USNR, was killed Tuesday afternoon when his F8F Bearcat spun and crashed into the sea while approaching the USS *Wright* for a landing. Lt. Shade, a student naval aviator attached to the carrier qualification unit at Corry field, is the son of Mr. and Mrs. Forrest L. Shade of 25 Cherry Street, Union City, Pa. Shade was making practice carrier landings on the carrier *Wright* in the Gulf of Mexico in the vicinity of Pensacola when the crash occurred. The aircraft, a single seat Grumman fighter, sank almost immediately. Shade was not recovered. Shade attended Bucknell University and the University of Rochester and served in NROTC units at both schools. He received his commission as an ensign in June of 1947 upon graduation from the University of Rochester. He reported to the USS *Siboney* for duty and in 1948 was ordered to the destroyer *Buchanan*. In March of 1949 he reported to Pensacola for flight training. Shade had completed basic training at Pensacola and advanced training at Corpus Christi where he specialized in fighters. He had returned to Pensacola for carrier-qualification in combat type aircraft. He was 24 years old and unmarried.

The Pensacola News Journal

1952 The Pensacola Journal, *Crashes Kill Two Navy Pilots Here,* 22 April. University of West Florida John C. Pace Library Microfilm Collection, Pensacola, Florida.

The Pensacola Journal

Fifty-Seventh Year – No. 112 Pensacola, Florida, Tuesday Morning, April 22, 1952.

Front Page: Crashes Kill Two Navy Pilots Here

Two Navy pilots were killed in separate plane crashes Monday, one of them six days before he was to be married. Naval Aviation Cadet Clifton Heald Stowers Jr., 24 of Glencoe, Ill. Was instantly killed at 10 a.m. Monday. The F8F Grumman Bearcat, a single-seated fighter plane he was piloting, crashed and burned while making an approach in field carrier landing practice at Bronson Field, an auxiliary field of the Naval Air Station here. The cadet's net of kin is his father, Clifton Stowers Sr., of Glencoe. Cadet Stowers was to have been married Saturday, April 26, to Miss Mary Alice Edmonds, daughter of Mr. and Mrs. Arthur Sterling Brewer, 8 Elizabeth Place, Mobile, Ala. In the second crash, an unidentifi-

(Continued on Page Nine)

Page Nine: Crashes Kill Two Navy Pilots Here

(Continued from Page One)

fied student pilot was presumably killed at 4 p.m. when the F8F Bearcat fighter he was piloting crashed in the Gulf of Mexico and sank. The student was making his carrier approach to the USS *Cabot* when his plane hit the water, inverted, and sank. A search for the student was made by the destroyer USS *Healy* but no trace was found. It is presumed that he sank with the plane. Name of the student was withheld pending notification of next of kin.

U.S. Department of the Navy

1950 Deck log of the U.S.S. *Cabot*, 1 February. National Archives and Records Administration, College Park, MD.

[Title Page]

Log Book

Of the

U.S.S. *Cabot*

CVL-28

Commanded By

C. L. Lee, Captain, U.S.N.

Chief of Naval Air Basic Training – Division,

Attached to Chief of Naval Air Training – Squadron,

Commander Air Force – Flotilla

Atlantic – Fleet

Commencing 0001, 1 February, 1950,

At U.S. Naval Station, Key West, Florida

And ending 2400, 28 February, 1950,

At U.S. Naval Air Station, Pensacola, Florida

To be forwarded direct to the Bureau of Naval Personnel at the end of each month

Page 109: Deck Log – Remarks Sheet

United States Ship *Cabot* CVL-28 Monday 13 February, 1950

8 to 12

Steaming as before, steaming at various courses and speeds to clear Pensacola inner Harbor.

0803 Pensacola light abeam to starboard. Distance 950 yards. 0821 Passed Buoy 1-A abeam to starboard distance 100 yards. Entered International Waters. Set course to 152° PGC and 143° PSC, speed 12 knots, 122 rpm. Secured special sea details. 0822 Went to flight quarters. USS *Corry* took plane guard station. 0835 Flight of five F8F type aircraft arrived over ship from U.S. NAS, Corry Field. Commenced carrier qualifications. 0855 Made daily inspection of magazines and smokeless powder samples, conditions normal. 0922 F8F BuNo. 95494, Pilot Hosemann, L.J. MIDN, USN, crashed in the sea, at Latitude [redacted]; Longitude [redacted]. Pilot recovered uninjured by USS *Corry*. 0930 Resumed course 155° PGC, 146° PSC, speed 10 knots, 101 rpm. USS *Corry* took plane guard station. Resumed carrier qualifications. 0940 F8F flight returned to

Corry Field. 0945 Flight of 6 F4U type aircraft arrived over ship from Corry Field. Commenced carrier qualifications. 1032 Changed course to 331° PGC, 329° PSC, increased speed to 15 knots, 152 rpm. 1042 Changed course to 153° PGC, 144° PSC, changed speed to 10 knots, 101 rpm. 1139 Completed qualifications. Flight returned to Corry Field. Changed course to 333° PGC, 330° PSC, increased speed to 18 knots, 183 rpm. 1142 Secured from Flight quarters.

Average rpm, 111, average steam 600.

[Signed]

C.H. Stephens,

LTJG., U.S. Navy

Approved: [Signed] — Examined: [Signed]

C.L. Lee, Captain, U.S.N. Commanding — R. K. Gould, CDR., Navigator

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U.S. Department of the Navy

1950 Deck log of the U.S.S. *Wright*, 1 November. National Archives and Records Administration, College Park, MD.

[Title Page]

Log Book

Of the

U.S.S. *Wright*

CVL-49

Commanded By

Captain B. B. Nichol, U.S.N.

– Division,

Attached to – Squadron,

– Flotilla

CINCLANT – Fleet

Commencing 0001, 1 November, 1950,

At Pensacola, Florida

And ending 2400, 30 November, 1950,

At Pensacola, Florida

To be forwarded direct to the Bureau of Naval Personnel at the end of each month

Page 621A: Deck Log – Remarks Sheet

United States Ship *Wright* CVL-49 Tuesday 7 November, 1950

12 to 6

Steaming as before. 1204 Chagned course to 145 (T) and (pgc), 140 (psc), changed speed to 17 kts. (159 RPM), resumed flight operations steering various course at various speeds into the wind while operating aircraft. 1334 Ceased flight operations temporarily, changed course to 340 (T) and (pgc), 336 (psc). 1339 Changed speed to 25 kts. (239 RPM). 1346 Changed speed to 29kts. (279 RPM). 1430 Changed course to 160 (T) and (pgc), 157 (psc), resumed flight operations steering various courses at various speeds into the wind while operating aircraft. 1440 One (1) F8F type aircraft Bureau #95496, pilot LTJG. L. L. Shade, 0501419, USN, crashed into water on port quarter of ship while making approach for landing. The plane guard, USS *Gainard* (DD-706), investigated scene of crash: plane sank immediately, pilot not recovered, cause of crash undetermined. Location of crash scene; [redacted]. 1440 Stopped main engines. 1445 All engines ahead to 15 kts. (140 RPM), commenced circling scene of crash. 1512 Changed speed to 20 kts. (188 RPM), resumed flight operations, steering various courses at various speeds into the wind while operating aircraft. 1528 Secured flight operations, changed course to 315 (T) and (pgc), 312 (psc). 1539 Changed speed to 25 kts. (239 RPM).

[Signed]

T. S. Hesse

LTJG., USN.

Approved: [Signed] Examined: [Signed]

B. B. Nichol, Captain, U.S.N. Commanding D. L. Soper, CDR., U.S.N. Navigator

U.S. Department of the Navy

1951 Deck log of the U.S.S. *Monterey*, 1 April. National Archives and Records Administration, College Park, MD.

[Title Page]

Log Book

Of the

U.S.S. *Monterey*

CVL-26

Commanded By

Donald Lewis Mills, Captain, U.S.N.

	– Division,	
Attached to	– Squadron,	
	– Flotilla	
	– Fleet	

Commencing 0001, 1 April Sunday, 1951,

At United States Naval Air Station Pensacola, Florida

And ending 2400, 30 Monday April, 1951,

At United States Naval Air Station Pensacola, Florida

To be forwarded direct to the Bureau of Naval Personnel at the end of each month

Page 311: Deck Log – Remarks Sheet

United States Ship *Monterey* CVL-26 Wednesday 18 April, 1951

0835 to 1220

Steaming as before. 0849 Changed course to 210° (T) (PGC), 204° (PSC). 0856 Chagned course to 111° (T) (PGC) 108° (PSC). 0901 Commenced flight operations, average course 112° (T) (PGC), 109° (PSC) average speed 8 knots 095 RPM. 0930 Secured from general quarters. 1000 Made daily inspection of magazine. Conditions normal. 1047 Ceased flight operations set course 304° (T) (PGC), 301° (PSC). Set speed 18 knots 185 RPM. 1054 Changed speed to 22 knots 230 RPM. 1124 Resumed 196 RPM. 1156 F8F° BuNo 94901, Pilot C.J. Gulshen, NavCad, USN crashed into the sea forward of ship after receiving wave off from Landing Signal Officer. Pilot reported to have received only minor laceration, plane lost (Long [Redacted], Lat [Redacted]) Commenced maneuvering on various courses and at various speeds to keep pilot in sight. 1212 Pilot recovered by U.S.S. *Douglas H. Fox* (DD779). Set course 124° (T) (PGC), 123° (PSC), average speed 15 knots 152 RPM. 1220 Changed speed to 18 knots 185 RPM. 1222 Resumed flight operations. Average course 121° (T) (PGC), 120° (PSC). Average speed 21 knots 218 RPM. 1236 Ceased flight operations. Set course 289° (T) (PGC), 286° (PSC). Set speed 25 knots 258 RPM.

[Signed]

R. P. Swanson

LTJG., U.S. Navy

Approved: [Signed] Examined: [Signed]

D. L. Mils, Capt, U.S.N. Commanding G. W. Smith, CDR., U.S.N. Navigator

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U.S. Department of the Navy

1952 Deck log of the U.S.S. *Cabot*, 1 April. National Archives and Records Administration, College Park, MD.

[Title Page]

Log Book

Of the

U.S.S. *Cabot*

CVL-28

Commanded By

E. H. Eckelmeyer, Captain, U.S.N.

Chief of Naval Air Basic Training– Division,

Attached to – Squadron,

– Flotilla

Atlantic – Fleet

Commencing 0001, 1 April, 1952,

At U.S. Naval Air Station, Quonset Point, Rhode Island,

And ending 2400, 30 April, 1952

At U.S. Naval Air Station Pensacola, Florida

To be forwarded direct to the Bureau of Naval Personnel at the end of each month

Page 331: Deck Log – Remarks Sheet

United States Ship *Cabot* CVL-28 Monday 21 April, 1952

16 to 20

Steaming as before. 1601 Spaeth, M.S., Naval Cadet, flying F8F type aircraft, bureau number 95134, crashed in the water on port quarter while making a carrier landing approach. Distance from ship: Thirty (30) yards. USS *Healy* (DD-672) dispatched to scene of crash but failed to recover pilot. Plane sank immediately in latitude [redacted]; longitude [redacted] in 100 fathoms of water. Changed course to 330° (t) and (pgc). Completed carrier qualification landings. 1616 Changed speed to 26 knots (265 RPM). 1713 Changed course to 135° (t) and (pgc). 1717 Commenced launching three (3) aircraft. 1719 Changed course to 330° (t) and (pgc). 1719 Completed launching aircraft. 1731 Set the special sea and anchor details. 1735 Changed course to 340° (t) and (pgc). 1741 Secured from flight quarters. 1743 Captain at the conn. Executive Officer, prospective Commanding Officer and Navigator on the bridge, leadsman in the chains. 1746 Buoy "1-A' abeam to port. Commenced using various courses and speeds to conform with the channel. Entering Pensacola Bay. 1815 All engines stop. Dropped port anchor in seven (7) fathoms of water, hard sand bottom with sixty (60) fathoms of chain to the waters edge on the following bearings: Coast Guard Tower, 174° (t); Pensacola light, 279.5° (t); Naval Air Station Stack, 311° (t); Fair Point, 056 3/4° (t). 1817 Secured the special sea and anchoring details.

[Signed]

I. Patch Jr.,

ENS., U.S. Navy

Approved: [Signed] Examined: [Signed]

M. P. Evenson, Captain, U.S.N. Commanding E. M. Padget, LCDR., U.S.N. Navigator

U.S. Navy Bureau of Aeronautics

1950 Navy Aircraft Accident Report of F8F-1 Bearcat, BuNo 95495, 13 February. Naval History and Heritage Command Archives, Microfilm Collection, Washington D.C.

Date: 13 February 1950 **Hour:** 0921 **Location:** USS *Cabot*

Pilots's Name, Rank, Service Group & Unit to Which Pilot Attached:
Hosemann, Leland S., Mid, USN CQTU-4

Unit to Which Aircraft Assigned: **Operating From:**
CQTU-4. NAAS, Corry Fld., CNABT, CNAT, BUAER, CNO

Purpose: CQ
Serial No.: 17-50

Ceiling: Unl.
Visibility: Unl.
Wind: L-90
Force: 20
Darkness: No

Weather at Time of Accident: Contact
Type of Clearance: Contact

Maneuver at Time of Accident: Carrier Approach – 125'
Angle of Impact, Stopping Dist, Est. Speed: 30° ----------- 85 kts.

Total Hours: 292.4
Total Hours This Model: 80.4
Total Hrs. Last 3 Months: 48.9

Hrs This Model Last 3 Months: 48.9
Time in Flight: 51 Min

Previous Accident Record: [None]
Injuries to Pilot: None

Name, Rank of Other Personnel: [None]
Their Notes: [None]

Aircraft Model & No.: F8F-1 #95495
Did Fire Follow Impact: No
Was Parachute Used: No

Damage: A
Damage Description: Strike

Specific Type Accid:
[Illegible]

Cause Analysis
[Illegible]

Classification of Accident Causes:
PE (Judg or Tech)

Notes:
Spec. Errors – Pilot Overcontrolled while making correction from what he believed to be stalled condition of his a/c.
Check off Items – Pilot hit a spot of very ruff air which caused his left wing to drop while he was making a carrier approach. Pilot thought airplane was stalled & overcontrolled his correction action.
Analysis – Pilot was engaged in making qual. Landings abd the USS *Cabot*. He had made 6 previous landings. On this approach he had reached the 90° position when he picked up the LSO who was giving a high dip signal to the pilot. Pilot started to answer the high dip, but just as he had lowered his nose left wing of his a/c dropped. Plane seemed to pilot to be stalled; so pilot dropped his nose even further, kicked full right rudder, & applied full throttle. However, he was unable to affect recovery before flying into water.
It is the opinion of this bd that a/c did not actually stall. Instead, wing dropped purely as result of gusty air. Pilot was wrong when he diagnosed the ruff air as a stalled condition of his a/c. The sudden application of full throttle caused a torque roll from which pilot was unable to recover in time to avoid flying into water.
Spec. Equip – Shoulder harness & life jacket effective
CO – Student remanded to SPDS which awarded him one period of familiarisation, 2 [?] periods of extra time & recheck. Failure to pass this recheck will result in automatic dropping of student from flight program. Analysis of x-dent posted on squad safety bul. Bd.

U.S. Navy Bureau of Aeronautics

1950 Navy Aircraft Accident Report of F8F-1 Bearcat, BuNo 95495, 13 February. National Archives and Records Administration, College Park, MD.

[Additional Information available on hard copy of Aircraft Accident Report]

Engine:	**Engine Manufacturing Number:**
R2800-34W	P-55346

Pilot's statement in regard to aircraft accident of F8F-1 KA-103 occurring aboard the USS *CABOT* on 13 February 1950

I started at my 180 degree abeam position at 85 knots and 150 feet altitude. At the 90 degree position I picked up the LSO with a high; then my left wing dropped. I added full power with full right rudder and stick but was unable to maintain flight and went nose down into the water.

[Signed]
Leland J. Hosemann
MidN. USN

LSO's statement in regard to aircraft accident of F8F-1 KA-103 occurring aboard the USS *CABOT* on 13 February 1950. Pilot HOSEMANN

Subject pilot had started his turn from the 180 degree position and was slightly high. As he approached the 090 degree position, he was in a flat attitude and was given a "high-dip" signal. The pilot lowered his nose slightly to answer this signal and at the same instance his port wing dropped. He immediately applied full throttle and picked up his nose slightly. The port wing tucked under more and the plane hit the water in a left wing nose down attitude.

At the time the pilot received the "high-dip" signal he was not in or approaching a three-point attitude, which is evident he was not slow.

[Signed]
Emmet B. LAWRENCE
Lt. USN

HEADQUARTERS
NAVAL AIR BASIC TRAINING COMMAND
U.S. NAVAL AIR STATION
PENSACOLA, FLORIDA

7 March 1950

FIRST ENDORSEMENT on CQTU-4 AAR Serial No. 17-50, F8F-1 Aircraft BuNo. 95495

From: Chief of Naval Air Basic Training
To: Chief of Naval Operations (Op-531D)

Subj: Aircraft Accident Report: forwarding of

1. Noted that although "Very Rough Air" is listed as an item having bearing on this accident, no Aerologists Statement is attached in compliance with ACL 119-45; however, in order to avoid further delay, subject AAR is forwarded herewith, uncorrected.

[Signed]
L. H. Mc ALPINE
By direction

U.S. Navy Bureau of Aeronautics

1950 Navy Aircraft Accident Report of F8F-1 Bearcat, BuNo 95496, 7 November. Naval History and Heritage Command Archives, Microfilm Collection, Washington D.C.

Date: **Hour:** **Location:**

7 November 1950 1430 USS *Wright*

Pilots's Name, Rank, Service Group & Unit to Which Pilot Attached:
Shade, Lester L., LTJG, USN, CQTU-4

Unit to Which Aircraft Assigned: **Operating From:**
CQTU-4. NAAS, Corry Fld., CNABT, CNAT, BUAER, CNO

Purpose: **Serial No.:**
1-D-4 CQ L-1 111-50

Ceiling:	**Visibility:**	**Wind:**	**Force:**	**Darkness:**
Unl.	10	6°	28 k	No

Weather at Time of Accident: **Type of Clearance:**
Contact Contact

Maneuver at Time of Accident: **Angle of Impact, Stopping Dist, Est. Speed:**
Carrier Ldg. 90° Nose Down 15° Inverted, 30', 50 k

Total Hours: **Total Hours This Model:** **Total Hrs. Last 3 Months:**
340.8 115.6 124.4

Hrs This Model Last 3 Months: **Time in Flight:**
115.6 5 Min

Previous Accident Record: **Injuries to Pilot:**
[None] Lost to Sea

Name, Rank of Other Personnel: **Their Notes:**
[None] [None]

Aircraft Model & No.: **Did Fire Follow Impact:** **Was Parachute Used:**
F8F-1 #95496 No [Blank]

Damage: **Damage Description:**
A Strike

Specific Type Accid:
[Illegible]

Cause Analysis
[Illegible]

Classification of Accident Causes:
PE: Judgement or tech.

Notes:
Spec. Errors – The cause of this accident can not be conclusively determined.
Description – LTJG Shade was picked up by the LSO with a "roger". As the LSO was about to give the pilot a fast signal, the plane executed a fast half snap roll to the left and apparently entered the water inverted at about a 15° angle. The pilot apparently applied full power halfway through its roll and held full power on as plane hit the water.
Analysis – 1. All witnesses to this accident state that the plane was in a slightly fast and flat altitude. 2. It is the opinion of the Safety Bd that the pilot increased his angle to bank and increased the back pressure on the stick to avoid overshooting on his approach. 3. By increasing the angle of bank and also momentarily increasing the "G" on the plane the pilot caused the aircraft to stall. 4. Addition of full power as the plane stalled or prior to the stall is believed to be a contributing factor. Just prior to the stall the pilot possibly felt "uncomfortable" and added power. In such a situation the F8F is very susceptible to torque roll.
Local Rec: That is accident be brought to the attention of all students and instructors in this unit.
CO – As of this date, no positive or definite reason as to the cause of this accident other than as indicated in the report, can be determined. An adm. Report is being submitted in accordance with Naval

(Over)

[Document indicates there may have been information on the opposite side]

U.S. Navy Bureau of Aeronautics

1950 Navy Aircraft Accident Report of F8F-1 Bearcat, BuNo 95496, 7 November. National Archives and Records Administration, College Park, MD.

[Additional Information available on hard copy of Aircraft Accident Report]

Engine:	**Engine Manufacturing Number:**
R2800-34W	P-53988

Local Action and General Recommendations:
As of this date, no positive or definite reasons as to the cause of this accident other than as indicated in the report, can be determined. An administrative report is being submitted in accordance with Naval Courts & Boards instructions. Salvage operations were initiated, but were unsuccessful and have since been discontinued. Unless further circumstances contributory to this accident can be established, no further report will be submitted and this will be considered a final AAR. 11-15-50

LSO's Statement Regarding Aircraft Accident of F8F-1 BuNo 95495, aboard the USS *Wright*, at 1430, on 7 November 1950.

I was one of the Landing Signal Officers standing on the platform of the USS *WRIGHT* when LTJG SHADE was making Carrier Qualification Landings. At the time I was manning the radio on the platform. SHADE's approach was normal in all respects and the Landing Signal Officer with the paddles picked him up at the ninety degree position with a "roger." Just after he left the ninety degree position his plane rolled abruptly to the left and entered the water on his back and slightly nose down. Full power seemed to be applied about halfway through the roll. The plane sank immediately.

[Signed]
R. E. Gallatin
Lt. U.S.N.

U.S. Navy Bureau of Aeronautics

1951 Navy Aircraft Accident Report of F8F-1 Bearcat, BuNo 94901, 18 April. Naval History and Heritage Command Archives, Microfilm Collection, Washington D.C.

Date: 18 April 1951
Hour: 1156
Location: USS *Monterey* [Long., Lat., Redacted]

Pilots's Name, Rank, Service Group & Unit to Which Pilot Attached:
Gulshen, Francis J., N/C USNR CQTU-4

Unit to Which Aircraft Assigned: **Operating From:**
CQTU-4. NAAS, Corry Fld., CNABT, CNAT, BUAER, CNO

Purpose: CQ
Serial No.: 29-51

Ceiling: Unl.
Visibility: 10
Wind: **Force:** Not Pertinent
Darkness: No

Weather at Time of Accident: Contact
Type of Clearance: VFR

Maneuver at Time of Accident: Upwind Turn of CL pattern
Angle of Impact, Stopping Dist, Est. Speed: 20-30° - Undet – 85 kts

Total Hours: 327.8
Total Hours This Model: 111.1
Total Hrs. Last 3 Months: 94.3

Hrs This Model Last 3 Months: 93.3
Time in Flight: 0-24

Previous Accident Record: None
Injuries to Pilot: [None]

Name, Rank of Other Personnel: [None]

Their Notes: [None]

Aircraft Model & No.: F8F-1 #94901

Did Fire Follow Impact: No

Was Parachute Used: No

Damage: A

Damage Description: Strike

Specific Type Accid:
Spun in on upwind [x-leg?] cross-controlled

Cause Analysis
[Illegible]

Classification of Accident Causes:
Spun as result of slip, steep bank, probably excited over previous 8 wave offs.

Notes:
Accident – Pilot had taken 8 consecutive waveoffs & was in the upwind turn of his 9th pass when the x-dent occurred. On his upwind leg he was maintaining 100 kts indicated airspd while using full R rudder and R aileron tab. At the 90° position of upwind turn the airspd was 90-95 kts, a/c was in 30-40° bank, & tab settings were full right rudder & full right aileron. As pilot started to roll out of this turn onto downwind leg the left wing stalled, dropped sharply & a/c started to spin. Full opposite rudder, forward stick & full power were applied & L wing had started to come up when a/c hit water on left wing & engine. Pilot evacuated the a/c as it started to sink & was picked up by plane guard destroyer.
Analysis – Tab settings were excessive for spd & power being maintained. The student had taken waveoff to left & in his upwind turn, instead of making standard turn & dog-legging back to downwind leg, he attempted to make steep turn directly to the downwind leg. There is no reason for ever exceeding a 20° bank on any turn in a correctly flown carrier landing pattern. With the combination of steep turn & excessive tab settings it is felt that student was flying in slip during the late stages of his upwind turn. Even the turn was started at safe spd & power was not reduced, the a/c decelerated rapidly due to the combination of a steep turn plus an unbalanced flight attitude. It is felt that a/c had decelerated to near stalling spd & as pilot applied right aileron to roll out of the turn, drag induced by down left aileron (over)

[Page 2]

Conclusions & Rec – Primary cause of this x-dent was excessive angle of bank in upwind turn. Excessive tab settings were probably contributing factor.

It is recommended that instructors continue to stress the importance of making standard shallow turns through the pattern & fact that stalling spd increases as angle of bank increases. It is recommended that this AAR, especially pilots statement, be distributed to all activities concerned with carrier aviation throughout Nav Service.

CO – Concur.

U.S. Navy Bureau of Aeronautics

1952 Navy Aircraft Accident Report of F8F-1 Bearcat, BuNo 95134, 21 April. Naval History and Heritage Command Archives, Microfilm Collection, Washington D.C.

Date: 21 April 1952
Hour: 1601
Location: USS *Cabot* [Long., Lat., Redacted]

Pilots's Name, Rank, Service Group & Unit to Which Pilot Attached:
Spaeth, Milton, Stanley, N/C 7554941 CQTU-4

Unit to Which Aircraft Assigned: **Operating From:**
CQTU-4. NAAS, Corry Fld., CNABT, CNAT, BUAER, CNO

Purpose: Carrier Qual. L-1 1D4
Serial No.: 48-52

Ceiling: Unl.
Visibility: 10
Wind: 5
Force: 31 k
Darkness: No

Weather at Time of Accident: Contact
Type of Clearance: VFR

Maneuver at Time of Accident: Carrier Approach
Angle of Impact, Stopping Dist, Est. Speed: 10-15°, Undeterm, 80 kts

Total Hours: 310.2
Total Hours This Model: 115.2
Total Hrs. Last 3 Months: 114.5

Hrs This Model Last 3 Months: 108.4
Time in Flight: 00-54

Previous Accident Record: [None]
Injuries to Pilot: [None] Lost at Sea

Name, Rank of Other Personnel: LSO/Capt. H. B. Stuckey
Their Notes: D-Spin in flight CV approach

Aircraft Model & No.: F8F-1 #95134
Did Fire Follow Impact: No
Was Parachute Used: No

Damage:
Damage Description:

A Strike

Specific Type Accid:
At about 70° [illegible]; spun in inverted.

Cause Analysis
Possible slipstream, put on power before levelling wings, too slow with the power, [illegible] & took off power.

Classification of Accident Causes:
PE

Notes:
Accident – NavCad Spaeth, M. C., was attempted to qualify on the USS *Cabot* (CVL 26) at the time the accident occurred. On his second approach he pressed through the ninety degree position in about a ten degree bank. At the seventy degree position in the approach, the a/c wing dropped to a fifteen to twenty degree bank. As the wing dropped the student was first given a "come on" by the ldg signal officer, followed by a reverse slant signal. The ldg signal officer handling the radio also told the student to roll his wings level. At about the same time as the come-on and reverse slant signals were given by paddles the student applied full power with left wing down about twenty degrees, without any apparent attempt to level the wings first in answer to the reverse slant signal. With the sudden application of full power in a left turn the a/c torque rolled to an inverted position and struck the water in an inverted attitude with full power on. The a/c sank in approximate ten seconds. The student pilot was not recovered.
Analysis – The student started his approach fast, and shortly after passing through the ninety degree position, the a/c either hit slip stream or stalled, causing the left wing to drop. After the left wing dropped the student applied power too rapidly prior to leveling his wings with a resultant torque roll. Power eq- was not reduced, and the a/c rolled inverted and settled into the water in a flat inverted attitude. Since neither pilot nor a/c was recovered no evidence is available to determine the effectiveness of the safety belt, shoulder harness and protective helmet.

[Page 2]

Conclusions – The board concludes that the primary factor causing this accident was pilot error. The student errored in failing to level wings prior to adding power and then added full power causing a torque stall. It cannot be determined if the student pilot attempted any recovery once the torque stall developed, however, no attempt at recovery was apparent to any of the witnesses. The board further concludes that slipstream in the approach pattern may have been a contributing factor causing the let wing to drop initially.
The board recommends that instructors of this unit will continue to stress to students the adverse torque effect inherent in this type a/c.
The board further recommends that a copy of this AAR be routed to all instructors and students in this unit.
Spec. Equip – Shoulder harness & life jacket effective
CO – Forwarded.

U.S. Navy Bureau of Aeronautics
1947 Aircraft History Card of F8F-1 Bearcat, BuNo 95495. Naval History and Heritage Command Archives, Microfilm Collection, Washington D.C.

Serial No. 95495 **Model** F8F-1 **Contract No.** NOa (s) 4799

Acceptance Date 8/29/47 **STRICKEN** 2-50

Delivery Date [None]

Date In	**Units**	**Date Out**
[No Date]	[In Del?]	[No Date]
[No Date]	Pool Norfolk	[No Date]
[No Date]	VF 4A	[No Date]
1948	VF 4A	[No Date]
[No Date]	Pool FASRON 1	[No Date]
[No Date]	[Onrt Blwn act?]	3-9-48
[No Date]	VA-3A	[No Date]
[No Date]	VF 171 ~~17A~~	[Quonset?]

Aircraft History Card NAVAER -1925 (9-44)

U.S. Navy Bureau of Aeronautics
1947 Aircraft History Card of F8F-1 Bearcat, BuNo 95495. Naval History and Heritage Command Archives, Microfilm Collection, Washington D.C.

Serial No. 95496 **Model** F8F-1 **Contract No.** NOa (s) 4799

Acceptance Date 8/28/47 **STRICKEN** 11-50 CQTU-4 Corry Field

Delivery Date [None]

Date In	**Units**	**Date Out**
[No Date]	[In Del?]	[No Date]
[No Date]	Pool Fasron-3	[No Date]
[No Date]	VF 10A	[No Date]
1948	[Enrt Bet Acl?]	[No Date]
[No Date]	Pool Norfolk	[No Date]

[No Date]	[Para Exp Unit?]	El Centro

Aircraft History Card NAVAER -1925 (9-44)

U.S. Navy Bureau of Aeronautics
1945 Aircraft History Card of F8F-1 Bearcat, BuNo 94901. Naval History and Heritage Command Archives, Microfilm Collection, Washington D.C.

Serial No. 94901 **Model** F8F-1 **Contract No.** NOa (s) 4799

Acceptance Date 10-25-45 **STRICKEN** 4-51 CQTU-4 Corry Field

Delivery Date 11-20-45

Date In	**Units**	**Date Out**
[No Date]	[In Del] New York	[No Date]
'46	[Illegible] / San Diego	[No Date]
6/27/46	Repair Alameda	[No Date]
[No Date]	Under Recons Alameda	[No Date]
[No Date]	Repair Alameda	[No Date]
[No Date]	Pool Fasron 8	[No Date]
[No Date]	VF 11A	[No Date]
1947	VF 11A	[No Date]
[No Date]	Pool Fasron-7	[No Date]
[No Date]	VF 14A	[No Date]
1948	[Pl?] Alemeda	[No Date] (Time in Status: O/H 7/30/48)
[No Date]	VF 12 ABD Tarawa	[No Date]

Aircraft History Card NAVAER -1925 (9-44)

U.S. Navy Bureau of Aeronautics
1946 Aircraft History Card of F8F-1 Bearcat, BuNo 95134. Naval History and Heritage Command Archives, Microfilm Collection, Washington D.C.

Serial No. 95134 **Model** F8F-1 **Contract No.** [Illegible]

Acceptance Date 8-12-46 **STRICKEN** 4-52 CQTU-4 Corry Field

Delivery Date [None]

Date In	**Units**	**Date Out**

[No Date]	Repair Norfolk	[No Date]
[No Date]	Pool Norfolk	[No Date]
[No Date]	VF-3	[No Date]
[No Date]	V7-3A	[No Date]
1947	VF 3A	[No Date]
1948	VF 3A	[No Date]
1948	Pool Norfok	[No Date]

(Time in Status: O/H 3-9-49)

Aircraft History Card NAVAER -1925 (9-44)