

WINGS BENEATH THE SEA:
the aviation archaeology of Catalina flying boats in Darwin Harbour,
Northern Territory

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I hereby declare that the work herein, now submitted as a thesis for the degree of Master of Arts by research is the result of my own investigations, and all references to ideas and work of other researchers have been specifically acknowledged. I hereby certify that the work embodied in this thesis has not already been accepted in substance for any degree, and is not being currently submitted in candidature of any other degree.

Silvano Jung

LEST WE FORGET

Royal Australian Air Force

A24-206

No. 123199 Leading Aircraftman Richard Lewis Graham

No. 131729 Leading Aircraftman Walter Alexander Strang

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ABSTRACT

Darwin Harbour, in Australia's Northern Territory, is reported to have seven Catalina Flying Boats that were lost during and shortly after World War Two. Five have been found, but their identification remains a puzzle. This thesis tests if a combined historical and archaeological study can identify the wreck sites and link history to otherwise amorphous assemblages on the harbour floor. This is the first study in Australia of an emerging science called aviation archaeology, which challenges previous attitudes and practices regarding aircraft wreck sites.

The United States Navy lost three Catalinas on 19 February 1942. The RAAF are reported to have lost four throughout 1945. The US Navy Catalinas were, hence, early types, whereas the RAAF had lost more advanced machines. This thesis examines the attributes of the different types of Catalinas that were lost and determines if this is a viable method for identifying the wreck sites.

The historical record relating to the Darwin Harbour Catalina losses is compiled and analysed for clues in the identification of the archaeological material found on the wreck sites today. This searching, prior to undertaking wreck inspections, has uncovered new information regarding the fate of one RAAF Catalinas that forces archaeologists and historians to re-evaluate the events that occurred in Darwin Harbour during World War Two.

In this thesis the assemblages on the harbour floor are linked to their individual histories. This has implications for their management as important places in the Northern Territory. The wreck sites represent the only tangible remains of the recent, but now forgotten Flying Boat history of the Northern Territory. They are an important archaeological resource and their condition suggests that they are also rare.

The results of this thesis, furthermore, suggests how the wreck sites can be managed and argues why they should be recognised as heritage places under the *Northern Territory Heritage Conservation Act 1991* (NTG 1991). The ultimate outcome of this thesis, however, is that this research will act as a starting point for the closure to the Catalina puzzle, by identifying the places where important events happened and in particular, where two RAAF fatalities occurred. This indicates that the place (wreck site) where death occurs is equally important to relatives as where the bodies are buried.

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LIST OF ABBREVIATIONS

1FBRD	Number 1 Flying Boat Repair Depot (Lake Boga)
2FBRD	Number 2 Flying Boat Repair Depot (Rathmines)
2FBMU	Number 2 Flying Boat Maintenance Unit (East Arm, Darwin Harbour)
AA	Anti Aircraft
ACMM	Aviation Machinist Mate
A/G	Air Gunner
AHSNT	Aviation Historical Society of the Northern Territory
AMM1/c	Aviation Machinist Mate 1st class
APU	Auxilliary Power Unit
AOB	Advanced Operations Base
AOM2/c	Aviation Ordinance Mate 2nd Class
ASR	Air Sea Rescue
ASRF	Air Sea Rescue Flight
ASV	Air to Surface Vessel (radar)
ATIS	Allied Translator and Interpreter Secition
AV	Seaplane Tender
AVP	Small Seaplane Tender
AWM	Australian War Memorial
BUAERNO	Bureau of Aeronautics Number
DD	Naval Destroyer
DPIF	Department of Primary Industries and Fisheries
ENS	Ensign
FAW	Fleet Air Wing
FBB	Flying Boat Base
F/Lt	Flight Lieutenant
F/O	Flight Officer
F/SGT	Flight Sergeant
FTR	Failed to Return
IJN	Imperial Japanese Navy
LAC	Leading Aircraftman
LT	Lieutenant
Lt (jg)	Lieutenant Junior Grade
MAGNT	Museum and Art Gallery of the Northern Territory
MLD	Marine Luchtvaart Dienst (NEI Marine Air Service)
NAP	Naval Aviation Pilot
NEI	Netherlands East Indies
NT	Northern Territory
NYRBA	New York, Rio and Buenos Aires Airline

OBU(s)	Operations Base Unit (plural)
PA	Public announcement
PatWing-10	Patrol Wing Ten
PBY	Patrol Bomber Consolidated
POWs	Prisoners of war
PPC	Patrol Plane Commander
QANTAS	Queensland and Northern Territory Airways Service
RAAF	Royal Australian Air Force
RAN	Royal Australian Navy
RANR	Royal Australian Navy Reserves
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
RFS	Recreational Fishing Section
RM1/c	Radio Man 1st class
RNNAS	Royal Netherlands Naval Air Service
RNNS	Royal Netherlands Naval Service
SCUBA	Self Contained Underwater Breathing Apparatus
SGT	Sergeant
USAAF	United States Army Air Force
USAT	United States Army Transport
USN	United States Navy
USS	United States Ship
VP	Patrol Squadron
WW2	World War Two

CHAPTER 1: INTRODUCTION

1.1 Research aims

The aim of this thesis is to verify the identity of five World War Two (WW2) Catalina Flying Boat wreck sites in East Arm, Darwin Harbour (Fig. 1), by using a combined historical and archaeological research paradigm. This will, for the first time, document and link their history to wreck sites in the harbour. These wreck sites, together with many other types of aircraft in the harbour, are lost in living memory. Significantly, the Catalinas are the only located aircraft wreck sites in Darwin Harbour (Jung 1996a) and as a result, have become the subject of speculation as their origins amongst maritime archaeologists, historians, cultural resource managers and the general public. This is a study in what has become known as aviation archaeology, but one which is distinctly different to previous studies of aircraft wreck sites in Australia. The definition of aviation archaeology will be investigated and it is demonstrated in this thesis that the research value of aviation archaeology has undergone a re-evaluation as an important and scholarly study towards understanding the recent past. Aviation archaeological research in Darwin Harbour can provide closure to many misconceptions as to the extent of this type of cultural resource in East Arm and aid in their management as a cultural resource.

Aviation archaeology, however, is still characterised as a salvage operation, predominantly focused on the recovery of human remains without regard for their context (Prossor 2001:77). The archaeological information that aircraft wreck sites contains about the society and the circumstances of the loss of aircrew is not considered by wreck salvors, who seek only to recover artefacts and are unaware of the research potential that those artefacts contain while *in situ*. (Robinson 1977). Consequently, once wreck sites have been cleared of human remains, their condition is left unrecorded (Eames 1999; Vetaffairs 2000:5). This thesis uses historical and archaeological research to demonstrate that aircraft wrecks can provide as much information about past human behaviour as a shipwreck site.

Studying underwater aircraft wreck sites in particular, also challenges the notions of accepted perceptions of what is maritime archaeology, indicating that there are other maritime activities,

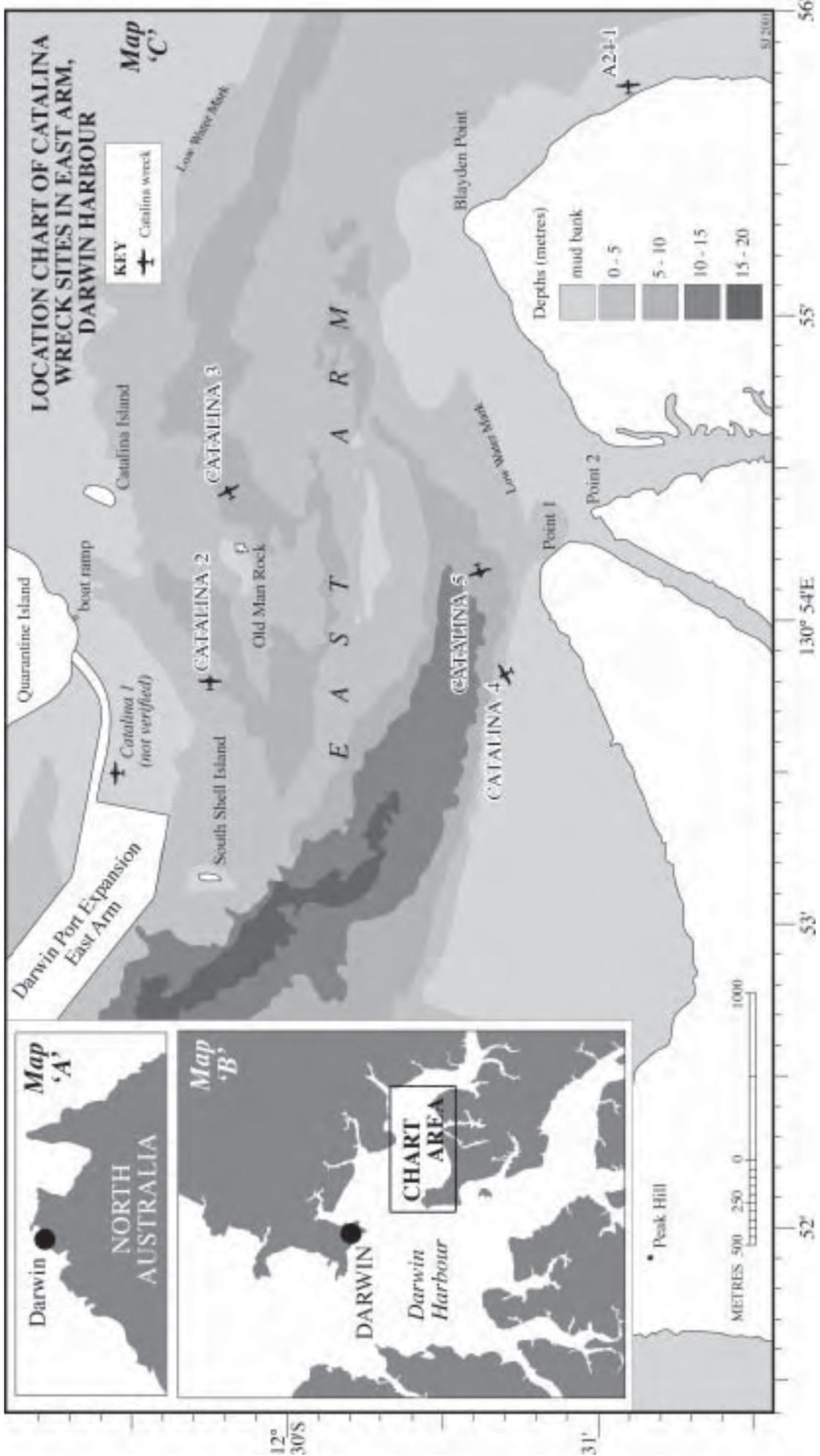


Figure 1. Location chart of Catalina wreck sites in East Arm, Darwin Harbour (After Admiralty Chart AUS 28, 1995).

such as naval aviation, represented in a diversity of archaeological site types that are yet to be investigated. For instance, a distinct lack of underwater aircraft wreck site research is evident in recent publications on the subject of underwater and maritime archaeology (Babits and Van Tilburg 1998; Delgado 1998). This study, furthermore, will investigate how these types of wreck sites can be managed and suggests that they become formerly recognised as heritage places.

The Catalina is a twin engine long range patrol bomber, built at Consolidated Aircraft Corporation's plant in San Diego. The design was initially known as the PBY, which stood for P-Patrol B-Bomber Y-Consolidated (Creed 1985:15). The name 'Catalina', however, was derived from the name of a popular holiday destination off the coast of San Diego, USA called Santa Catalina Island. Reuben Fleet, Consolidated's managing director, had suggested to the British Government that they rename the PBY to Catalina when they ordered PBY Flying Boats for Coastal Command (Wagner 1976:216). The Americans then abbreviated the name to 'Cat' and after they were painted black for night operations, they became known as 'Black Cats' (Knott 1981:9). To be consistent, the name Catalina will be used throughout this thesis to refer to all the PBY variants that were lost in Darwin Harbour.

The history of WW2 in the Northern Territory is ambiguous as to the fate of what is said to be seven Catalina Flying Boats lost in Darwin Harbour. While it is generally known that the Flying Boats were lost somewhere in East Arm, the identity of the located wreck sites has become confused over the years since their loss. The causes of their loss have been documented, but the effects that have acted upon them since they sank is unknown (Trotzig 1986). As a result, it is not known which Catalinas have been located and which ones are still missing, or how many were actually lost in the harbour.

The United States Navy (USN) lost three Catalinas during the first Japanese air raid on 19 February 1942 while at their moorings (Messimer 1995; PatWing Ten War Diary). Two Catalinas are reported to have been lost by the Royal Australian Air Force (RAAF) towards the end of the war and two shortly after (Vincent 1988; Series: A9845/1, National Archives of Australia).

The RAAF losses were accidents rather than combat losses. Both the USN and RAAF losses are listed in Table 1. This information sets out the current understanding of the number and identity of the Catalina Flying Boats believed to be lost in East Arm, but it does not indicate where they are. In the haste to leave Darwin during the air raid, the USN omitted to record where in East Arm their Flying Boats were moored. Such details are also lacking in the RAAF records.

Historical records will be used to determine the diagnostic features, or attributes, of the different types of Catalinas that were lost, as a tool for interpreting the archaeological material. Historical research is also aimed at determining the circumstances of the loss of each of the Flying Boats, which will provide clues as to how the located wreck sites can be identified. These two functions of the historical component represent an essential first stage and a pre-requisite for wreck site recording and interpretation.

Archaeological data will determine the diagnostic attributes exhibited by each Catalina wreck site. Interpretation of the archaeological data uses a deconstruction technique to develop a wrecking sequence for each wreck site. It is argued in this thesis that an understanding of the site formation process at each wreck site has an important bearing on their identity. Each Flying Boat sank due to different causes and as a result, there may be archaeological evidence to indicate how they sank.

Table 1. Catalina Flying Boat losses reported in Darwin Harbour

Owner	Serial Number	Previous Serial Number	Model	BUAERO Number	Delivery Date	Date Lost
USN	#4	ex- 102-P-27 ex- 102-P-12 ex- 21-P-12	PBY-4	1214	n/a	19/02/42
USN	#8	ex- 101-P-8 ex- 18-P-8	PBY-4	1233	n/a	19/02/42
USN	#41	ex- Y-41	28-5MNE	n/a	n/a	19/02/42
RAAF	A24-1	ex- RAF AH534 ex- VH-AFA	PBY-5	n/a	02/41	30/08/45
RAAF	A24-69	ex- USN 34056	PBY-5A (M)	34056	12/43	14/12/45
RAAF	A24-205	ex- RAF JX614	PB2B-1	44224	01/45	09/08/45
RAAF	A24-206	ex- RAF JX611	PB2B-1	44217	02/45	20/06/45

1.2 Definitions

Since its inception, the scope of maritime archaeological research in Australia has broadened to include many other types of cultural resources found in the sea apart from Dutch shipwrecks (McCarthy 1996:7-8; Green 1996:87). For example, iron sailing vessels and then steamers were investigated, followed by submarines (Henderson 1988; McCarthy 1996, 1998; Smith 1998, 1999). Flying Boat wreck sites, it is argued in this thesis, can be added to this growing list of recognised submerged cultural resources (Jung 1996b; McCarthy 1997; Rodgers, Coble & Van Tilburg 1998).

The archaeology of the Flying Boat presents an opportunity to expand upon the notions of what is maritime archaeology. An important point in the definition of maritime archaeology is that it is ‘the scientific study, through the surviving material evidence, of all aspects of seafaring’ (Muckelroy 1978:6). These aspects of seafaring are listed as:

Ships, boats, and their equipment; cargoes, catches, or passengers carried on them, and the economic systems within which they were operating reflecting their specialised lifestyle (Muckelroy 1978:6).

This list of seafaring aspects were constrained by a contemporary understanding of what was found in the sea and is not a comprehensive list of what all seafaring aspects of past human behaviour are. As a result, aviation archaeology can be seen as a part of maritime archaeological research, since Flying Boat wrecks are found in the marine environment and their operation involved many aspects of seafaring. Aircrew, for instance, were as much sailors as they were aviators (Leach 1999).

The definition of aviation archaeology has been extended to include all aspects of flight, including past missions in space (Wittenberg 1999). Capelotti (1996) calls this new development ‘aerospace archaeology’ and similar to the developments in maritime archaeological theory, the function of aerospace archaeology:

must ultimately examine questions of where, how and why the human species uses air and space technology, and how the answers to these questions bear on behavioural questions of humankind (Capelotti 1996:5).

The study of aircraft wrecks, however, was first called ‘aviation archaeology’ (Robertson 1977). Previous notions of how aviation archaeology was defined, like maritime archaeology, were predominantly focused on salvage or artefact collecting (West 1989). A later understanding of aviation archaeology suggested that aircraft wreck recovery memorialised the dead:

“Wreckage recovered - courage recalled” was self-evidently about what some people are calling aviation archaeology. Sometimes I hear it deplored: I hear people saying that there is something bad about recovering wreckage, and sometimes the bodies, of fallen aviators. I don’t quite follow the argument and urge no relative to feel distressed. If it was my father, my brother or my son I would not prefer that he remains forgotten in some unmarked spot (McLachlan 1989:7).

This view advocates that aircraft wrecks are primarily a source of relics to memorialise past heroic events (McLachlan and Zorn 1992; McLachlan 1994). As a result, Australian aviation archaeology has previously been dismissed as too well known to interest collectors of aircraft memorabilia:

Australia is far too vast a country for there to be any wreck areas, apart from isolated finds, except in the Darwin area which has been well searched. Most Australian enthusiasts have been looking further north to New Guinea, one of the centres of activity in the South-West Pacific Theatre of World War 2 (Robertson 1977:33).

This implies that there is nothing left to find in Darwin and that collectors should go to New Guinea to find undiscovered aircraft wrecks. The value of aircraft wrecks, however, is subject to how their study is defined. A developed definition for aviation archaeology is that it is:

A subdiscipline of archaeology...in its infancy worldwide...The field addresses both the archaeology of single airplane wrecks and the archaeology of the support structures of aviation, such as airfields and related structures (air operations centres, flight controls etc.). Research issues focus on the archaeological site formation process of aircraft wrecks and patterns therein; on the study of modern mass transportation systems, and their social and political impacts; as well as on the interpretative uses of such sites for educational and recreational purposes (Spennemann 2000).

Aviation archaeology, in light of the definition above, offers an insight into past human behaviour. This is as significant as the remains of aircraft and their support structures themselves. As a

result, aviation archaeology's overlap with maritime archaeology offers an insight into the past maritime activities (Flying Boat operations) that occurred in East Arm during WW2.

1.3 Rationale

The Catalina Flying Boat wreck sites in East Arm represent part of the answer towards understanding the recent past in East Arm. Determining their identity will link the histories of each of the Flying Boats to a wreck site, so that important events in the history of the Northern Territory are understood and not forgotten. For example, the material evidence for the hundreds of aircraft that participated in the first air raid on Darwin is now only represented by the USN Catalina wrecks. The rest have been salvaged or not found. Where these USN Catalinas are, however, is unknown. Secondly, to record the wreck sites before they are disturbed or destroyed. Thirdly, to determine which Catalinas are missing and where they may be found. The terrestrial evidence for the RAAF Operations Base Unit (OBU) on Quarantine Island in East Arm, that once accommodated two hundred personnel, is virtually all gone as a result of post war development (Series: A705/7, National Archives of Australia). Archaeological research of the events that occurred in East Arm during WW2 is constrained, as a result, to the Flying Boat wreck sites. This makes them significant sources of information to archaeologists, historians, veterans, families of veterans, cultural resource managers, heritage resource managers, archaeological resource managers, small business, such as dive tour operators and anyone interested in aviation.

When WW2 began in 1939, the Catalina Flying Boat was an obsolete machine (Contact 1985). Britain's entry into the war, however, necessitated the purchasing of as many aircraft as possible and in particular, long range patrol bombers to counteract the U-Boat threat. This led to new production orders at the Consolidated Aircraft Corporation's plant in San Diego for Flying Boats. Even though the Catalina was obsolete, the war ensured the continuation of the design and the development of new models, resulting in 3,272 units being produced from three different plants (Scarborough 1983:50). Very few, however, are still flying and there are no operational examples in Australia (Hall and Hall 1979). Both located wreck sites and operating examples

are, hence, rare. As a result, little is understood about the archaeology of these types of sites as archaeologists have only recently begun to study aircraft wreck sites (Gould 1983; Rodgers, Coble & Van Tilburg 1998).

More than fifty years have passed since their loss. Darwin Harbour's Catalina wrecks will, as a result of the corrosive effects of the sea, eventually disintegrate (Florian 1987a). Unlike iron or steel shipwrecks, Flying Boats had to be made of aluminium for strength and lightness. From the point of view of the preservation of the material evidence at those wreck sites, aluminium is highly susceptible to corrosion in salt water and would not have the durability of shipwrecks built using base metals (Florian 1987b). Archaeologists must now record these wreck sites before they are lost to the elements.

The Catalina wreck sites in East Arm are also threatened by the construction of a wharf, known as the East Arm Port Development, which will act as a terminus for the rail link between Darwin and Alice Springs (Acer/Vaughan 1994). Identification of the wreck sites will give closure to the Catalina identification puzzle of Darwin Harbour before threats such as development and vandalism obscures the features of the wreck sites, which may hold the answer to their identity. The outcome of this thesis is that more will be understood about the past events in East Arm. Archaeologists will understand the extent of the resource and cultural resource managers will be able to make informed decisions regarding the conservation and preservation of these wreck sites.

1.4 Environmental description

The Northern Territory city of Darwin is located in the tropics which experiences two defined seasonal changes known as the Wet Season (October to March) and the Dry Season (April to September). The region experiences tropical cyclones during the Wet Season that occasionally hit Darwin with destructive force.

Darwin Harbour is made up of three waterways that are known as West Arm, Middle Arm and East Arm. Like most of the intertidal zone in the harbour, East Arm consists of mud flats with

mangrove populations growing along the high-tide line (Hanley 1988:135). Three Islands occur in East Arm. These are North Shell Island, South Shell Island and *Yirra*, otherwise known as Catalina Island (Aboriginal Areas Protection Authority Site Ref: 5073/66; Murgatroyd, Jung and Oliver 2001). Old Man Rock is a pinnacle that also becomes submerged at high tide and this is marked with a navigation beacon together with South Shell Island. North Shell Island has recently been covered over and incorporated into a land-backed wharf, the East Arm Port Development, which began construction in 1995.

The sub tidal environment in East Arm is composed of fine sands and mud with a scour zone of gravel in channels which are flushed by fast flowing tidal streams (Hanley 1988:135). Darwin experiences tidal variations of up to eight metres resulting in strong currents. Underwater visibility in the Dry Season is between 0 to 5 metres. Wet Season run-off, however, reduces visibility even further, but corals manage to survive as well as sponges and ascidians in the murky waters. The located wreck sites also form important artificial reefs that attract a diversity of fish species such as Golden Snapper, Jew Fish, Moon Fish, Estuary Cod, Spanish Flag and Coral Trout (DPIF 1992:10-11).

Under water fieldwork in Darwin Harbour is limited to the Dry Season. Water run off during the Wet Season through creeks and rivers into Darwin Harbour introduces a sediment load into the water, reducing underwater visibility to virtually zero metres.

1.5 Wreck site locations

The Catalina wreck sites occur towards the edges of the northern shore and southern shore of East Arm in deep water between ten to sixteen metres during neap low tide conditions (see Fig 1). Only five of the seven Catalina Flying Boats said to have sunk in East Arm have been found (Table 2 and Table 3). A24-1 is the only identified Catalina wreck site and it is exposed during spring low tides of less than 2.5 metres.

The Department of Primary Industries and Fisheries (DPIF 1992) have re-named the submerged assemblages found at the other locations given in Table 2, as Catalina 1, Catalina 2 etc.

Differential Global Positioning System (DGPS) coordinates were recorded on 14 August 2000 by staff from the Department of Lands, Planning and Environment and the Museum and Art Gallery of the Northern Territory (Table 3). Photographic transit marks are available in Appendix 1.

It was not possible to verify the location of the wreck site known as Catalina 1 as it is covered by landfill for the East Arm Port Development. The reported location for Catalina 1, however, is at odds with the location's actual physical description. The wreck site is said to be in twelve metres of water (DPIF 1992), yet the coordinates given for its location indicate that it is exposed at low tide (see Fig. 1).

1.6 Thesis outline

Chapter 2 outlines the previous research on the Darwin Catalina wreck sites. Problems with the current understanding of the wreck sites are described and the initial archaeological investigations in 1995 by archaeologists from the Museum and Art Gallery of the Northern Territory (MAGNT) are evaluated as a starting point for how the wreck sites could be identified.

Table 2. Latitude and Longitude GPS coordinates for the Darwin Harbour Catalina wreck sites

Site Name	Latitude (South)	Longitude (East)	Depth (m) (neap low tide)
A24-1	12° 31.099'	130° 55.751'	Exposed low tide
Catalina 1	12° 29.450'	130° 53.500'	12 (not verified)
Catalina 2	12° 29.750'	130° 53.812'	10
Catalina 3	12° 29.820'	130° 54.410'	12
Catalina 4	12° 30.710'	130° 53.823'	16
Catalina 5	12° 30.620'	130° 54.170'	14

Table 3. Darwin Harbour Catalina DGPS Locations - AGD84AUST, UTM:52 (Courtesy of the Department of Lands Planning and Environment)

Site Name	Easting	Northing	Description
A24-1	709504.3	8615101.3	In mangroves
Catalina 2	706026.9	8617736.5	Submerged
Catalina 3	707292.3	8617634.3	Submerged
Catalina 4	706147.4	8616107.6	Submerged
Catalina 5	706645.2	8616061.3	Submerged

Salvaged artefacts by SCUBA divers are also evaluated for clues about the nature of the wreck sites that they are said to have come from.

Chapter 3 defines the nature of Flying Boats, outlines their evolutionary history and identifies the diagnostic attributes of the particular Catalina types that were lost in Darwin Harbour. These diagnostic attributes will be used as variables to identify the wreck sites. There were five different types of Catalinas lost in East Arm. With the absence of paintwork and serial numbers, wreck site diagnostic attribute recording must turn to the technological aspects of the archaeological material for empirical data.

The operational service lives of the Catalinas and the circumstances of their loss in Darwin Harbour are reconstructed in Chapter 4 through an archival and literature survey. Information from both primary and secondary sources is compiled to establish what archaeologists should expect to find on the wreck sites and to provide an aide in the analysis of recorded wreck site attributes.

The archaeological surveys of the Catalina wreck sites are recorded in Chapter 5 describing the spatial distribution of the major wreck site elements and the diagnostic attributes found at the sites. Comparison of survey data should indicate a patterning in the assemblages of each of the wreck sites. This, it is argued, resulted from the circumstances of their loss, indicating the identity of some of the wreck sites, but poses further questions as to how other Catalina wreck sites may be interpreted.

Chapter 6 presents the results of this thesis, pointing out the correlations between the historical and archaeological data. A wrecking sequence is set-up to explain the current condition of the wreck sites. Since the circumstances of their loss were different, the layout of each wreck site is argued to be reflective of the causes of them having sunk. Results of the historical and archaeological investigations also indicate that the wreck sites are significant. This is explained using current Heritage Advisory Council (HAC) assessment criteria and those formulated by archaeologists.

The identity of the Darwin Harbour Catalina wreck sites, based upon verifiable historical and archaeological data, is presented in the conclusions, Chapter 7. Further work is outlined for Darwin Harbour and elsewhere. A broad management plan for the wreck sites is suggested, together with the nomination of the wreck sites for listing on the heritage register under the *Northern Territory Heritage Conservation Act* (Northern Territory Government 1991).

CHAPTER 2: PREVIOUS STUDIES AND SALVAGED RELICS

2.1 Introduction

This chapter reviews the results of the previous archaeological research on the Darwin Catalinas. The Museum and Art Gallery of the Northern Territory (MAGNT) inspected the wreck sites in 1995. The MAGNT wreck inspections are evaluated as to how useful they are in determining the identity of the Catalina wreck sites. The MAGNT wreck inspections represent the only archaeological data that has been recorded. Others who have reputedly assessed the wreck sites did not verify their location or produce a report of their findings. This makes the MAGNT wreck inspections an important body of information and a starting point for evaluating and identifying the wreck sites.

A study of the raised artefacts found in dive shops, private collections and in the Aviation Historical Society of the Northern Territory's workshop is also evaluated. These artefacts contain clues useful to the identification of the Catalina wreck sites.

Prior to the description of the archaeological work, it is fitting to outline and discuss the origins and hypothesised identifications of the reported Flying Boat wreck sites. Prior to the MAGNT wreck inspections, the story of the East Arm Catalinas has become confused, so that it was neither understood how many Flying Boats had been found or how the verified wrecks could be identified. This started a cycle of mis-information that serves to perpetuate the myths of how many Flying Boats were actually lost and where they are found.

2.2 Origins of the reported Catalina wreck sites and their identification

Tom Lewis (1991) produced a general discussion paper on the submerged cultural material in Darwin Harbour that included the Catalinas in East Arm. No mention is made there of exactly how many Catalinas were lost in East Arm, but two wreck sites are described: A24-1 and another, which is referred to as A24-206. Of interest in this research is the description of the

A24-206 wreck site, which is later referred to as A24-205. The following quote describes the Catalina 3 wreck site and will be used to compare observations of the wreck site made in this thesis:

The two giant engines are easy to find, identifiable by their large curved cowlings. One propeller can be seen, the blades bent underneath the wreck itself. The tail of the aircraft is half buried under sand at the end of the fuselage (Lewis 1991:6).

The reasons why this wreck was believed to be A24-206 are not mentioned, but his observation of the state of the propellers prompted him to later change the suggested identification for this site from A24-206 to A24-205 (Lewis 1992:45).

The first published source on the number and location of the Catalina wrecks in East Arm was a book called *Wrecks in Darwin Waters* by Lewis (1992). On a chart inside the front cover, five Catalina wrecks are marked. Three wreck sites are located north of Wickham Point. One wreck site is marked as being adjacent to North Shell Island; another is near to South Shell Island and one near Old Man Rock. The site near Old Man Rock is labelled A24-205. Two other sites are marked on the chart south of Wickham Point. One is labelled as A24-1 and the other simply as 'Catalina'. The description given for this wreck site near Old Man Rock is exactly the same as that used to describe the site previously known as A24-206, except that a new theory is introduced as to how the aircraft can be identified.

A further description of the Catalina 3 wreck site is the mention of the propeller blades under the wing: 'the latter's blades are bent underneath the wreck itself, perhaps indicating a take-off accident' (Lewis 1992:45). As a result, what was first thought to have been the wreck of a stationary aircraft on a mooring, is now speculated to be the wreck of an aircraft that crashed during take-off.

According to this theory, Catalina A24-205 has been found, since it was the only other Catalina to have crashed while flying, apart from A24-1. This identification of the Catalina 3 wreck site has been unchallenged and has become an accepted truth and reproduced in subsequent publications (DPIF 1992; Acer/Vaughan 1994; Lewis 1995).

One other important observation that was made regarding the Darwin Harbour Catalinas should be related here and that is the location of the USN aircraft. The ambiguity of the locations of the other Catalina wrecks and how they have been interpreted match the inconsistencies in the identification of this wreck site. The USN aircraft are said to be:

specifically near South Shell Island. Although the U.S. Navy Archives Service is of the opinion that the machine guns were later salvaged, no other attempts at recovery have been made (Lewis 1992:43).

It is significant that a Catalina wreck is marked near North Shell Island as this could indicate that the northern group of wrecks (ie., Catalina 1, Catalina 2 and Catalina 3) appear to be the three USN aircraft. Could the southern group (Catalina 4 and Catalina 5) be RAAF aircraft then?

2.2.1 Chart plotted locations

A publication produced for anglers and sports divers by the Department of Primary Industries and Fisheries (DPIF) called *Darwin's Artificial Reefs* (DPIF 1992:10-11) provided chart plotted Latitude and Longitude co-ordinates for five Catalina wreck sites, coinciding with four of the locations given by Lewis (1992). The publication gives each Catalina wreck site a number, beginning from one through to five. This thesis has adopted this numbering system as a convention in referring to the wreck sites. Two differences in this publication, however, compared with Lewis (1992) are the addition of a wreck site position called Catalina 5 and the omission of A24-1.

2.2.2 East Arm Port Development Draft Environmental Impact Statement

The Draft Environmental Impact Statement (Acer/Vaughan 1994:91,92,101) for the new port development in East Arm uses Catalina locations given by Lewis (1992) and DPIF (1992) in their report. However, one reported wreck site, Catalina 1, has never been located and is said to have been confused with the position of the nearby site of Catalina 2 (Coulter, B. 1996. pers.

comm., 1 November). The environmental impact statement did not verify the location for this wreck site because it still included the reported location of Catalina 1 in its findings and recommendations, even though nothing is now said to have been found at that location (Acer/Vaughan 1994:90-91). Furthermore, according to Lewis (1997. pers. comm., 9 April), the Royal Australian Navy Reserves (RANR) Dive Team 11 did do a survey, as a training exercise, of the area where Catalina 1 was reported to be, but found nothing.

2.2.3 Environmental Assessment Report - aims and results

In the Environmental Assessment Report and Recommendations for the Darwin Port Expansion - East Arm (Environment Protection Unit (EPU) 1994), mention is made of the remains of the East Arm Flying Boat Base and the Lugger Maintenance Section, but the sunken Catalinas are only briefly referred to (EPU 1994:18). The one reference to these submerged aircraft wrecks is in the Appendix: 'Undertakings by the Proponent'. The undertaking in regard to these sites is that: 'Assistance will be provided for the salvaging and relocation of the two Catalina Flying Boat wrecks in the port construction area' (EPU 1994).

The two wreck sites, which are referred to, are Catalina 1 and Catalina 2. As mentioned above, the existence of Catalina 1 has not been verified. No professional archaeological assistance was sought for the relocation of the wreck site. The RANR were brought in instead. As a training exercise they raised one engine, a propeller and a collection of artefacts. It sufficed that the proponents were seen to be conserving the wreck site by moving it to another part of the harbour. A substantial and significant amount of the Catalina, however, was left on the sea bed. As a result, the EPU's undertakings by the proponent were not carried out and only a token and publicity seeking gesture to move parts of the wreck was undertaken. Furthermore, no conservation resources were provided for the objects that were raised.

2.3 MAGNT wreck inspections

Four of the six Catalina wreck sites in East Arm, reported by the Department of Primary Industries and Fisheries (DPIF 1992:10-11), were visited during the 1995 field season to verify their

locations. MAGNT archaeologists (Paul Clark and Cosmos Coroneos) visited the wreck sites of Catalina 4, Catalina 5, Catalina 2 and A24-1. Sketches of Catalina 4 and Catalina 5 were drawn, illustrating the condition of these two wreck sites (Fig. 2).

Their dives also documented the port wing, engine and forward section of the fuselage of Catalina 4 with photography and underwater video. The wreck sites of Catalina 2 and A24-1 were not surveyed. The first of the museum dives was on the wreck site of Catalina 5. Cosmos Coroneos and Paul Clark inspected the wreck on 5 March 1995. The site sketch shows an extensively damaged aircraft with some structure remaining.

The Catalina 5 wreck site lies on a silt bottom at a depth of 9 to 12 metres. The port wing is upside down on top of the starboard wing. The port engine sits inside the navigator's compartment. The starboard engine is located under the port wing next to the fuselage. One of the propellers of the starboard engine protrudes through the port wing. The tail section, although not seen, is apparently 40 metres off site (Weisse, R. 1996 pers. comm., 7 October).

Coroneos, Clark, Rob Smith (informer), Didier Rouer (MAGNT volunteer) and Silvano Jung (contract archaeologist) inspected Catalina 4 on 20 August 1995. A further two site inspections were done on 5 October (Coroneos and Bob Ramsey) and on 16 November (Clark and Rouer). An underwater video camera and a Nikonos 5 camera were taken down on the second wreck inspection to record an image of the wreck.

This wreck site is at a depth of 12 to 14 metres and like Catalina 5, is broken up. The intact elements of the wreck site are the fuselage forward of the mainplane and the port wing. The port wing is approximately 15 metres long by 2.4 to 4.2 metres wide. The trailing edge, on the western facing edge of the wing is missing. The wing is well preserved towards the tip but deteriorates towards the fuselage, with the skin missing and the air frames visible. At one point, at the centre of the wing, the leading edge is cracked. There is also a large hole in the centre of the wing.

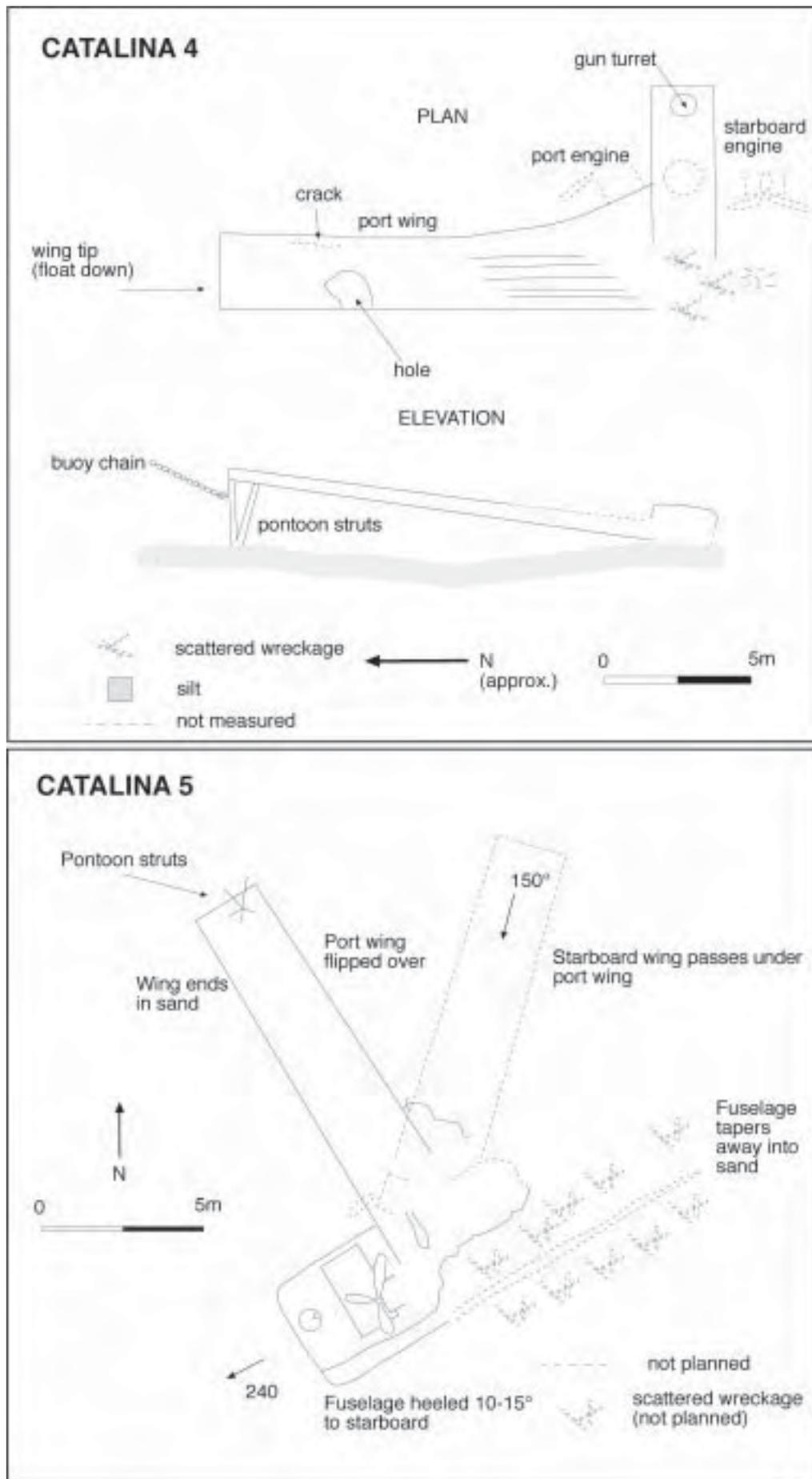


Figure 2. Museum and Art Gallery of the Northern Territory Catalina 4 (above) and Catalina 5 (below) wreck site sketch plans.

The port wing sits upright and is supported off the bottom by the wing tip pontoon strut. However, the pontoon that would have been attached to the strut, was not located. The port wing appeared to be attached to the fuselage. The starboard wing was not located.

Both engines are on site, although they have collapsed from their mounts. The starboard engine has turned 180° and faces aft. The port engine is buried in sediments with only one propeller visible. Two propeller blades are visible on the starboard engine. On the starboard engine propeller is a cylindrical shaped spinner.

A gun turret is recognisable by the circular opening on top of the nose. The perspex of the turret itself is gone, leaving empty spaces between the turret struts. Furthermore, there was no evidence of the machine guns fitted inside the turret, but ammunition was seen strewn about the wreck site. The cockpit is visible behind the gun turret and is distinguished by a large opening just above the point where the port wing joins the fuselage. The cockpit frame structure with perspex is gone. The aft section of the fuselage, together with the tail, was not seen.

The second dive on the 5 March 1995 was done on one of the Catalina wreck sites reported to be between South Shell Island and Old Man Rock at a depth between 12 to 14 metres. This was the wreck site of Catalina 2. The wreck inspection involved two divers (Coroneos and Clark) going down to see if there was a Catalina at this reported location. What they saw was the scattered remains of a Catalina, but time and the poor visibility on the wreck site did not permit the development of a site plan (Coroneos, C. 1996 pers. comm., 1 November).

The last Catalina wreck site to be inspected on 16 November 1995 by Clark, Jung and Rouer was A24-1, stranded upon a mud bank in East Arm. The wreck site was located from a dinghy during the high tide, which enabled a close approach. Most of the aircraft elements are still at the site, but are now scattered and structure is much less intact than what was seen on the underwater wreck sites. The starboard wing could be seen above water with evidence of an engine mount. The engines were not seen because the wreck site was underwater at that time. The wings themselves are no longer attached to the fuselage. The port wing was submerged, but just visible below the surface. Another recognisable feature was the forward gun turret.

2.4 Salvaged artefacts

The RANR raised an engine and propeller, together with smaller artefacts in 1994 (Photo 1 and 2, Fig. 3), from the Catalina 2 wreck site (Lewis 1995). One diagnostic artefact was the propeller that was raised with the engine (Photo 3 and 4). The propeller has a short tube type spinner, referred to in this thesis as a cylindrical spinner, suggesting that it is a late model aircraft. The second propeller was also raised, but by divers from Cullen Bay Dive Shop and is displayed on their premises (Photo 5). Unfortunately, the spinner hub was either not recovered or did not survive and as a result, is not as useful in determining the type of engine it came from as is the propeller raised by the RANR.

The most diagnostic artefact seen so far from the Catalina 2 wreck site, however, is attributable to Rick Wiese's discovery of the contractor's plate (Fig. 4). This type of plate has not been found on any of the other located wrecks. It is, as result, a rare find. The plate recovered from Catalina 2 is for a PBY-5A model Catalina. Historical records show that the only Catalina of this model lost in East Arm was A24-69.

Apart from the contractor's plate, another plate was removed from one of the engines, a specifications plate (Fig. 5). This plate gives the engine type as an R-1830-92 (Photo 6). Inset 2 in Photo 7 shows the engine number. It is currently not understood what the significance of this number is, but it is likely that it is significant in identifying which engine was raised from the site ie., either the starboard or the port engine.

The other wreck sites have been impacted by sports SCUBA divers as well. One of the most popular artefact targets has been the Catalina folding anchors. Several are known to been removed, such as both large and standard types from Catalina 4 (Photos 8 and 9). Figure 9 is of a standard type of anchor, which has been found on all of the wreck sites, but the large type anchor has only been found on the Catalina 4 wreck site.



Photo 1. A engine and propeller recovered off Catalina 2 (Candler 1994:2).



Photo 2. Catalina 2 propeller being loaded for transport to the Aviation Museum workshop (Lewis 1995:26).

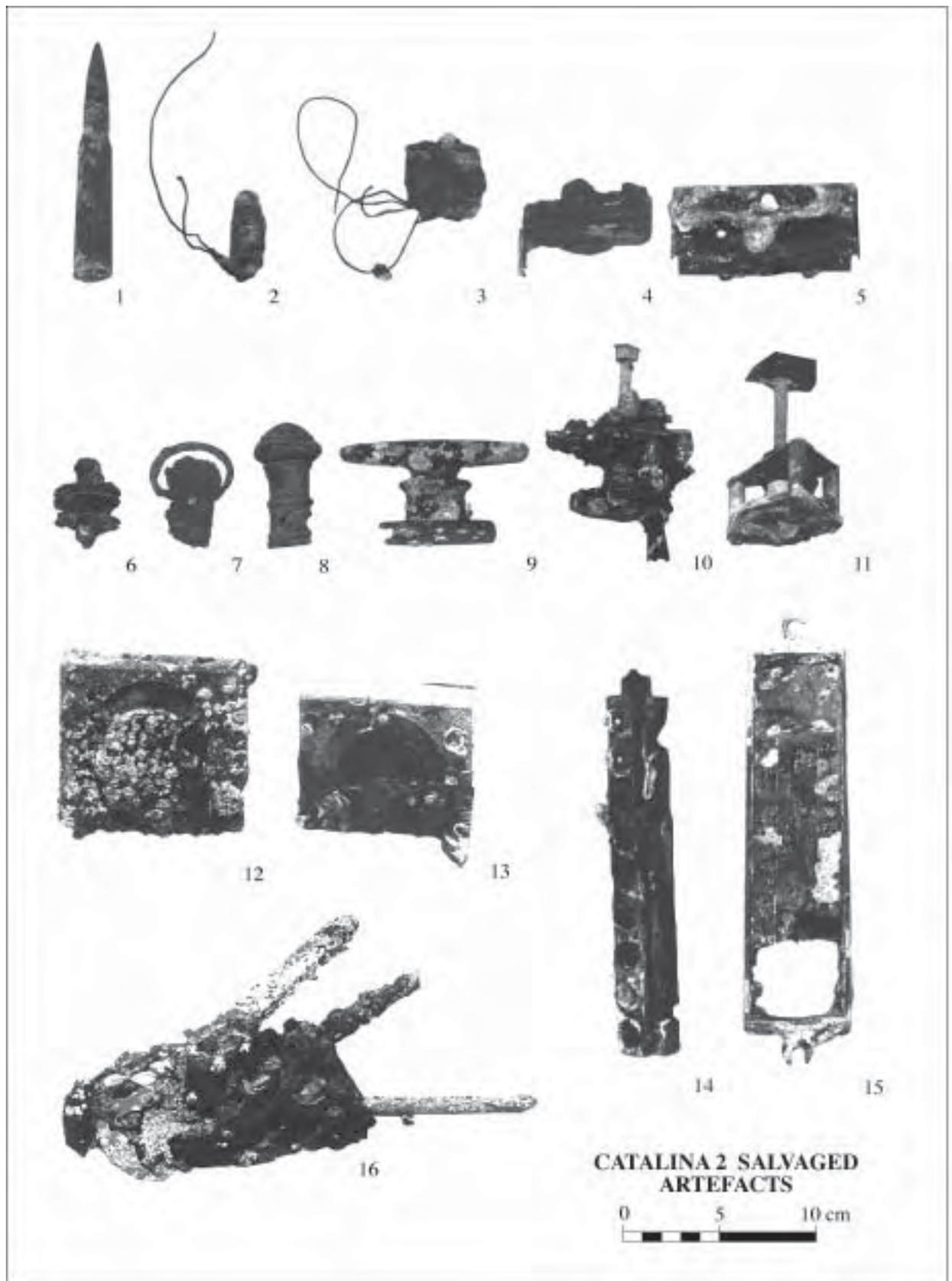


Figure 3. *Catalina 2* artefacts raised by the RANR in 1994. (1) 0.30' calibre bullet. (2) instrument panel light bulb. (3) instrument panel light bulb. (4-6) radio components. (7) handle. (8) bakerlight knob. (9) cleat. (10-11) radio tuners. (12-13) flight instrument gauges. (14) flight instrument panel light array. (15) scale. (16) throttle.



Photo 3. Catalina propeller at the Aviation Museum workshop. Note the bent tip on the propeller blade on the right.



Photo 4. Close up of Catalina 2 cylindrical propeller hub.



Photo 5. Propeller raised from the Catalina 2 wreck site by Cullen Bay Dive Shop.

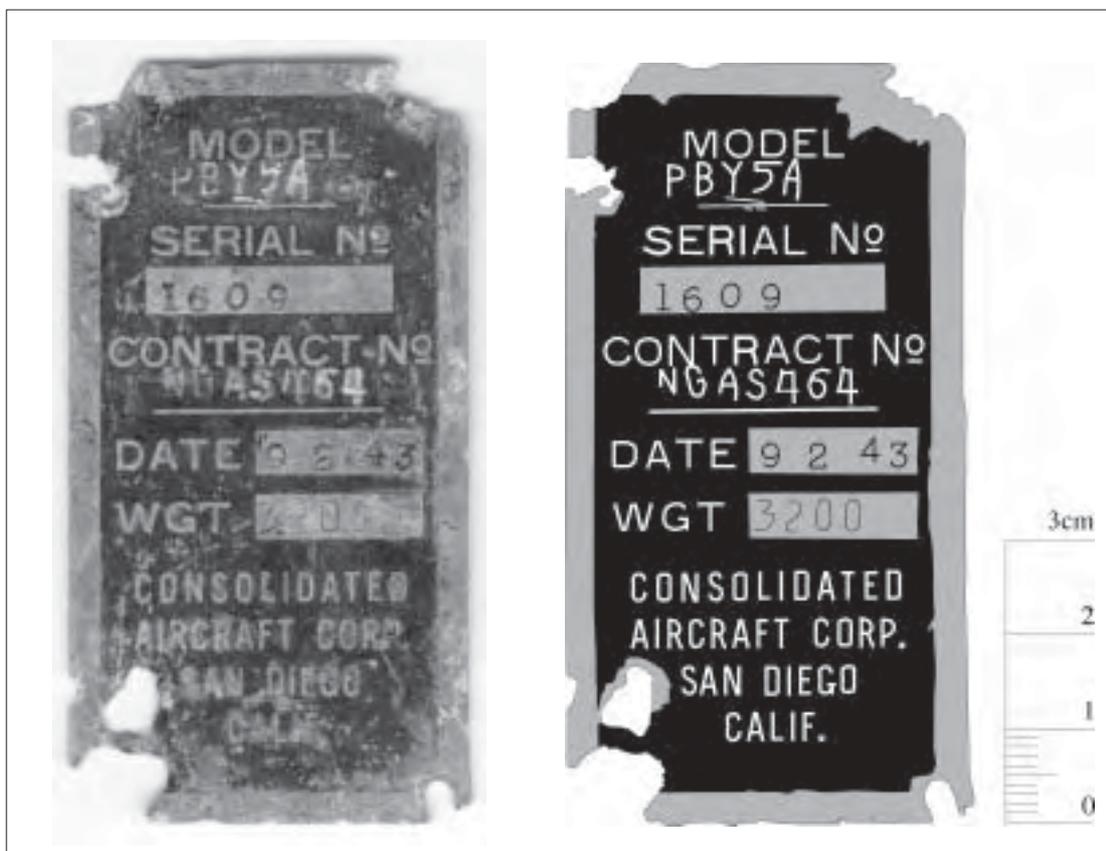


Figure 4. Contractor's plate photograph and line drawing.

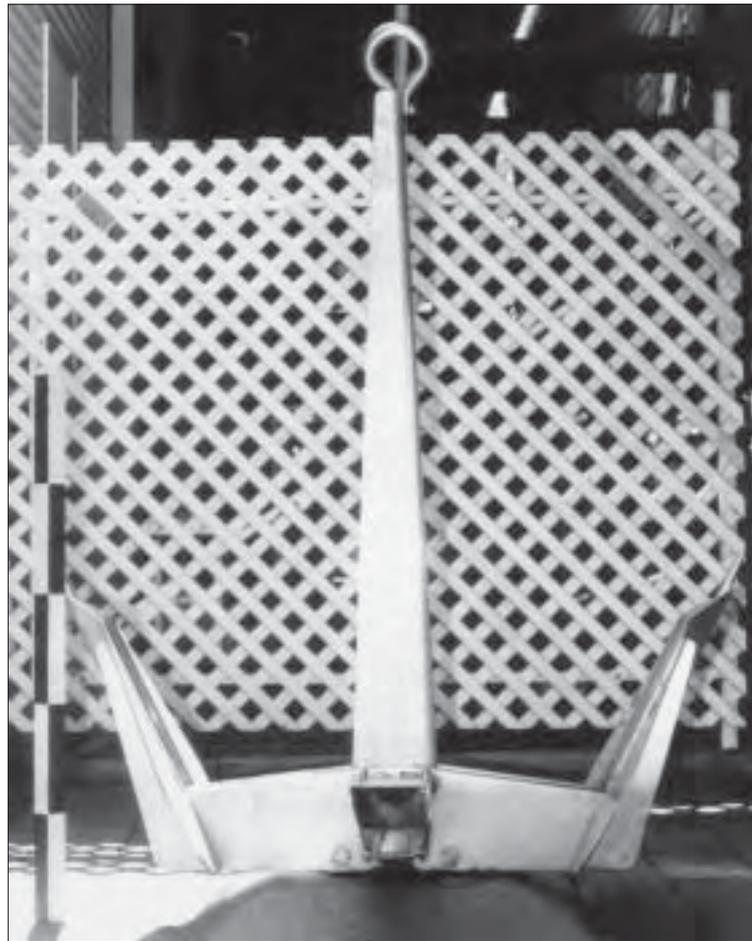


Photo 8. Large type folding anchor recovered from Catalina 4. Scale in 20cms (Photo: Jung 2000).



Photo 9. Standard size folding anchor from Catalina 4, folded (left) and extended (right) (Photo: Jung 1995).

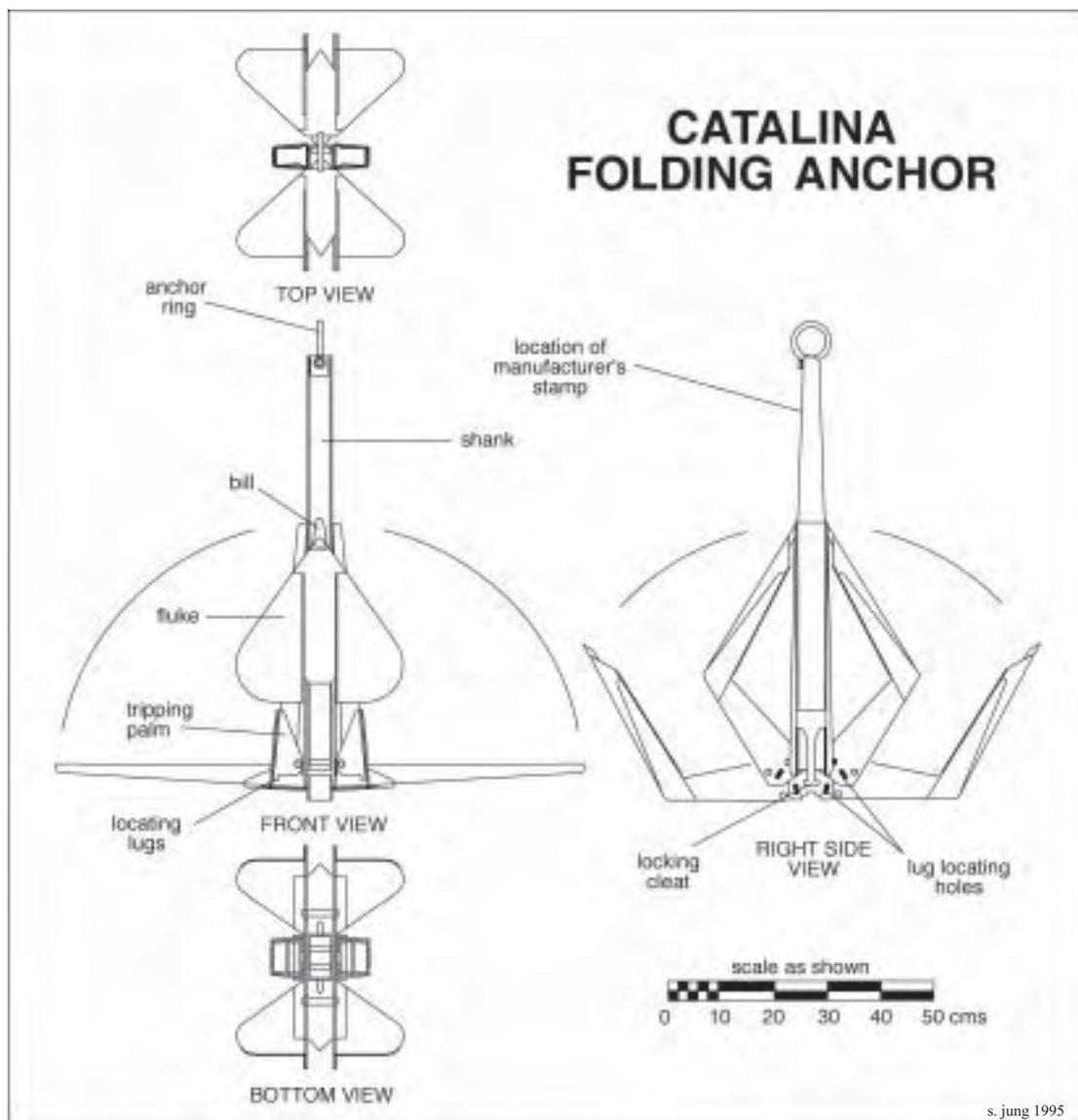


Figure 6. Line drawing of a standard type folding anchor recovered from Catalina 4.

2.5 The Peter Dermoudy research files

Peter Dermoudy was employed at the Museum and Art Gallery of the Northern Territory researching the military history of this region. He had amassed a collection of data consisting of some primary references, secondary references and most importantly to this study, interviews with former RAAF personnel who were based in Darwin during the War. Dermoudy had recorded interviews with two people in particular, whose statements provide additional evidence as to how we can identify the Catalina wrecks.

Dermoudy had researched the Darwin Catalina wrecks and had received material relating to other Catalina wrecks around Australia as well, such as the unidentified wreck on Enderby Island off the Western Australian coast. Of significance to the Darwin wrecks though, are two

taped interviews, one with Maurice Tasman Taylor (Serial No. 428192) of No. 20 Squadron Marine Section and Bill Smart of No. 20 Squadron. Unfortunately the tapes of the interviews have not survived and neither has a transcript of what was spoken. What has survived is a list of topics spoken about on the tapes.

Taylor's interview topic list contains information on mishaps with mines and depth charges and the sinking of a Catalina, but Bill Smart's interview is perhaps the most informative as to how we can identify one of the Catalina wrecks. In the topics list for his interview, item number 460 is of particular interest, as it indicates where the location for A24-206 might be: 'Cat. which was blown up was straight out from base and beyond the island'. The island that Smart referred to is Catalina Island and there is only one wreck known to be there: Catalina 3.

2.6 Results

The wreck inspections by MAGNT were conducted on four of the five located sites. This verified their published locations, except for two wreck sites. One located and one reported wreck site were yet to be investigated.

Catalina 1, has never been located and it is assumed that it was confused with the position of the nearby site of Catalina 2. Catalina 3 was not inspected by MAGNT archaeologists, but some descriptions of wreckage seen at the location for Catalina 3 have been published. There is an emerging belief that this is the wreck site of the RAAF Catalina A24-205 (Lewis 1991:5-6; 1992:45).

The findings made by the MAGNT archaeologists of the inspected wreck sites: Catalina 2, Catalina 4, Catalina 5 and A24-1 show that they are all extensively damaged. The A24-1 wreck site was in the worst condition, whereas the underwater Catalinas still had recognisable major structural elements, such as the bow and cockpit sections, but broken wings and tails.

An examination of the artefacts that have been raised from the Catalinas also indicates how one wreck site, Catalina 2, could be identified. For instance, the contractor's plate identifies the type of Catalina aircraft, of which only one is reported to have been lost in Darwin Harbour, A24-69.

2.7 Conclusion

Many artefacts have been recovered from the Darwin Harbour Catalina wreck sites. This salvage history is poorly understood. What this study has shown is that some of the material in public hands is very useful in determining the identity of the wreck sites that they are said to have come from. The problem with using salvaged archaeological material is that artefacts are always removed from their contexts without recording where they were found.

The salvaged artefacts described in this thesis, point to the identification of one wreck site as that of the RAAF Catalina A24-69. Descriptions of another wreck site suggest that the RAAF Catalina A24-205 is also among the group of located wreck sites. These claims, however, have not been verified.

The MAGNT wreck site inspections have verified the location of several wreck sites. The inspections determined that although the Catalinas had broken up, diagnostic structure still existed. This crucial point indicates that, despite the vandalism and other threats to wreck site integrity, the extent of the material evidence is suitable for a technological analysis of the Catalina type found at each wreck site.

Technological specifications are described in the following chapter for each of the different Catalina types that were lost in Darwin Harbour. Identifying the attributes of the different Catalina models will verify our understanding of the located wreck sites.

CHAPTER 3: THE CATALINA DESIGN AND DIAGNOSTIC ATTRIBUTES

3.1 Introduction

This chapter presents a background history of the development of the Catalina types lost in Darwin Harbour. WW2 had important ramifications in the use of Flying Boats as a long-range patrol aircraft. The Allied requirements for a proven patrol plane meant that the role of Flying Boats in modern warfare was not over. The war meant that the Catalina was saved from the scrap heap. It setup the manufacturers to improve on the design through the production of different types. The design concept advances in the Catalina were accelerated during WW2 and as a result, Darwin Harbour has a representative sample of Catalina types dating from 1938 to 1943. This sample is represented by the early PB4Y-1 Flying Boats of the US Navy through to the Canadian built PB2B-1s that were lost by the RAAF towards the end of WW2.

There were five types of the Consolidated Aircraft Corporation's Catalina Flying Boats and one from Boeing of Canada lost in Darwin Harbour. The technical specifications for these types are listed in Appendix 2. Those lost in Darwin Harbour are known as PB4Y-1, PB4Y-2, 28-5MNE (similar to PB4Y-2), PB4Y-3, and PB2B-1 (the Canadian type). Figure 7 illustrates these in relation to their place in the evolution of the PBY.

The identification of attributes or features that characterise the types of Catalina lost in Darwin Harbour can be traced back through the development of Consolidated's Flying Boats from the 1920s. The original concept of a Flying Boat was developed from the US Navy's Curtiss Flying Boats of World War One. The Curtiss Flying Boats were twin-engine biplanes with masses of struts and had open cockpits (Wagner 1972:2). The PBY Catalina was a revolutionary concept in Flying Boat design. It was the first monoplane plane Flying Boat without struts, except for two remnants on either side of the fuselage that formed a triangle brace with the wing.

Many Catalina Flying Boats were lost early in WW2, but once effective tactics were developed on how best to deploy Flying Boats in aerial warfare, aircraft manufactures developed

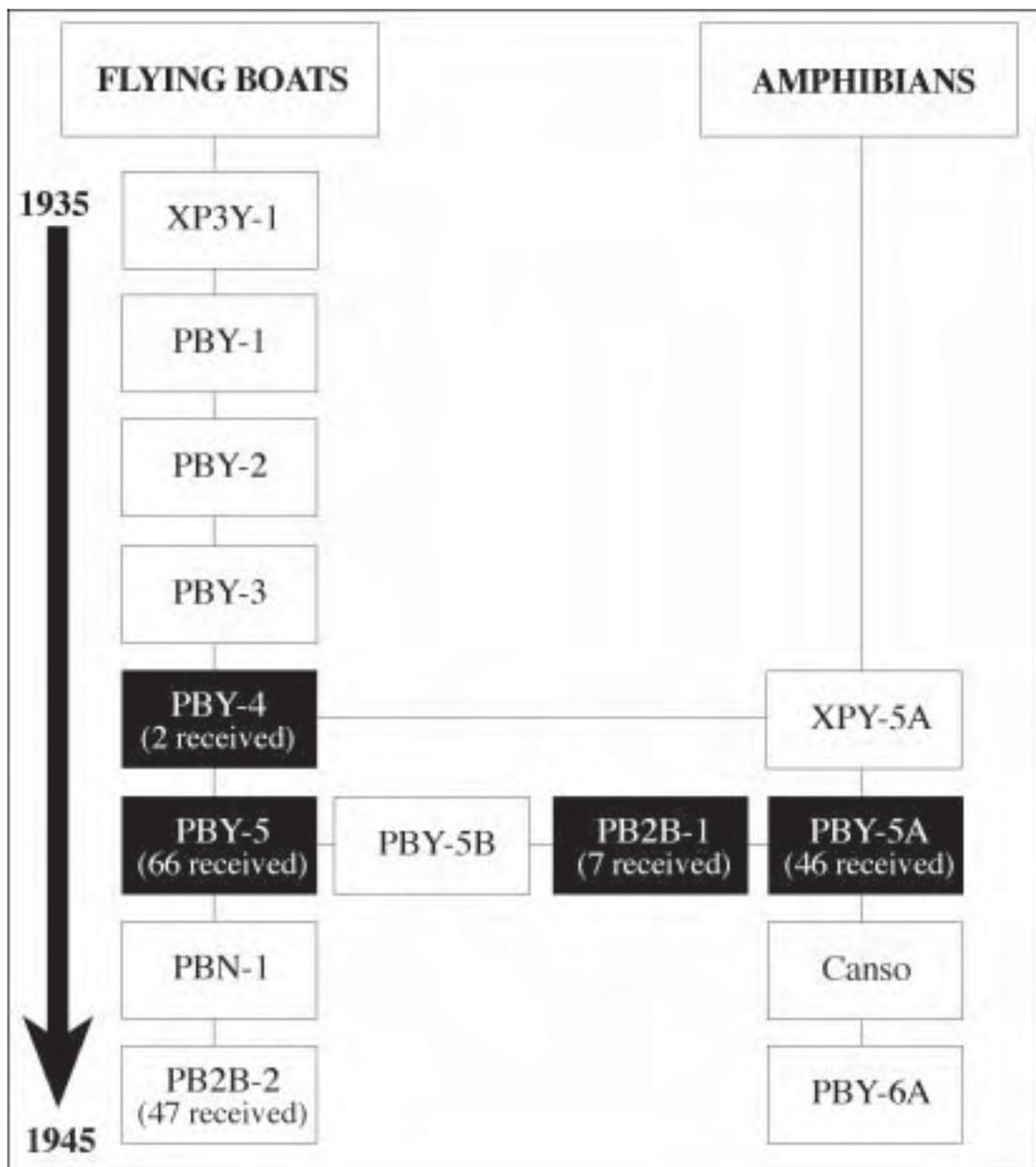


Figure 7. Evolutionary tree of the Catalina Flying Boat. Number received by the RAAF and examples lost in Darwin Harbour are in black boxes. Note: Type 28-5MNE same as PBY-5, USN only (After Vincent 1981:106).

modifications to improve the defensive and offensive capabilities of the machines. Developments to the Catalina during WW2 were, hence, refinements to an already existing design. These changes resulted in the development of different types of Catalina as the war progressed.

Diagnostic features of the different types of Catalina Flying Boats in Darwin Harbour, in the absence of any serial markings or identification plates on the wreck sites, are useful attributes to determine wreck site identity. Catalina type is indicative of individual Flying Boat identity in Darwin Harbour. The exception, however, is that Catalina of the same type i.e., two PBY-4s

and two PB2B-1s are recorded to be lost. Diagnostic features of Catalina types are, hence, limited. If two Catalina Flying Boats of the same type are amongst the found wreck sites, their identification is limited. Both PB2B-1s, for instance, were RAAF and both PBY-4s were USN. Which particular PB2B-1, or which particular PBY-4, has been found will be difficult to determine solely on the basis of wreck site morphology.

3.2 Antecedents of the Catalina Flying Boat

Catalina Flying Boats originate from the USN's need in 1927 for a 100-foot wing span patrol aircraft that could fly to Panama, Alaska and Hawaii. The Consolidated Aircraft Corporation, in Buffalo New York, tendered to build the patrol plane on 28 February 1928. Reuben Fleet, the Corporation's general manager, put Isaac Macklin Laddon in charge of the Flying Boat design, called the Model 16 by Consolidated and the XPY-1 (X for experimental, P for patrol and Y for Consolidated) by the Navy. Laddon was a pioneer aircraft designer for the Army Air Service and Consolidated and is best remembered for his famous design of the B-24 Liberator bomber (Creed 1985:15; Wagner 1972:1). The XPY-1 was designated the Admiral in honour of Fleet's aviator friend, Admiral William Moffett (Creed 1985:15).

Consolidated's XPY-1 lost out, however, to Glenn L. Martin, who had underbid Consolidated to build the XPY-1 for the Navy. Consolidated had included engineering costs that would pay off in the future (Mueller 1992:125). This initial failure to obtain military contracts did not deter Fleet, who instead focused on the production of the XPY-1 as a commercial aircraft and with modifications, the XPY-1 was re-designated the Model 16 Commodore (Creed 1985:18).

The Commodore introduced luxury to passenger air travel never before seen. Fleet employed a decorator to design a plush interior and added innovations such as lavatories, mandatory for long distance flights (Creed 1985:18). The cockpit was enclosed to offer some comfort to the pilots who had to previously endure the elements and noise in open cockpits, which added to the fatigue of long distance flying.

The development and success of the Commodores presented the first signs that Consolidated would become a world leader in the building of long range Flying Boats. The construction of the Commodores set a record with fourteen being built in fifteen months. Martin managed to construct only nine aircraft in twenty-seven months. They lacked the prototype XPY-1 and the design experience Consolidated had gained through the venture, as well as the stock pile of materials Fleet had amassed in anticipation for getting the Navy order (Creed 1985:19). The sale of fourteen Commodores, all to a South American service called the New York, Rio and Buenos Aires Airline (NYRBA), also enabled further developments to the XPY-1 Admiral (Creed 1985:18).

The XPY-1 Admiral was developed further by the addition of a third engine, mounted above the wing. This was intended to increase cruising speed, but caused problems for hanging and did not increase performance, resulting in the concept being abandoned. The three engine version of the XP2Y-1 was redesignated the Ranger, but the production version went ahead with only two engines and an enclosed cockpit, an innovation borrowed from the Commodore.

Design of the Ranger aimed at cleaning up the lines of the Admiral to make it more aerodynamic. The Admiral had so many bracing struts that it resembled 'a flying bird cage' (Wagner 1976:158). The major design feature of the Ranger was the addition of a horizontal structure on each side of the hull creating a 'sesquiplane', or one and a half wing. These provided additional lift, as well as creating space for more fuel tanks and bomb racks (Wagner 1976:158). Floats were fitted to these lower half wings, doing away with the struts necessary to mount floats as on the Admiral.

Consolidated won its first Navy contract with the Ranger and an order was placed for a prototype XP2Y-1 on 26 May 1931 and twenty-three production versions called the P2Y-1 on 7 July (Wagner 1972:2). The endurance of the P2Y-1s was demonstrated when six VP-10 (Patrol Squadron Ten) boats flew from San Francisco to Pearl Harbor in January 1934. The P2Y-1 was the best Flying Boat yet made and met the Navy's requirements for many years (Wagner 1972:2).

The last P2Y-1 was modified into what became known as an XP2Y-2. This new model was developed in August 1933 with more powerful engines, which now had quarter cowlings to assist with directing cooling air to the cylinder heads. These could be shut off, trapping hot air around the engines, preventing over cooling problems during operations in cold climates.

The next development of the P2Y-2 was called the P2Y-3, which had engines set into the leading edge of the wing. This method of mounting the engines increased performance and range. So successful was the new model, that the Navy ordered twenty-three P2Y-3s on 27 December 1933. Streamlining the engines with cowlings and the later adaptation of putting the engines on the leading edge on the P2Y-3, were two ideas that were later adopted on the Catalina.

3.3 The PBV Catalina design

On 28 October 1933 Consolidated received a production order 'for one experimental aircraft with 3,000 mile range as successor to the P2Y-3' (Wagner 76:178). This was an eventful date in the life story of the Catalina. The prototype was delivered to the Navy in 1935, becoming the first PBV.

The flight test of the Consolidated Model 28, XP3Y-1 began on 21 March 1935 at Norfolk, Virginia. The aircraft had been disassembled and transported there by rail from Buffalo and reassembled in a Navy hanger. Following the successful tests, the Navy redesignated the aircraft mission from patrol to patrol bomber classification (Wagner 76:178).

Consolidated's prototype XP3Y-1 was challenged in the bid for Navy contracts, by the Douglas Flying Boat XP3D-1 which performed similarly to the XP3Y-1. Consolidated won this order on the issue of price. The Douglas machines were estimated at US\$110,000 each, whereas the P3Ys were US\$90,000 each, plus spares. The designation was subsequently changed to PBV-1 in August 1936 (Wagner 1972:3).

The PBV-1 incorporated all of the lessons that Ladden and the Navy had learnt about long distance Flying Boats. Streamlining became a fundamental part of the design. Like the Ranger,

the PBY-1 had engines, with long cord cowlings, mounted into the leading edge of the wing. The pontoons were incorporated into the wing tips, which folding up once the aircraft was in flight. This did add to the streamlining of the wing, but functioned more to increase lift (Wagner 1976:177-178). The wing also incorporated Ladden's concept of integral fuel tanks, an important weight saving measure, which would become a standard feature in aviation design.

The design of the integral fuel tank in the PBY-1 was the world's first fuel proof wing. Previously fuel was carried in separate tanks, but with the Catalina wing, internal sections were sealed off. The weight saved by not having separate fuel tanks 'was calculated at half a pound per gallon of fuel capacity, adding substantially to the PBY's payload' (Wagner 1976:179).

Figure 8 illustrates the development of the 100+ foot wing span Flying Boat from its early appearance as a strut supported winged aircraft of the Admiral to the sleek lines of the PBY Catalina. Lemonnier (1989) argues that aircraft design is based on the preconceptions of already existing designs. This is reflected in the development of the Catalina. As a result, later Catalina types would change little, all being based on the basic concept of the PBY-1. Changes were based on improvements of an already proven design as new technologies arose during WW2. Martin Mariners represent how problems with the horizontal wing were overcome by use of a dihedral, or gull wing. Although the Mariner was a better design, Consolidated won USN contracts with the PBY, which had innovations in aircraft design that are used in aircraft today.

The wing of the PBY-1 was all aluminium, except for the ailerons and elevators, which were covered in fabric. The hull of the PBY-1, however, incorporated innovative changes that saw streamlining taken to its extremes. The bi-plane antecedents of the PBY were plagued by the complexity of struts supporting their wings and pontoons. The wing on the PBY was attached directly to the hull on top of a pillar, which contained the flight engineer's compartment. This pillar was faired into the fuselage, creating a parasol or pedestal for the wing. On either side of the fuselage underneath the wing were two struts, which is the only reminder of the aircraft's origin as a bi-plane. The tail assembly was also streamlined by using internal bracing (Wagner 1976:177 -178).

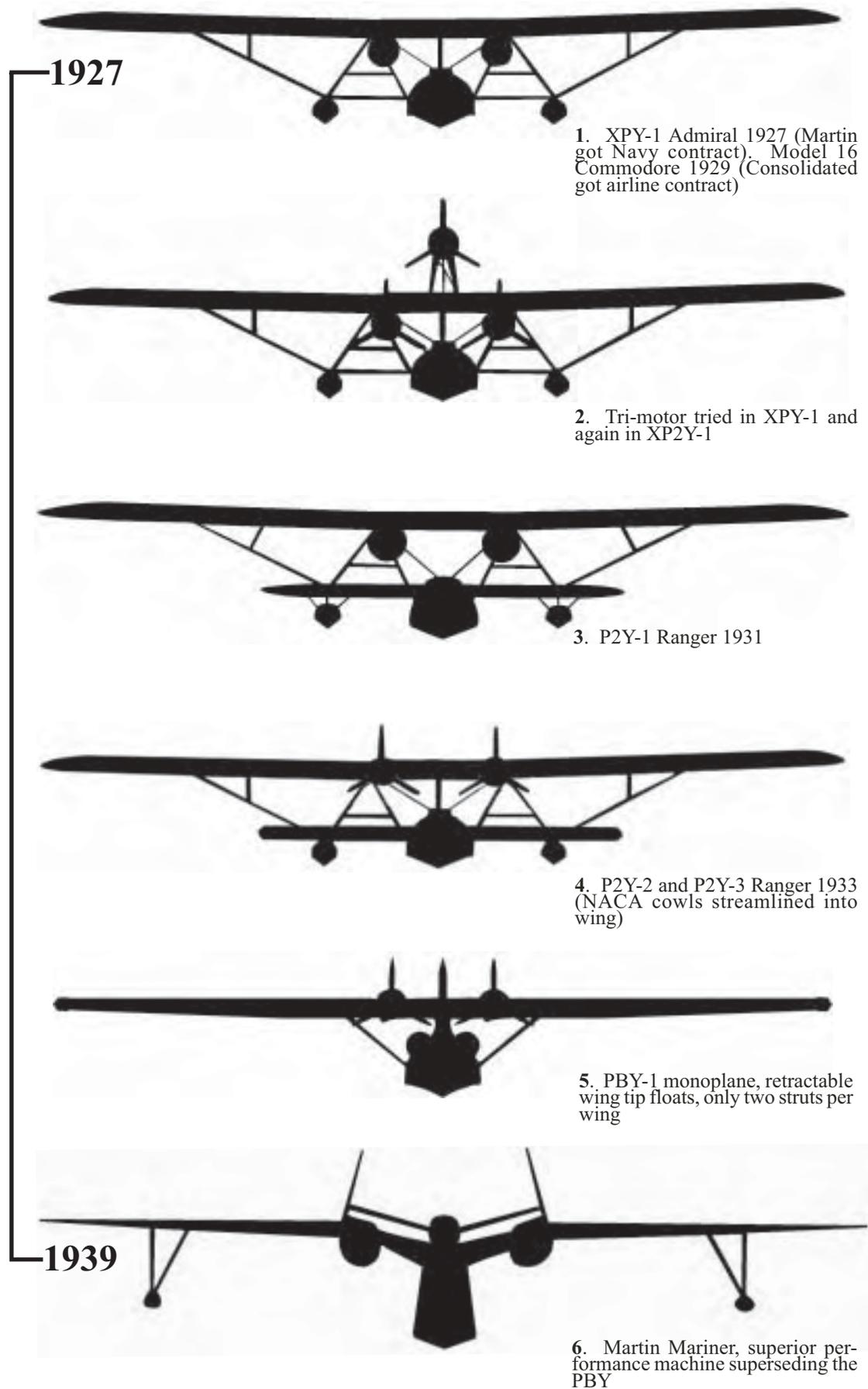


Figure 8. Flying boat lineage illustrating developments in wing and engine layouts over time. Not to scale (Wagner 1976:162; Freeman 1995:145).

Construction of the PBV incorporated new techniques that would later become the standard in aircraft manufacturing. For instance, the PBV was the first aircraft to be built with 'extruded aluminium wing stiffeners and bulkhead boarders' (Creed 1986:28).

Reuben Fleet was faced with a dilemma using Buffalo as the site for Flying Boat production. His aircraft kept hitting submerged ice in the Niagara River during the winter. One solution was to transport Flying Boats by rail to ice free water ways, but the time and expense would prove to be prohibitive as well as impractical. Owing to their size, the Flying Boats had to be disassembled for loading onto freight trains and even still, problems were encountered when trestle bridges were reached. Fleet had three solutions to this problem to choose from: a) stop building Flying Boats, b) build smaller Flying Boats (so they could be transported by rail to ice free water ways), or c) move Consolidated to a more favourable climate (Wagner 1976:160).

Leased factory space in Buffalo meant that Consolidated did not have to invest in infrastructure development. The unpredictable weather, however, was a real detriment to the Flying Boat business and Fleet decided it was time to move. He chose Lindebergh Field in San Diego as the new site for Consolidated's operations.

San Diego offered good weather all year round, a not too congested harbour as well as a locally available skilled work force (Wagner 1976:182). The approval to build the factory was given in 1935 and for the first time, Consolidated had a facility, which was made to suit their requirements instead of having to fit the business into an existing building (Wagner 1976:177). The new factory was dedicated on 20 October 1935; changing the Navy dominated town of San Diego into an important aircraft production centre.

The first production aircraft from Consolidated's new plant was, however, a fighter aircraft known as the P-30 (PB-2A). The Army ordered fifty of these aircraft in December 1934, followed by an order for sixty PBV-2s by the Navy on 29 June 1935 (Creed 1985:35).

PBV-2s were essentially the same as their predecessor, except that ice shields had been added to the outside of the hull adjacent to the line of the propellers. This was to stop ice from flying

off the propellers and damaging the hull. Another difference from the previous model was that the rudder was cut-out to clear the horizontal stabiliser instead of the stabiliser being cut out to accommodate the solid rudder (Wagner 1972:4). The modification of the tail section was to continue until 1943 with the production of the high tail Nomad. Up until this time, directional stability was a characteristic problem with the PBY design (Creed 1985:31).

The USN received its first production PBY-1 in September 1936. VP-11 was the first squadron to receive the new Flying Boat on 5 October (Wagner 1972:4). By June 1937 the PBY-1 contract was completed. The first PBY-2 had been received in May prior to the completion of the PBY-1 order. The remainder were accepted from September 1937 to February 1938 (Wagner 1972:4).

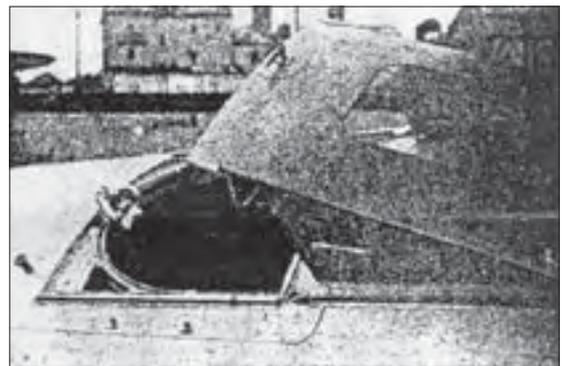
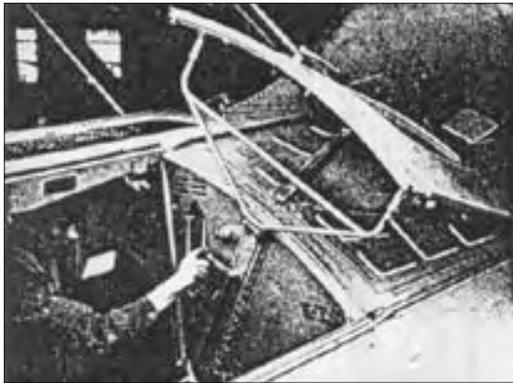
Sixty-six PBY-3s were ordered on 27 November 1936, the first being accepted a year later in November 1937, followed by the remainder from March to August 1938 (Wagner 1972:5). This model of the PBY varied from the previous model by the use of the Pratt and Whitney R-1830-66 engines.

A waist hatch was a feature of the PBY until the development of the waist blister on the PBY-5 and later types. The series of photographs in Figure 9 shows how the waist hatch was made ready for mounting a gun. The waist hatch was an awkward arrangement that gave gunners a bad back and offered limited traverse and visibility (Katz 1999). Subsequent waist blisters, or Mae Wests as they became known, allowed better visibility and better manoeuvrability for the gunner (Photo 10 and Fig. 10). A problem with the blisters, however, was that they made the loading and unloading stretchers difficult.

Thirty-three PBY-4s were ordered on 18 December 1937, the first being accepted in May 1938. The PBY-4s were distinguished from PBY-3s by engines with increased performance. This model had R-1830-72 engines that produced 1,050 horsepower for take off, bringing the top speed to 297 mph at 12,000 feet or 176 mph at sea level (Wagner 1972:5). Thirty-one PBY-4s were accepted from October 1938 to June 1939, with the last three aircraft of the order being



Figure 9. 'Five views of the two decks gun positions. On the left the portion of decking which protects the gunner from the airstream is shown being raised after having been slid forward. The third view shows the side plates in position. Below is a "shot" of the gunner's position from inside the hull and below that is a view showing everything ready for action, except that the gun is not fitted to the track-type mounting which, incidentally, operates very smoothly' (Flight 1939:b).



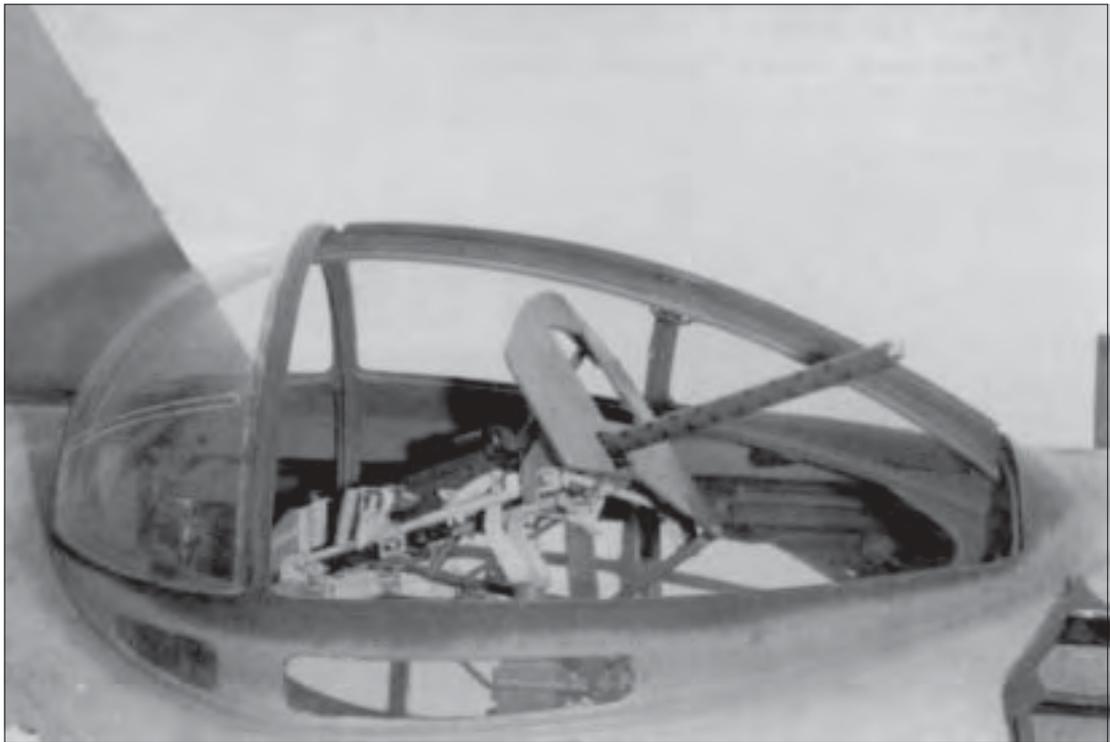


Photo 10. Port waist blister of a PBY-5A with the gun in firing position (Scarborough 1995:23).

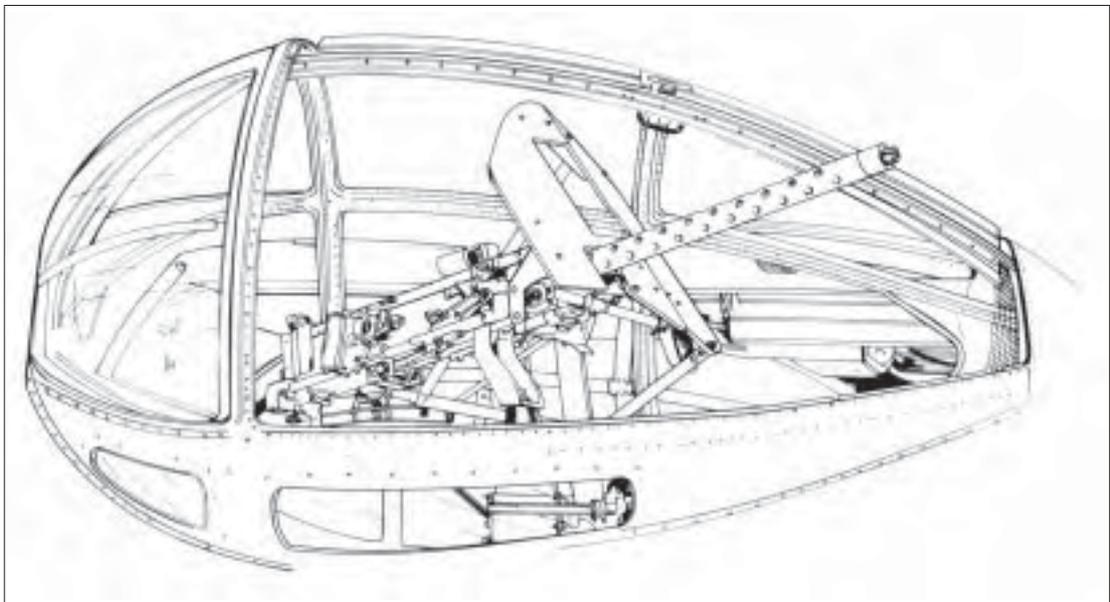


Figure 10. Schematic drawing of a port waist blister on PBY-5s and later types (Scarborough 1995:21).

used for special modifications, that included a new enclosure for the waist hatch (waist blister) and a straight rudder trailing edge (Wagner 1972:5).

Catalina production appeared to be nearing its end with the final delivery of the PB4Y-4s. No new orders were received and Consolidated as well as Martin was testing new types of Flying Boats. The XPBM-1 was to become the Martin Mariner, a twin engine Flying Boat with a dihedral, sea gull shaped wing and twin tail. Consolidated was working on, among other types, the Model 29, PB2Y Coronado, a four engine leviathan. As a result, a general design philosophy regarding Flying Boats was emerging, suggesting that bigger was best.

The onset of WW2, however, affected the events in Flying Boat production, resulting in the choice of this, the Catalina, obsolescent machine with inferior performance. The reason for this was that the PB4Y was a reliable and tested machine that could be produced without delays.

Admiral John Towers is quoted in Wagner (1976) asking Reuben Fleet what aircraft the Navy should buy, should war with Japan eventuate. Fleet's reply is indicative of the reason why PB4Ys were chosen:

Well, Jack, the twin-engine PB4Y has been flying long enough now so that it has most of our ideas in it, and its a damn good ship. You ought to buy it. But I don't think the four-engine PB2Y-1 is worth a damn: Why? Because its a conglomeration of ideas of your engineers and ours. Therefore, it doesn't suit anybody. That's the curse of this business. But before you buy more PB4Ys I'd suggest you wire out to the fleet and see whether those "MAE WEST" gun blisters on the PB4Y-4 model are a success or not (Wagner, 1976:213).

On 20 December 1939 the USN ordered two hundred PB4Y-5s. This represented the largest Naval purchase order for aircraft since World War One, worth US\$20 million (Wagner 1976: 213). While this was significant to US Naval History, Commonwealth orders for more Flying Boats the day war was declared with Germany, resulted in new types being produced (Wilson 1991:16).

The Model 28-MN PB4Y-5 was characterised by observation blisters on either side of the fuselage and changes to the tail surfaces as well as the change to more powerful Pratt & Whitney engines.

This was to become the most numerous of the different types, with 978 made out of a total of 1,854 Flying Boats, not including amphibians (Scarborough 1983:50).

There is only one PBY-5 in Darwin Harbour and that is A24-1. The USN, however, lost a similar looking Catalina to the PBY-5 during the first air raid on Darwin. The third Catalina they lost that day was a Model 28-5MNE, which they had taken over from the Royal Netherlands Naval Air Service (RNNAS) while Patrol Wing Ten (PatWing-10) was in Java. This Catalina was known as #41 according to the PatWing-10 numbering system, explained in the next chapter. The Model 28-5MNE was morphologically the same in every respect to a PBY-5, except that the instruments and gauges were calibrated in metric measurements, instead of US imperial (Dorny 1999a, 1999b).

Thirty-six Consolidated 28-5MNEs were built for the Dutch East Indies. These were completed from August to October 1941. They first arrived in the Indies on 5 September 1941 (Wagner 1972: 8 and 13).

3.4 Development of the Catalina during WW2

England's urgent need for aeroplanes as a result of war being declared with Germany boosted the American aviation manufacturing industry. An initial order of 106 planes was sent to Consolidated Aircraft Company's factory in San Diego, California on the day war was declared with Germany (Wilson 1991:16). This demand for patrol aircraft spurred on further production that meant the rebirth of the Catalina Flying Boat (Wilson 1991:12).

3.4.1 The emergence of amphibians

Reuben Fleet insisted that an amphibious version be made, so as to enable the Catalina to move out of the water and to move up a ramp under its own power after alighting, or land on an airstrip as a conventional aircraft (Wagner 1976:216). The Navy was apparently happy with this arrangement, as they did not have to contend with beaching gear (Wagner 1976:216).

Flying boats had no undercarriage. The reason why these aircraft got so big was that it was always intended that their weight should be supported by water via their hulls. They were, hence, bound to the sea. Flying boats, however, need to come out of the water for maintenance and the way this was done was by using beaching gear. The Flying Boat had to have its beaching gear attached to its hull while in the water and subsequently removed once back in the water prior to flight. Consolidated first developed the system for their Ranger models while they were building Flying Boats at Buffalo. The XP2Y-1 had first beaching gear, but in order to make it work, Fleet filled the tires with water until they were neutrally buoyant (Wagner 1976:158). In Dwight Messimer's (1985) book *In the Hands of Fate* a humorous description is given of one episode involving the attachment of the beaching gear, a task that should have taken ten minutes:

The men were standing in water up to their chests when the heavy leg and wheel assembly slipped out of their hands. At first it did not appear that the fumble would cause any real problem, since the water was relatively shallow and crystal clear. Unfortunately, directly beneath the plane was a hole about fifteen feet deep, and that is exactly where the beaching gear went (Messimer 1985:21).

The recovery of the beaching gear went ahead, once they had managed to send a skin diver down to loop a rope around the leg. Messimer (1985) continues to relate what happened next:

Thirteen sturdy airmen gave Sloatman's order [to haul away] everything they had. Swenson, still gripping the line with his right hand was jerked beneath the surface, and almost reached the bottom before he let go. Abruptly relieved of what little there was at the other end, the men on the beach collapsed like a row of dominoes. The line whipped away from the beaching gear, and settled to the bottom (Messimer 1985:22).

This provides an insight into Flying Boat operations and why beaching Flying Boats was a laborious task, made worse in cold weather conditions and the resultant appeal for a Flying Boat that carried a retractable undercarriage. The amphibious version of the Catalina became the next numerous type made after PBY-5s. Of a total of 3,272 PBY/Catalina/Canso (Canadian designation) production, 1,418 would be amphibians (Scarborough 1983:50).

The order for amphibious Catalinas known as PBY-5As (A - for amphibian) doubled production at Consolidated. The last PBY-4 and the last thirty-three PBY-5s in the USN order were converted

to the amphibious version. The last PBY-4 was redesignated XPBY-5A and first flew in November 1939 (Wagner 1976:216).

The RAAF received forty-six PBY-5As during the war, but information in Table 4 indicates the figure to be thirty-six (Vincent 1981:106; Creed 1985:307). Problems with the tricycle layout of the PBY-5A, however, meant that they had to undergo modification.

The tricycle arrangement of the PBY-5A landing gear added considerable weight and took up space inside the Catalina. The performance figures of the PBY-5A, as a result, compared unfavourably with the PBY-5. The extra weight of the undercarriage added 2,400 lbs. and produced extra drag. This led Flight Lieutenant R. Graft of the RAAF to insist on 13 March 1944, that the 36,500 lbs. take off weight for the PBY-5A was for land operations from an aerodrome and that ‘under no circumstances are they permitted to operate at this weight when taking off from the water’ (Series: A705/1, Item: 9/30/203, National Archives of Australia).

During WW2, the Catalinas flew sorties to far-away targets. In order to achieve their objectives, every bit of space was needed as well as the need to keep the aircraft as light as possible. The Flying Boat was lighter and could travel further with a heavy bomb load than the PBY-5A. Consequently, the RAAF converted many of these amphibious aircraft to Flying Boats known officially as PBY-5A (M), ‘M’ for modified (Vincent 1981:66).

Temporary conversion involved removing the amphibious gear and installing an auxiliary power unit in the port wheel well and food lockers in the starboard wheel well (Vincent 1981:66). Auxiliary fuel tanks were fitted into the main wheel wells during production. These auxiliary

Table 4. US Navy production and serial numbers (Creed 1985:306,307)

Type	Number built	Serial Numbers	Date Ordered	First Delivered	Last Delivered	Contract Number	Remarks
PBY-4	32	1213-1244	18/12/37	5/38	?	58101	VP-1, 18
PBY-5A	100(1st of three batches)	33960-34059	11/10/42	7/43	10/43	NXa 13595	36 to RAAF

tanks were disconnected and left in the main wheel, so that the minimum amount of water was shipped during take off. The nose wheel well compartment was temporarily boxed up using plywood or light alloy boxes (Series: A705/1, Item: 9/30/203, National Archives of Australia).

Prototype modifications to permanently seal off the wheel well compartments were well underway at No. 1 Flying Boat Repair Depot (1FBRD) with the method of the modification shown in Photo 11 and Photo 12. The keelson is carried through the nose compartment. The nose wheel well was blocked off by constructing frames and stringers across the opening. Two frames and four stringers were fitted to support the skin. Later advice from the U.K. suggested that the Sanders and Roe method was faster than constructing new frames and stringers.

The Sanders and Roe method used the existing nose wheel well doors and sealed them shut. This presented a short cut to sealing the nose wheel well, but not the main wheel wells (Series: A705/1, Item: 9/30/203, National Archives of Australia). For the main wheel wells, an unsealed metal cover was suggested for the skin as an alternative to the complicated method. This method would not only be faster to work with, but it also ensured that no water would be shipped during take off.

The tare weight of aircraft modified by using either method was about the same at 350 lbs. heavier than the PBV-5. A minute sheet written by Wing Commander H. Smith, dated 26 February 1944, states that 1FBRD was making sufficient parts to modify the Catalinas according to the frame and stringer method, the most difficult. Smith had requested that the first five PBV-5As be modified in this way, but that subsequent aircraft be modified using the simple, more expedient method (Series: A705/1, Item: 9/30/203, National Archives of Australia). Given that A24-69, the PBV-5A lost in Darwin Harbour, was the first of its type in the country, it is a valid assumption that the aircraft was modified according to the complex, more permanent method.

A cut out section of aluminium was used as a patch on the outside of the hull. Photo 33 shows the modification underway, with a patch already on the starboard wheel well. Catalinas modified

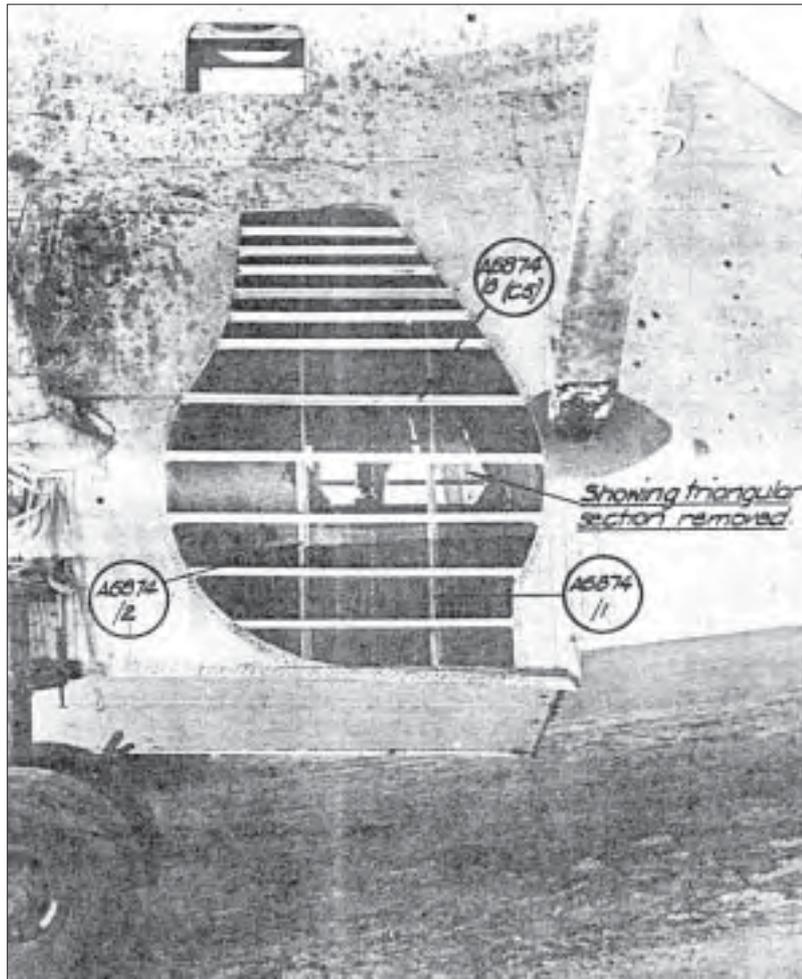


Photo 11. Sealing off the main wheel well compartment of a PB5-5A (Series: A705/1, Item: 9/30/203, National Archives of Australia).

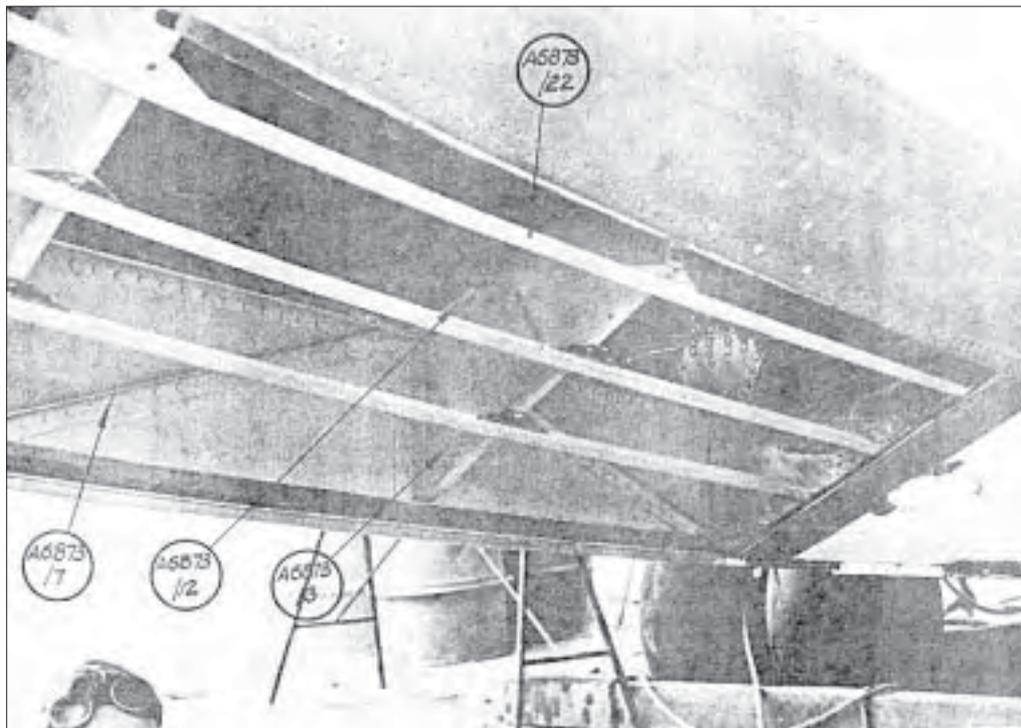


Photo 12. Sealing off the nose wheel compartment of a PB5-5A (Series: A705/1, Item: 9/30/203, National Archives of Australia).

in this way would have had scars for life as the wheel well was patched according to the shape of the initial opening in the hull, leaving a distinctive mark.

While A24-69 was the first of its type received by the RAAF, it was also one of the first batch of PB5Y-5As to be produced (see Table 4). Wagner (1972:16) states that ‘the first PB5Y-5As had one .30 calibre gun in the bow, later ships had two, with 2,100 rounds’ (compare Photo 13, 14, Fig. 11 and 12). The bug-eye turrets were made at the Naval Air Station for installation in PB5Ys already in service and radar started being built into the Flying Boats on the assembly line in May 1942 (Wagner 1972:16).

3.4.2 The Canadian PB2B-1 of 1943

The Boeing Aircraft Corporation’s plant in Vancouver, Canada, assisted by the British Purchasing Commission, continued building Catalina Flying Boats after production ceased at Consolidated’s San Diego plant in March 1944 (Wagner 1963:299-300; Wagner 1976:216). The Vancouver plant produced a new model Catalina Flying Boat called the PB2B-1 (Vincent 1981:77). A total of 240 PB2B-1s were built, but the RAAF received only seven. A24-206 was the last to be delivered (Scarborough 1983:50). The other six PB2B-1s arrived on the following dates: A24-200 (11 November 1944), A24-202 (24 November 1944), A24-203 (3 December 1944), A24-204 (22 December 1944), A24-201 (27 December 1944), A24-205 (4 January 1945) (Hendrie 1988:207).

Boeing began Flying Boat construction on an order for fifty-five PB5Y-5As, which they called the Canso. The first delivery to the Royal Canadian Air Force began on 27 July 1942. Deliveries of the 240 PB2B-1s began after July 1943 (Table 5). These machines were built with lend-lease funds for the RAF, RAAF and the Royal New Zealand Air Force (RNZAF). The British called them Catalina IVBs (Pearcy 1996:116).

The PB2B-1, otherwise known as the 200 series, was one of the later types of Catalina Flying Boats lost in Darwin Harbour. The most distinguishing feature of this type of Catalina was ‘the



Photo 13. The standard type gun turret on pre-PBY-5A Catalina types with the single .30 in. calibre machine gun (Kinzey 2000:56).

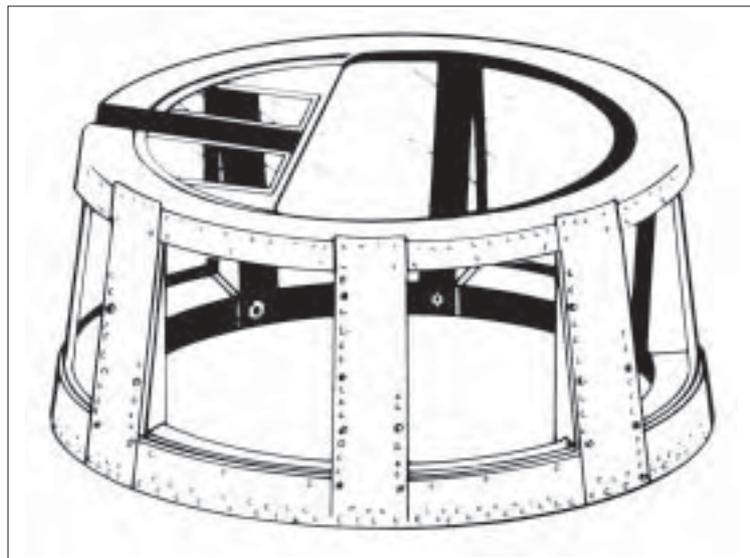


Figure 11. Line drawing of the standard type gun turret on early Catalinas (Scarborough 1983:34).



Photo 14. Bug eye turret on the PBY-5A and later Catalina types with twin .30 in. calibre machine guns (Scarborough 1995:16).

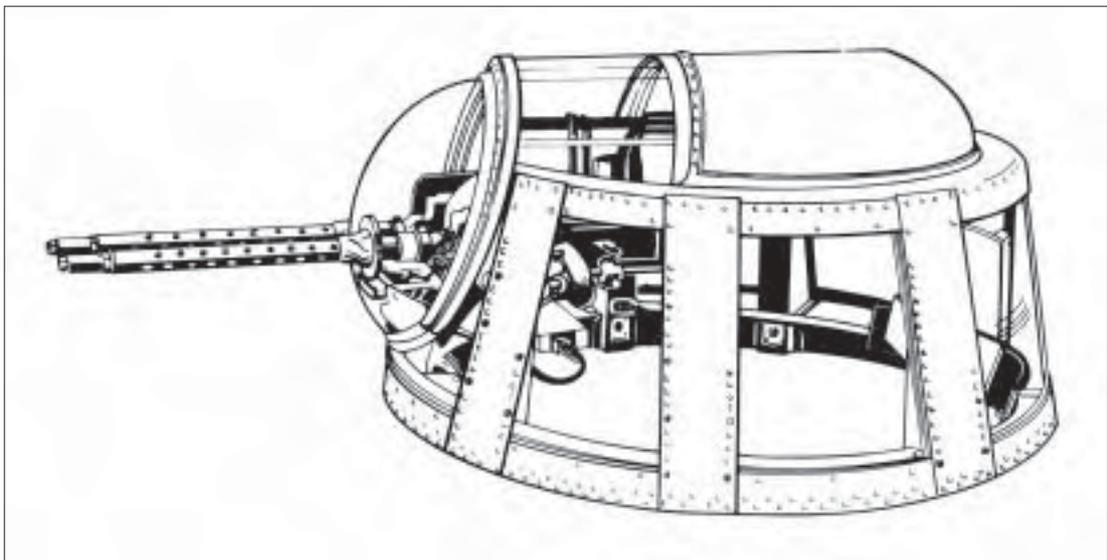


Figure 12. Line drawing of a bug eye turret on the PBY-5A and later Catalina types (Scarborough 1983:34).

Table 5. *PBYs built on non-navy contracts (Darwin Harbour types only) (Creed 1985:308; Percy 1996:115)*

Type	Number built	Serial Numbers	Date Ordered	First Delivered	Last Delivered	Contract Number	Remarks
Catalina 1 (PBY-5)	9	A24-1 to 18	?	2/41	10/41	AUS58 (SO-4)	Australia
PB2B-1 IVB,	240	72992 - 73116	31/12/42	7/43	10/44	NOa-782	Catalina JX270 - 617; 7 to Australia

radome mounted disk driven by an electric motor which replaced the mass of aerials on the earlier PBY-5 and 5A models' (Vincent 1981:77). Photo 15 shows the radome above the cockpit of a PBY-6A, the same as what would have been fitted on the Canadian built A24-206.

The pressures of war meant that something had to be done to protect the fuel tanks from bullet hits. According to LeBaron (2000a), Catalinas that had the R-1830-92 engines, such as the PB2B-1s, almost certainly had the bullet proof tanks. Catalina types built after the PBY-5 had their fuel tanks lined with a rubber like substance, similar to the consistency of PRC compound. This compound was also used for the leading edge of the wing.

When the fuel tank was punctured 'the contact with avgas makes the rubberized material foam and swell up, effectively sealing the leak (Dagnese 2000). The concept worked well for punctures caused by weapons of up to .50 calibre, but was ineffective against cannon fire. Self sealing fuel tanks were only a temporary measure as once the fuel level went below the puncture, the hole would start to leak again if refuelled without repair (Dagnese 2000).

Earlier unprotected fuel systems carried 1,750 gallons, whereas the self sealing fuel tanks protected 603 gallons of a 1,478 gallon total capacity (Wagner 1972:16). The self-sealing liners, as a result, decreased the fuel carrying capacity of the later Catalina types by 272 gallons and added considerable weight.

The Americans had developed radar further after the British had used it successfully in the Battle of Britain, by installing the first operational ASV (Air-To-Surface Vessel) radar on board



Photo 15. The radome mounted above the cockpit of a PBY-6A, similar to the one mounted on A24-206 (Kinzey 2000:73).

USN Martin PBM-1 Mariners for anti-submarine patrols. By 1942, the ASV radars were being installed in Catalinas, which effectively enabled the aircraft to see in the dark (Knott 1981:90-91). These early ASV radar were simplistic in comparison to the new radome which was fitted to the PB2B-1 Catalina. The radome operated much like the turning radar bar that can be seen on surface vessels today, except that it was enclosed in a football shaped housing that made the unit aerodynamic. Figure 13 shows some of the diagnostic attributes of the PBY-4, PBY-5A and the PB2B-1.

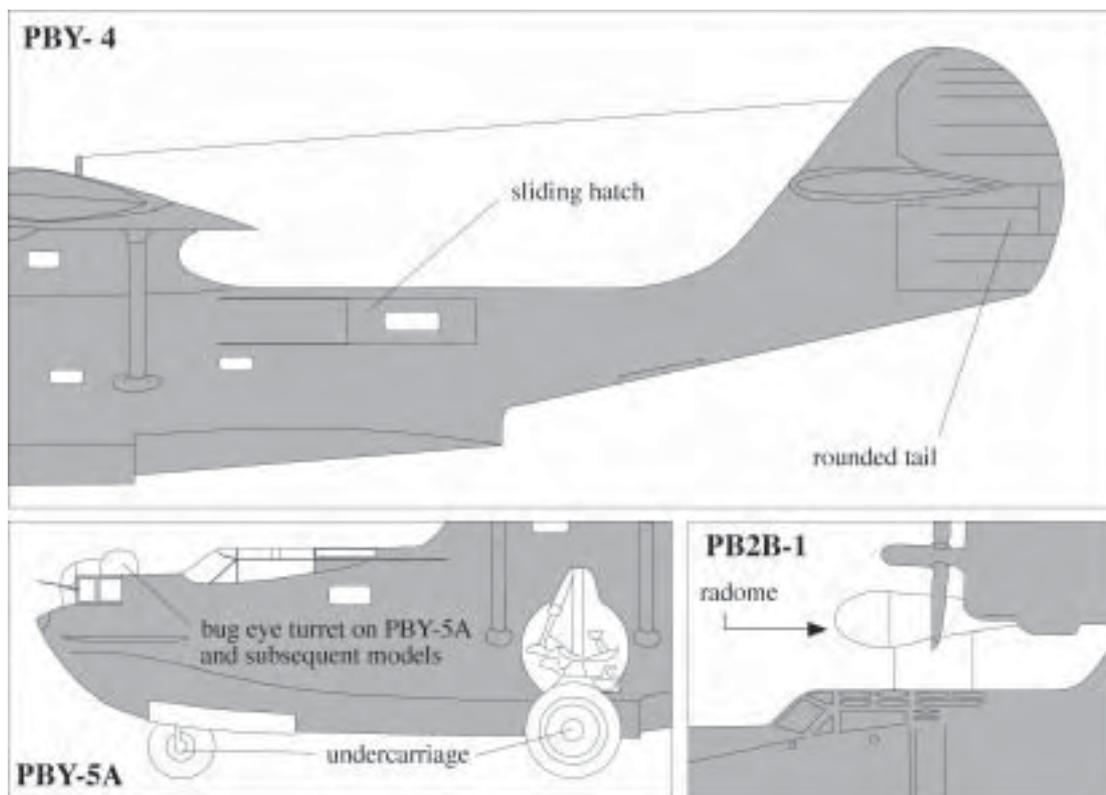


Figure 13. Diagnostic attributes of the tail, gun turret, undercarriage and radar on the different types of Catalinas wrecked in Darwin Harbour (After Knott 1979:177; Knott 1981:138).

3.5 Catalina engine diagnostics

The early PBY-4s had Pratt & Whitney R-1830-72 Twin Row Wasp engines. These engines had a number of diagnostic features, namely: 1) an air cooler on top of the cowling, an oil cooler set into the leading edge of the wing outboard of the engine and propeller spinners for aerodynamic purposes. The spinner is the only diagnostic feature of the PBY-4 (Figure 14 and Photo 16). The last of the PBY-3s, however, were converted to PBY-4s, which had the same diagnostic features of a PBY-4, making their identification in photographs more difficult (Photo 17).

Prior to the Pratt and Whitney R-1830-72, the smaller counterweight propellers could be tolerated without a spinner (Graham 1999a; Sawruk 1999a). As a result, the PBY-3s had a propeller hub that resembled a short, flat capped tube, sometimes referred to as a top-hat spinner (Graham 1999b).

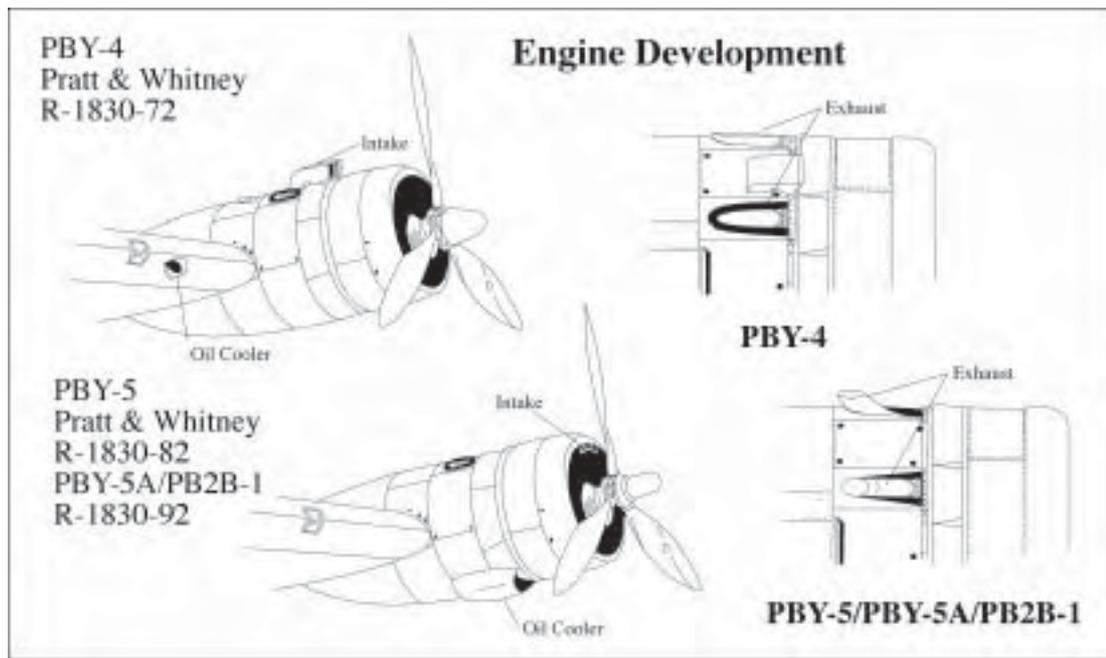


Figure 14. Engine developments from PBY-4 to PBY-5 engines. Note: both PBY-5As and PB2B-1s had the same engine type (After Scarbrough 1983:24).



Photo 16. 'Spinners were fitted on the propeller hubs of PBY-4s, and they were an identifying feature of this variant' (Kinzey 2000:31).

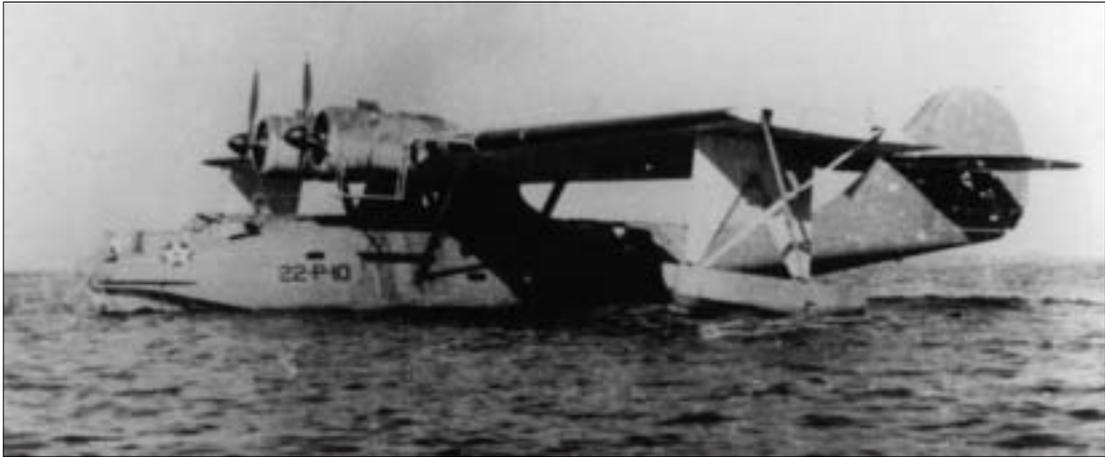


Photo 17. A US Navy Catalina 22-P-10 (BUAERNO: 0875) of Patrol Wing 10 on Darwin Harbour in August 1941. This aircraft is a PBX-3, but note the spinners, which were a diagnostic feature of PBX-4s (Duncan Jenkins Collection PH106/9, Northern Territory Library).

With the development of the R-1830-82 and subsequent engines, horsepower went up to 1,200 compared with the 1,050 hp of the R-1830-72 engines. These more powerful engines were not fitted with counter weights, but were capped with a short cylindrical shaped spinner. The conical spinner on the R-1830-72 engine/propeller combination is, as a general rule, restricted to PBX-4 models.

Some model PBX-4s, however, had later attributes modified to their structures. The last three PBX-4s, for instance, had experimental waist blisters, a characteristic feature of the PBX-5 and later types. Similarly, Consolidated used the last aircraft of the PBX-3 order as experimental versions of the PBX-4 (Dorny 2000a; LeBaron 2000b).

Catalina engines that followed the R-1830-72s were the R-1830-82s on the PBX-5s, while later model Catalinas, such as the PBX-5A and the PB2B-1 all had the R-1830-92 Pratt and Whitney Twin Row Wasps. The R-1830-82 and the R-1830-92 engines were identical in appearance and varied only by power output (Photo 18).

3.6 Discussion of Catalina diagnostic features

Whipple (1995:11) points out that aircraft, by virtue of the unforgiving nature of the environment they operate in, ‘incorporate redundant critical systems and a systematic process of inspection



Photo 18. The Pratt & Whitney R-1830-92 engine. Note the oil cooler below the engine to left on the nacelle and the air intake inside the cowling (Kinzey2000:48).

and replacement of components' and as a result, aircraft engines were 'replaced on the basis of time in operation and condition' (Whipple 1995:11). Engine changes, therefore, were a necessary process in the life of an aircraft. Developments in the engines of the PB4Y-1 through to the PB2B-1, represented in the Darwin Harbour sample, were progressively moving towards more powerful power plants, producing better performance (Appendix 2).

Given the long engine running times of the USN PB4Y-1 Catalinas that had travelled from the Philippines to Darwin, could their engines have been upgraded to later, more powerful version Pratt and Whitney's? There is a tenuous link between engine type and aircraft identity. Engine changes were performed throughout the operational life of an aircraft, but whether this affects how archaeologists can interpret engines on aircraft wreck sites as diagnostic features of aircraft type, will be tested in this thesis.

The range of diagnostic attributes differentiating between the types of Catalina Flying Boats lost in Darwin Harbour is listed in Table 6. These are essential surface diagnostic attributes, predicted to have survived in the archaeological record. The term surface diagnostics, in this thesis, relates to the structural elements of a wreck site.

Surface diagnostic attributes are defined as the structural elements of a Flying Boat wreck site that reflect the integrity of the type of aircraft represented in the archaeological record. For example, the bug eye gun turrets are indicative of models later than the PB4Y-1. Another example is that conical propeller spinners relate to machines prior to the PB4Y-1. Surface attributes, as a result, are inextricably linked to the historical record, that have the potential to provide information on the morphology of the Flying Boats under investigation in this thesis.

Sub surface attributes are those attributes evident in the archaeological record that are indicative of depositional events, post depositional disturbance and *in situ*. degradation of the fabric of a wreck site. Once each of the Catalinas lost in the harbour sank, they in effect left the social system that they operated in and entered into an archaeological system. Some sub surface attributes, therefore, relate to site formation processes that may be indicative of the effects that have acted upon the wreck sites at the time of their loss.

Table 6. Surface diagnostic variables between Catalina types

Catalina Model		PBY-4	PBY-5	28-5MNE	PBY-5A (M)	PB2B-1
Aircraft lost		#4 / #8	A24-1	#41	A24-69	A24-205 A24-206
Air intake	nacelle	0	1	1	1	1
	cowling	1	0	0	0	0
Engines	R-1830-72	1	0	0	0	0
	R-1830-82	0	1	1	1	0
	R-1830-92	0	1	1	1	1
D/F loop	wing	0	1	1	1	1
	cockpit	1	0	0	0	0
Metric gauges		0	0	1	0	0
Oil cooler	wing	1	0	0	0	0
	nacelle	0	1	1	1	1
Conical prop. spinners		1	0	0	0	0
Cylindrical prop. spinners		0	1	1	1	1
Self sealing fuel tanks		0	0	0	0	1
Radar	ASV	0	1	0	1	0
	Radome	0	0	0	0	1
Rudder	Rounded	1	0	0	0	0
	Squared	0	1	1	1	1
Turrets	standard	1	1	1	0	0
	bug eye	0	0	0	1	1
Waist blisters		0	1	1	1	1
Waist hatches		1	0	0	0	0
Wheel well modifications		0	0	0	1	0
Total variables		8	10	10	11	10

An important clue to identifying sub surface attributes on the Darwin Harbour Catalina wreck sites lies in the historical record of the loss of the machines. Given that they were lost due to different circumstances, ie., some burnt and one (or perhaps two) were blown up, it is predicted that the evidence for the cause of their loss should be traceable in the archaeological record.

There are, hence, two sets of attributes available for study that archaeologists can use to identify the Darwin Catalinas. One set consists of surface attributes that indicate the morphology of types of Catalina Flying Boats. The second set contains sub surface attributes that relate to site formation processes.

3.7 Conclusions

The Catalina Flying Boats lost in Darwin Harbour offer archaeologists an opportunity to study the development of this type of Flying Boat, as there were five types lost. The Catalina Flying Boats were lost during different events, over a period of time and as a result, different types of Catalina Flying Boats are represented in the archaeological record. These different types present archaeologists with a set of surface attributes, by which individual aircraft can be identified out of a group of aircraft wrecks in the same area.

The following chapter relates the background histories of each of the machines lost in Darwin Harbour and provides a description to how they were lost. An appreciation of the events that caused the loss of each of the machines is important in developing an understanding of the site formation processes and other sub surface attributes that may provide addition clues as to how to identify the wreck sites.

CHAPTER 4: CATALINA SERVICE HISTORIES AND ACCOUNTS OF LOSS

4.1 Introduction

The purpose of this chapter is to detail the individual service histories of the seven Catalinas that are said to be wrecked in East Arm. An historical synopsis is presented, based on a critical review of both primary and secondary sources.

There were three phases of Catalina losses in the Northern Territory. The first phase was in 1942 when the Japanese sank three USN Catalinas at their moorings in East Arm, Darwin Harbour and shot down one near Bathurst Island in the Timor Sea. The second phase was in 1945 when two RAAF aircraft are said to have been lost due to accidents. The third phase is represented by another two RAAF aircraft losses shortly after WW2.

Currently, there are four located deep water Catalina wreck sites in East Arm, but which loss phase each wreck site belongs to is unknown. The wrecks represent amorphous aircraft assemblages without a linked history. Like surface vessels, however, the Flying Boats had records kept of their operational lives. Aircraft Status Cards (RAAF) or Aircraft History Cards (USN), for example, were similar to a Lloyds or Customs House Register for shipping, documenting each aircraft's movements, modifications and eventual fate. This historical information provides the identity of those aircraft. The concept of identity is more than just a name. It is also the series of events that an individual aircraft had gone through. This is particularly true in the case of the USN losses, whereby aircraft designation numbers were not unique and were changed according to events that occurred during WW2.

4.2 Darwin Harbour's United States Navy Catalina service histories

Understanding the numbering system for the USN Catalinas destroyed in Darwin Harbour is the key to reconstructing their service histories. The following is an historical break-down of the USN numbering system. I have used this to identify the USN Catalinas that were lost in Darwin Harbour.

At the time of their loss, the aircraft belonged to Patrol Wing Ten (PatWing-10) and were numbered according to what has been referred to as the simple numbering system (Graham 1999b). By the time PatWing-10 had retreated from the Philippines to Darwin, the unit had sustained heavy casualties. As a result, PatWing-10's remaining aircraft, from Patrol Squadrons 101 and 102 (VP-101 and VP-102) were redesignated with wing numbers instead of squadron numbers (Table 7).

PatWing-10 consisted of two squadrons at the beginning of the war, VP-101 and VP-102, with fourteen PBV-1s apiece. These aircraft had squadron serial numbers painted on the side of their hulls, 101-P-1 to 101-P-14 in Squadron VP-101 and 102-P-16 to 102-P-29 in VP-102. There was no aircraft known as 101-P-15 (Graham 1999b). By 23 December, however, VP-102 was decommissioned and merged with VP-101 (Messimer 1985: 87). At about this time, all remaining aircraft in PatWing-10 were redesignated with the simple numbering system. There was one other squadron attached to PatWing-10 and that was VP-22, which joined the wing in early January 1942. VP-22 eventually merged with and operated under VP-101 on 18 April 1942 and was later decommissioned while in Perth, Australia (PatWing Ten War Diary, Microserial 41176; Joll 1982).

Table 7. Chronological designated number changes for aircraft #4 and #8 of Patrol Wing Ten (Aircraft History Cards 1214, 1233; Graham, W. 2001, pers. comm., 25 February)

Designation date	#4 BUAERNO 1214 Unit (Plane #) (Location)	#8 BUAERNO 1233 Unit (Plane #) (Location)
17 Oct 1938	VP-1 (1-P-12) (Hawaii)	N/a
10 Jan 1939	VP-1 (1-P-12) (Hawaii)	VP-18 (18-P-8) (San Diego)
Jul 1939	VP-21 (21-P-12) (Hawaii)	VP-18 (18-P-8) (San Diego)
Sep 1939	VP-21 (21-P-12) (Philippines)	VP-13 (18-P-8) (Hawaii)
Jun 1940	VP-26 (21-P-12) (Hawaii)	VP-26 (18-P-8) (Philippines)
Jun 1940	VP-26 (21-P-12) (Hawaii)	VP-21 (18-P-8) (Philippines)
Oct 1940	VP-26 (21-P-12) (Philippines)	VP-21 (18-P-8) (Philippines)
Dec 1940	VP-102 (102-P-27) (Philippines)	VP101 (101-P-8) (Philippines)
20 Dec 1941	VP-102 (102-P-27) (Surabaya)	VP-101 (101-P-8) (Surabaya)
Jan 1942	PatWing-10 (#4) (Surabaya)	PatWing-10 (#8) (Surabaya)

VP-22 departed Hawaii on 3 January with new PBY-5s, bound for Darwin, via Townsville to reinforce PatWing-10. All of the squadron's PBY-5s were previously from VP-51. They were also the first PBY-5s produced for the USN (LeBaron 1999a). The squadron departed in two groups of six planes each. The two groups reached Darwin on different days, the first arriving on 10 January 1942. The second group arrived in Darwin on 11 January (Messimer 1985: 155). As a result, however, of the worsening military situation for the Allies, detachments from VP-22 were dispersed from Darwin and only three aircraft of VP-22 stayed in the Northern Territory. These were #10 (ex-22-P-2), #18, BUAERNO 2306 (ex-22-P-4) and #16, BUAERNO 2309 (ex-22-P-6) (Graham 1999a; Dorny 2000b; PatWing Ten War Diary, Microserial 41176). Catalina #18 is sometimes erroneously referred to as 22-P-9 (BUAERNO 2304), but 22-P-9 later became #13 (Graham, W. 2001, pers. comm., 25 February). The squadron, however, never functioned as a complete unit throughout its assignment with PatWing-10, which was by this stage of the war spread-out across a 1,300 mile front stretching from Surabaya on Java to the Tanimbar Islands in the Banda Sea (Messimer1985:223-224).

The three Catalinas sunk in Darwin Harbour during the first Japanese air raid on 19 February 1942 were all from VP-101. They are identified as # 4 (BUAERNO 1214), #8 (BUAERNO 1233) and #41 (no BUAERNO) according to the simple (wing) numbering system (Aircraft History Card, BUAERNO 1214; Aircraft History Card, BUAERNO 1233). The origin of #41 is different to aircraft #4 and #8 and this will be explained further on. It is suffice to state, for the moment, that this aircraft did not have a BUAERNO because it was a non-US military forces contract order (Sawruk 1999b). Only aircraft built for the USN had BUAERNOs allocated to them, the rest were outright cash purchases.

PatWing-10 moved a detachment of its units from Surabaya to Darwin during 9 and 10 January 1942. The detachment consisted of six aircraft, three from VP-101 and three from VP-22. Two of the PBY-5s from VP-22 were out on patrol on the morning of the air raid. The third aircraft from VP-22, #16, flown by Lt. (jg.) R. S. Bull was shot down previously on 5 February while on Patrol to Ambon prior to the air raid on Darwin (Dorny, 2000b and PatWing Ten War Diary, February 1942, Microserial 41176). Ensign Hargrave was Bull's co-pilot. He returned to Australia some time later and was the only survivor (Hargrave 1942; Knott 1981:56).

The two key US Naval historical documents (Aircraft History Cards and PatWing Ten War Diary) relating to the Catalinas lost in Darwin Harbour refer to the aircraft by their wing numbering system. In order to trace the service histories of these aircraft, however, it is vital that their previous designated numbers are understood according to the chronological sequence of events relating to their deployment in the South West Pacific. Aircraft numbers changed according to deployments with other units and as a result of casualties sustained during the opening stages of the war in the Pacific. The following retraces PatWing-10's origins and presents a history of events, relating specifically to the role played by the four aircraft which would later be lost in Australia's Northern Territory.

US military planners had foreseen the possibility of war with Japan and had provided their aging Asiatic Fleet with long range reconnaissance bombers, the PBY Flying Boats. VP-21 with fourteen PBYs arrived in the Philippines in 1939 to act as scouts, finding the Japanese at sea (Davis n.d.). The deployment was an indispensable part of the planned defences for the Philippines. The USN's role was to intercept the advancing Japanese forces off-shore and either drive them back, or damage them to such an extent that they would be weakened sufficiently for General Douglas MacArthur's American and Filipino troops to destroy them on the beaches (Messimer 1985:7). The PBY was an excellent patrol and air sea rescue aircraft for its time. However, it proved to be completely unsuited to daylight, high-level horizontal bombing missions. It was used for this purpose nonetheless, as no other aircraft were available.

B-17 army bombers were also reinforcing the Philippines. These aircraft flew further, faster and could carry heavier armament than the PBY, but the reason they were not used for the missions given to the PBYs was that fleet operations depended upon the observations and reports of its naval aviators. One other reason was that the B-17s could only operate from land bases in the Philippines. This meant that when they ran low on fuel, they had to return to base, whereas the PBYs could alight on water and refuel from a seaplane tender, which could move around within the area of operations (Messimer 1985:7). With prior planning, fuel caches could be established on Islands anywhere in the Pacific, enabling the PBYs to operate without the establishment of prepared airfields.

A problem with the use of the PBYS for bombing missions was their vulnerability to attacks by fighters. Apart from the large size and slow speed of the PBYS, other factors did not make it a suitable aircraft for the role it would be used for. The early PBYS did not have self sealing fuel tanks, which meant that when they were hit, they would ignite, often sending the aircraft down in a ball of flames. The PBY also lacked sufficient armament to defend itself. The forward gun turret, for instance, was open to the elements. Firing the single 0.30' machine gun in the bow position, and hitting the target was difficult owing to the wind buffeting the gunner and gun as the aircraft moved through the air at 110 knots. Gunners in the waist positions had the same difficulty in bringing their guns to bear and prior to the development of the waist blister, also had limited manoeuvrability as they had to fire the waist guns through a sliding hatch in the fuselage behind the wing (Messimer 1985:7-8).

The PBY's vulnerability to fighter attack was to be solved by the use of escorting army fighters (Messimer 1985:8). It was not foreseen, however, that the Japanese would destroy the fighters, mainly on the ground, leaving the PBYS with the same problem. Many PBYS would consequently be shot down as a result of their continued use in daylight bombing missions.

Out gunned and out numbered, PatWing-10 would soon retreat to Australia. The retreat of the PBY squadrons from the Philippines to Australia was to result in the fastest and furthest retreat in military history (Messimer 1985:158). The archaeological manifestations of this retreat survive in the form of three aircraft wrecks in Darwin Harbour.

By June 1940, VP-21 aircraft had been in constant service since 1938 and were in need of a major overhaul. VP-26 had recently had their aircraft serviced in Hawaii and a decision was made to exchange their aircraft, for the worn-out PBYS of VP-21. The exchange was made at Sangley Point in the Philippines. In December 1940, VP-26 returned to the Philippines in the overhauled PBYS and joined VP-21. The two squadrons VP-21 and VP-26 were redesignated VP-101 and VP-102 respectively. PatWing-10 was formed in December 1940 to control these two PBY-4 squadrons (Messimer 1985:11; Graham, W. 2001, pers. comm., 25 February).

As previously mentioned, VP-102 was formerly known as VP-26. However, VP-26's squadron lineage starts as VP-18, which later became VP-13 (Douglass 1999). This squadron was flying P2Ys in 1938, out of Pearl Harbor, but was later transferred to San Diego for transition to new PBYS. Patrol Wings were instituted in 1939 and VP-18 was redesignated under Patrol Wing One as VP-13. The squadron, with new PBYS-4s, then flew back to Pearl Harbor and upon their arrival were made part of Patrol Wing Two and redesignated VP-26 (Douglass 1999).

The fact that aircraft #4 and #8 were PBYS-4s is a historical irony. PatWing-10 had to fight the opening stages of the war with out-dated PBYS (Messimer 1985:60). It was with some resentment that PatWing-10 aircrew watched the Marine Luchtvaart Dienst (*MLD* or Royal Netherlands Naval Air Service - RNNAS) take delivery of new PBYS-5s in November 1941 at Manila Bay, while they had to contend with obsolete aircraft (Messimer 1985: 24). Pilots from Consolidated Aircraft Company had flown these aircraft to Manila, whereby Dutch pilots later flew them on to Surabaya. PatWing-10, however, would take-over 5 of these new aircraft in Surabaya. One of these five ex-*MLD* aircraft was the third PatWing-10 aircraft lost in Darwin Harbour: #41.

The war came to the Philippines the same day Pearl Harbor was attacked. Clark, Nichols and Ibo airfields were bombed on 8 December 1941 (7 December east of the date line), destroying nearly all of the army B-17s and P-40 fighters on the ground, virtually neutralising the United States air power in the Philippines (Crocker 1987:21). According to Messimer (1985:45), the effect on PatWing-10 was as if their own aircraft had been destroyed. Without the fighter escort the PBYS needed to survive against fighter attacks, many aircrews must have thought that it would only be a matter of time before that they too would be destroyed.

The USN yard at Cavite was bombed on 10 December at the same time Laguna de Bay was attacked. Two aircraft were lost P-12 while alighting on Laguna de Bay and P-5 while attempting to take-off from the same location (Messimer 1985:56-57). On this day, #4 (flown by Ens. Collins) departed Los Banos for the USS *William B. Preston* (AVP-20, ex-AVD-7, ex-DD-344), which was at Polloc Harbour (PatWing Ten War Diary, Microserial 41176). By day two of the war in the Pacific, PatWing-10 had lost only two aircraft. The causality rate increased

when seven aircraft, moored in a line on Olongapo, were destroyed when attacked by five Zeros (Japanese fighter aircraft) on 12 December 1941 (Messimer 1985:60). Catalina #4 (102-P-27) flew to TuTu bay on 12 December, but was still attached to the *Preston* (PatWing Ten War Diary, Microserial 41176). The situation on Luzon was untenable and Admiral Hart ordered Wing Commander, Captain Frank D. Wagner to move PatWing-10 to Java (Messimer 1985:64). The move commenced on the night of 13-14 December when a messenger was sent to inform all of the crews sleeping aboard their aircraft, which were camouflaged along the shore of Laguna de Bay, that it was time to leave. Only six of the nine aircraft on Laguna de Bay left that morning at 0430 hours, leaving three behind. Apparently the messengers had failed to locate these three aircraft in the dark night to inform their crews of the move (Messimer 1985:65).

Messimer (1985:65) lists an aircraft, which he refers to as 'plane 8' having been amongst the group of aircraft that departed Laguna de Bay that night. The 'plane 8' referred to is 101-P-8 ie., #8.

On 15 December 1941, all of the PatWing-10 units which had left Manilla were either resting on Lake Lanao or en-route for Balikpapan on the Island of Borneo. Catalina #4 departed the *Preston* (in TuTu Bay) and arrived at Lake Lanao on 14 December 1941 (PatWing Ten War Diary, Microserial 41176). Assuming that the group, which departed on the night of 13 December, including #8 were going to Balikpapan, #4 was probably waiting on Lake Lanao as well (Messimer 1985:74). Lake Lanao, by this time had ten PBYS awaiting further orders, which came on 17 December 1941.

The Lake Lanao group departed for Lake Tonadano near Manado on 17 December 1941, but facilities at Tonadano were discovered to be vulnerable to attack. On the same day that the PBYS departed Lake Lanao, the sea plane tender USS *Childs* was attacked by a Mavis Flying Boat while approaching its anchorage in Manado. The PBYS were subsequently diverted to fly straight to Balikpapan, for fear of further attacks on Manado (Messimer 1985:79).

The main group of PBVs from Lake Lanao reached Balikpapan without incident. Catalina #4 is recorded to have been there on 19 December 1941, with nine other Catalinas attached to the USS *Childs* (PatWing Ten War Diary, Microserial 41176). PatWing-10 was, however, now stretched out along a line 1,200 miles long ‘with less than a third of its planes and three tenders in Borneo, one tender at sea, and half its personnel still in the Philippines’ (Messimer 1985:80). Catalina #4 left Balikpapan for Surabaya on 20 December 1941 (PatWing Ten War Diary, Microserial 41176). All PatWing-10 units left Balikpapan for Surabaya by 21 December 1941 (Messimer 1985:87).

Surabaya provided excellent seaplane maintenance facilities. The Dutch had built the world’s largest Flying Boat base at Morokrebang, in Surabaya Harbour, whose facilities PatWing-10 used to service and repair their worn-out Flying Boats. Their Flying Boats had not been out of the water since the war started. It was also during this time that PatWing-10 underwent a re-organisation resulting in VP-102 merging with VP-101:

Along with servicing and repairing the planes, the badly depleted wing underwent a major reorganization. Because most of the pilots had been brought out with the planes, there were many more pilots than available planes. Many of the senior pilots, mostly lieutenants, were given assignments on Captain Wagner’s staff. The reorganization also included merging VP-101 and VP-102 into one squadron, VP-101. Peterson was named squadron commander with Neal as his executive officer. It made sense. There were not even enough planes for one squadron, much less two (Messimer 1985:87).

Despite the merger, 102-P-27 (#4) still maintained its VP-102 designation (Dorny 1999a). It would never have been known as 101-P-27 (Graham, W. 2001, pers. comm., 25 February). Catalina #8 would also still have been referred to as 101-P-8. Therefore, their side numbers remained the same until the designation changes later in January 1942.

Eight of the PBVs in Surabaya were sent to Ambon on 23 and 24 December 1941 (Messimer 1985:87). The Americans felt some obligation to send units to support the Australians and Dutch on Ambon, even though strategically, the island would be indefensible. They left in two groups, with four planes per group. Catalina #4 was in the second detachment of four planes and arrived at Ambon on 24 December 1941 (PatWing Ten War Diary, Microserial 41176).

Two more went to Ambon on 25 December, bringing the total number of Catalinas in Ambon to ten (Graham, W. 2001, pers. comm., 25 February). The Japanese had landed on Davao, Jolo and North Borneo by 23 December, effectively isolating the Philippines, preventing any further assistance from the south to MacArthur's forces.

The reported presence of Japanese naval surface vessels in the vicinity of the island of Jolo set in motion PatWing-10's first large scale operation against the Japanese since the war had started. The Japanese ships seen near Jolo, however, were attacked by six of the ten PBYS from Ambon, on 27 December 1941, without the PBYS scoring any hits. The attackers were intercepted by 25 Zero fighters, which were not known to have been on Jolo. As a result of the surprise and by the intense anti-aircraft fire from the ships, heavy casualties were sustained, reducing PatWing-10 to just eight PBYS in total (Messimer 1985:122). The Jolo attack was a failure and another demonstration of the unsuitability of the PBY in high level horizontal bombing attacks. The USN was still learning the hard way, how best to deploy the PBY.

Of interest in the Jolo attack by PatWing-10 is an insight into where #4 (ex-102-P-27) and #8 (ex-101-P-8) were at this time. After their departure from Balikpapan, it is assumed here that all the PBYS were either in Surabaya or Ambon, except for those aircraft that were left in the Philippines. Given that only six of the ten planes that went to Ambon were involved in the attack at Jolo, it is possible that either aircraft may have been operating from Ambon. Neither of them, however, was involved in the Jolo attack and if they were in Ambon, they must have been the two aircraft left behind. One clue as to the whereabouts of #4 is a reference to John Sloatman flying in what Messimer (1985:128) refers to as P-27, which went out looking for survivors of the Jolo attack.

On 30 December P-27 was attacked by Zeros near Sangi Island, north of the Molucca Passage, but escaped by flying into cloud. In this instance, the plane that Messimer refers to must have been 102-P-27. As was mentioned previously, even with the changes in the designation system while at Surabaya, this particular aircraft was always referred to as No. 27. Up until that time, it was only P-27's squadron designation that had changed not the aircraft's individual number.

Therefore, it is a valid inference to assume that #4 was at Ambon in December. As to the whereabouts of # 8, the trail is lost after Surabaya.

Messimer (1985:128) indirectly indicates aircraft #8's location by late December as being also at Ambon. While the aircraft is not directly stated as being there, Messimer relates an incident that leads to the assumption that aircraft #8 was indeed at Ambon. Tom McCabe and Gordon Ebbe in P-8 (Messimer 1985:128), were also looking for survivors from the Jolo attack when they were radioed to look for the USS *Peary* which had gone missing. P-8 found the *Peary* camouflaged against the shores of Ternate. The *Peary* had maintained radio silence so as not give away its position to the Japanese (Messimer 1985:127; Crocker 1987:33-34). P-8 had to alight to tell the captain to come to Ambon. Both the *Peary* and P-8 would later be lost in Darwin. Gordon Ebbe describes the encounter with the *Peary* at Ternate:

We had been nosing around the southern Philippines one day and were coming back near the Spice Islands when I decided to take a turn around a small island with a big, beautiful bay, something along the shore didn't look just right so we made another pass. There lay the USS *Peary* broadside on the beach. The destroyer had been worked over from one end to the other. I don't think they even had their radio working. They were in such a bad shape they had beached the ship and were living under the palm trees. Palm fronds had been cut and were covering the ship to camouflage it.

I landed the PBY all right but the currents through there were so horrendous that the *Peary*'s captain had to send a boat out for me. When I talked to the captain I said "Don't stay here. The Japs are moving down on you. Get on your way to Darwin" (Crocker 1987:33-34).

It is evident from this description that PatWing-10 was gravitating to Ambon, including aircraft #4 and #8. Messimer (1985) must be referring to #8 because this was the only aircraft in PatWing-10, which had the numeral 8 in its designation. VP-22 had an aircraft with the designation 22-P-8, but VP-22 had not joined PatWing-10 at this time.

PatWing-10 was assigned to patrol with RAAF Hudsons from Ambon. The *MLD* were also on Ambon, but left for Surabaya with their PBYs as soon as the Americans arrived (Messimer 1985:133). The military situation by early January for PatWing-10 was, however, relatively stable. Their aircraft were involved in long patrols, which began at dawn. During this time,

PatWing-10 had also received distress signals from Catalina aircrews missing from the Jolo raid and other Allied pilots who had ditched in the sea, involving the wing in air sea rescue work which would become the PBYS' most famous role (Messimer 1985:139).

The PBYS were still, despite lessons learnt from the Jolo raid, being sent on bombing missions against Japanese shipping in full daylight, with an attack on targets north of Manado on 11 January 1942. The target was a fleet made up of two groups. One group was the landing force to take Manado and the other was headed for Tarakan. The significance of these objectives to the Japanese was that their capture would enable Java to be cut-off from Australia and that Ambon would be set up for attack by land based aircraft, which could fly from newly captured airstrips (Messimer 1985:152).

The attack on the Japanese fleet failed. Only one aircraft was lost by PatWing-10, the brunt of the casualties being taken by the RAAF who lost four Hudson bombers (Messimer 1985:154). This now left only five Catalinas in Ambon in VP-101; four had been lost previously (Messimer 1985:158; Graham, W. 2001, pers. comm., 25 February).

This was the last time PBYS were used on high-level daylight bombing missions. Wing Command had finally appreciated that crews in ships could actually see bombs fall from high level aircraft and divert the course of the vessel as necessary. The pilots of the attacking aircraft would seldom anticipate, correctly, the direction the vessels would turn (Messimer 1985:151). From now on, PatWing-10 would only fly reconnaissance and rescue missions.

VP-22 began to reinforce PatWing-10 from 11 January 1942. Departing from Darwin, two aircraft deployed at Surabaya and four went to Ambon (Messimer 1985:156-157). By the time of VP-22's arrival at Ambon, the island was beginning to become untenable, as a result of increasing Japanese pressure. The wing would disperse its aircraft again, falling back to Surabaya and to tenders that were to become the focus of operations (Messimer 1985:159). Lieutenant Commander Frank O'Beirne of VP-22 went to Kendari to establish a Flying Boat base there. The *Preston* (Photo 19) went ahead to act as the detachment's tender while at Kendari (Messimer 1981:4, 11).



Photo 19. 'Darwin, NT. 1942-02. William B. Preston...leaving the harbour after the Japanese air raid on 1942-02-19' (Australian War Memorial, Neg. No. 134961).

O'Beirne departed for Kendari on 12 January with two aircraft. The *Preston* was already there upon their arrival, but before they could alight in Kendari Harbour, a Japanese reconnaissance aircraft spotted the ship. *Preston* had advised the PBYS to return later and not to alight in case they should be attacked. Since the spotting of the Japanese aircraft, both Lieutenant Commander Etheridge Grant of the *Preston* and O'Beirne agreed that Kendari would now be attacked and that they should give up the idea of using Kendari as a forward base. Their assumptions were correct. Kendari was bombed three days later on 15 January 1942.

While Grant and O'Beirne were scouting out Kendari as a forward base, Lieutenant Commander Peterson had returned to Surabaya from Ambon with three of the PBYS, leaving Lieutenant Commander Neale in charge of the remaining aircraft at Ambon (Messimer 1985:158). These PBYS were to undergo major repairs and maintenance at Surabaya. With the addition of the twelve new aircraft from VP-22, it was hoped that some of the older aircraft could be returned to operational serviceability. An additional five aircraft were also transferred to the USN from the *MLD* at Surabaya and it was during this time that PatWing-10 received the aircraft known as #41 (according to the simple numbering system). Aircraft #41 would later be the third USN casualty lost in Darwin Harbour.

After the *MLD* had departed Ambon for Surabaya, negotiations were carried out between American and Dutch officials for transfer of some of their PBVs to the USN. The Dutch had more PBVs than qualified pilots and PatWing-10 had brought more pilots out of the Philippines than it did planes. The transfer was made with some trepidation on the part of the Dutch, but eventually they agreed to give-over five of their aircraft in late January (Messimer 1985:149). These were the newer version PBV-5s, which had better engines, an improved tail design, but most notably, they had waist blisters. These aircraft, were in fact, not PBV-5s, but a variant referred to as the Model 28-5MNE (Dorny 1999b).

The Dutch had placed orders for thirty-six 28-5MNE model aircraft under a direct contract from the Consolidated Aircraft Corporation. As a result, none of these aircraft have BUAERNOs, making them impossible to track through records at the Naval Historical Centre at Washington, DC. These BUAERNOs are the key to tracking aircraft histories and without them, searches cannot be made (Baker, W., 1998, pers. comm., 6 August). Basically, the Americans did not keep records of foreign aircraft, which makes reconstructing the service history of aircraft #41 difficult. What is known about these aircraft is that the *MLD* numbered them Y-37 through Y-72 and that deliveries started in September 1941 via Manila (Dorny 1999b). When PatWing-10 adopted the simple numbering system, this aircraft was given the number #41, which is thought to have been a carry-over from its original *MLD* designation 'allowing a tenuous equation of #41 to ex-*MLD* Y-41' (Dorny 1999b).

It was hoped that the five ex-*MLD* aircraft, together with the aircraft brought in by VP-22, would provide spares to keep the ailing PBV-4s in the air. As indicated above, a valid assumption has been made on the available evidence, that aircraft #8 was in Ambon since it was referred to when contact was made with the USS *Peary* when the ship was hiding at Ternate. Aircraft #8 must have flown from Ambon to notify the *Peary* of the wing's move there and not from Surabaya where other PatWing-10 aircraft were stationed. Since there is no reference to aircraft #4 having been in Ambon, this aircraft must have been in Surabaya since the wing's move from the Philippines. Although it is not stated, aircraft #8 might have been one of the three PBV-4s that Peterson had taken back from Ambon for repairs and engine changes in Surabaya. One thing for certain is that #8 would have been in poor condition, since

it was a veteran of the Philippines and in dire need of a complete overhaul. Peterson would not have left this aircraft in Ambon if its mechanical condition would not allow it to fly patrols.

Once Peterson had returned to Surabaya, the three aircraft, which would later be lost in Darwin, met for the first time since the start of the war. Ambon was bombed on 15 January with the loss of two PBYS: 22-P-8 and 22-P-10 underlying the need for PatWing-10 to disperse its aircraft to other locations (Messimer 1985:163). All of the remaining PBYS on Ambon retreated to Surabaya the day after the raid. From 16 January onwards, PatWing-10 would operate from Surabaya, patrolling up the Makassar Strait. The wing's sea plane tenders, operating from anywhere they found a suitable hiding spot for their aircraft, would cover the Molucca Sea (Messimer 1985:166). Therefore, the Flying Boats, which would be lost in Darwin Harbour later on, would have been either operating out of Surabaya or attached to a sea-plane tender by mid-January. It would not be until Java itself was threatened that PatWing-10 would retreat into Australia.

Catalina #4 (under the command of Lt. jg. Campbell) is recorded to have rescued seven army bomber crew of a B-24, while enroute from Makassar to Surabaya on 25 January 1942. However, this may have been the crew of a bomber that had gone down on Greater Mesalembu Island, under the command of Army Lt. Dougherty, as ships were sighted by #4 in that area (PatWing Ten War Diary, Microserial 41176; Graham, W. 2001, pers. comm., 25 February). The day after, on 26 January 1942, Ens. Gough arrived at Surabaya from a patrol flight. The aircraft was again used for patrol work on 30 January 1942 and the following day (31 January), when it is recorded to have been attacked by fighters, but managed to return to base (PatWing Ten War Diary, Microserial 41176).

Plans for another attack by the Allies against the Japanese were again formulated, despite the shortcomings of the units available to carry out the attack. On 2 February 1942, #4 under the command of Ens. Hendricks, departed Surabaya for a patrol of Makassar Strait and made contact with the Japanese at Balikpapan (PatWing Ten War Diary, Microserial 41176). On 3 February, aircraft #4 from Surabaya took Admiral Purnell to Vice Admiral K. W. F. M. Doorman's flagship, the destroyer RNNS *De Ruyter* to discuss the attack plan. It is ironic that while #4 was on this assignment, Surabaya was being bombed later that day by 138 Kendari based Japanese bombers,

resulting in the loss of, among other aircraft, five unspecified Dutch Flying Boats (Messimer 1985:230). The trip to *De Ruyter* had spared #4's destruction in Surabaya, but the raid signified that Java too, was doomed.

Messimer (1985: 232) refers to aircraft #4 by the slang term P-27. He is referring here to 102-P-27 that was redesignated as simply #4. This shows the importance of understanding the changes in the designation system in order to recognise the specific aircraft histories. The planned attack was on Japanese naval vessels, but of interest here is not the ensuing debacle the Allies would experience, but an unusual and extremely fortunate episode in the life of aircraft #4.

After Leroy Deede, captain of aircraft #4, delivered Admiral Purnell to *De Ruyter*, the aircraft was ordered to a scatter base and to wait there until it was summoned to return back to the ship. Forty-five minutes after he was sent away, Deede returned to the ship. Unfortunately, a lone Zero engaged in strafing Indonesian vessels, spotted #4 and climbed to attack. Deede's gunners were alerted to the danger and fired at the Zero while it was making its climb. The Zero flew into the fire path coming from #4 and 'fell off on one wing and flew directly into the water' (Messimer 1985:232-233). Vulnerable as the PBY was to fighter attacks; quite clearly they did have their occasional victories.

Deede alighted upon the water near to where the Zero had gone down and picked-up the pilot's chart, which was floating on the surface. Deede took off with the chart and headed back to *De Ruyter*, but was again confronted by Japanese aircraft. This time eight twin-engine bombers pursued him, but Deede's gunners put out such a volume of fire that six of the bombers broke off immediately. The two others tagged along at a safe distance for some time, before they too, turned back (Messimer 1985:233). While aircraft #4 was avoiding the Japanese on 3 February, there is reference to aircraft #41 as having been on patrol over Ambon:

Barrett and Jacobson in P-41 were reporting many ships anchored at Ambon, while they dodged antiaircraft fire from a patrolling destroyer. They then flew north, at wave-top level, through Greyhound Strait and ran into three more destroyers, a cruiser, and five transports. Again dodging antiaircraft fire, P-41 climbed for the clouds and headed for home (Messimer 1985: 234).

The aircraft designation in this instance is again, referred to in slang. P-41 is aircraft #41, the ex-*MLD* 28-5MNE model. These incidents demonstrate some of the activities that the USN Catalinas were engaged in, prior to their loss in Darwin Harbour. Wear and tear was, however, beginning to take its toll and soon these aircraft would be too worn out to participate in patrol work.

When PatWing-10 settled in Surabaya Harbour at Morokrembangan, of the original twenty-eight aircraft that they started the war with, only eight had remained. VP-22 had eight aircraft left and there were still the five ex-*MLD* aircraft, bringing the total number to twenty-one available for operations (Messimer 1985:201).

The Dutch aircraft were still being serviced and would not be available for another few days. These, however, were destroyed soon after by the Japanese air raid of 3 February. Messimer (1985:201) also comments on the poor condition of the PBV-4s, which were long overdue for overhaul.

One incident which indicates the location of aircraft #4 by 5 February, was when P-27 alighted near the USS *Childs* to relieve the crew of P-42 which was refuelling off the back of the tender at the time. It is stated that P-27 was too worn out for patrol work and that the relief crew took over P-42 leaving its former crew to return in P-27 (Messimer 1985: 237). The USS *Childs* is said to have been at Soembawa during the transfer of aircraft and crew and it is indicated that during that day, P-27, was left moored to a buoy, instead of going out on patrol. P-41 is referred to again, but this time as having taken off from the USS *Childs* to patrol north toward the Celebes (Sulawesi) on the morning of 5 February 1942 (Messimer 1985:238). There is no reference to P-41's arriving at the USS *Childs* (Messimer 1985: 237). Assuming that it was P-41 and not P-42 which took off from the sea plane tender USS *Childs*, it is nevertheless the last reference to the movements of both aircraft before their loss in Darwin Harbour.

Events in the Southwest Pacific Theatre were beginning to move quickly with the fall of Makassar on 9 February and Bandjamasin on 10 February. The two Japanese naval groups met and were set up to seize Timor, Bali and to attack Darwin (Messimer 1985:242). PatWing-10, in the face

of the Japanese advance began their move to Darwin. By 11 February, PatWing-10 had only twelve operational aircraft, six were based with the *Preston* at Darwin and the other six were at Morokrembangan (Knott 1979:163). Of the Darwin aircraft, four were down for repair (Messimer 1985:242). The Java based aircraft were to patrol up the Makassar Strait to Balikpapan, while the Darwin based aircraft patrolled north to Ambon. It was during his patrol to Ambon in aircraft #18 (ex-22-P-4) that Lieutenant Thomas Moorer became involved in the first aerial combat over Australian territory on 19 February 1942.

4.3 Loss of US Navy Flying Boats in Northern Territory waters

On the morning of 19 February 1942, #18 started out for a patrol to Ambon to search for the Japanese at sea, while #10 (ex-22-P-2) started a patrol to the northwest. The crew for #18 was as follows:

Lt. T. H. Moorer, USN	J. C. Shuler, AMM2/c, USN
Ens. W. H. Mosley, USN	R. C. Thomas, RM1/c, USN
J. J. Ruzak, ACMM, USN (NAP)	F. E. Follmer, RM3/c, USN
A. P. Fairchiled, AMM2/c, USN	T. R. LeBaron, A0M2/c, USN

(Aircraft History Card. BUAERNO 2306. Naval Historical Centre)

‘Buzz’ LeFever and AMMic Maynard Humphreys (NAP) were to cover the Tanimbar Islands and Timor (Messimer 1985:246). They departed at about 0800 hrs. The flight of #10 would be relatively uneventful, but #18 would fly into the first wave of Japanese aircraft heading to attack Darwin, starting a chain of events significant to archaeologists trying to establish which of the aircraft wrecks in East Arm belong to PatWing-10.

There are few photos of the wing in Darwin. The Australian War Memorial (AWM) has a series of three photos showing what appears to be a PB5Y-5 taxiing and subsequently taking off amongst shipping in Darwin Harbour. It is, however, difficult to determine exactly which aircraft is in the photographs and the precise date the photos were taken. Considering that PatWing-10 arrived in Darwin some time in January, the photographs may depict one of four

PBY-5s that were in Darwin between January and February. These four PBY-5s were #10, #18, #41 and #16. Aircraft #16 was lost over Ambon on 5 February, the same day *Zealandia* arrived in Darwin Harbour (McCarthy 1992:28). It is unlikely, therefore, that the photographs depict this aircraft.

Assuming, however, that the photographs were taken on the morning of 19 February, it is necessary to consider that only two PBY-5s took off that morning at 0800 hours, Moorer's #18 and LeFever's #10. It is known that aircraft #41, the ex-Dutch Catalina that looked like a PBY-5, was undergoing repairs that morning and did not go out on patrol. The AWM photographs are, hence, probably the last photographs of either #18 or #10.

The first photograph in this take-off series shows the PBY-5 with *Zealandia* anchored to the left of picture and the hospital ship *Manunda* in the middle of picture (Photo 20). In the next image (Photo 21) the PBY-5 turns to commence its take-off run, showing clearly the waist blisters characteristic of the type. In the background are two unnamed RAN vessels. In the last photo of this series (Photo 22) the PBY-5 is captured during its take-off run, showing the straight edge tail, another characteristic feature of its type.

Moorer had reports of four Japanese aircraft carriers off the coast of Ambon. His mission was to locate them, however, he also met with a transport vessel, the *Florence D*. The vessel was enroute to the Philippines with supplies for MacArthur's troops on Corregidor, but the journey was abandoned half way through (McCarthy 1992:28). Moorer spotted the vessel while on its return journey from its aborted mission. Satisfied that it was a friendly vessel, Moorer continued on his way, but while climbing away from the *Florence D*, his Catalina was intercepted by nine Zeros from the carrier *Hiryu* (Powell 1992:93). The following is Moorer's account of the attack on his Catalina, which is historically significant as the first account of aerial combat over Australian Territory at sea:

We were at about a thousand feet when they attacked the plane and set it afire. We didn't have any leak-proof tanks, and they were shooting little low-muzzle-velocity twenty-millimeter guns. You could actually see the bullets. They had practically no velocity and they were explosive. When the plane caught fire it burned all the

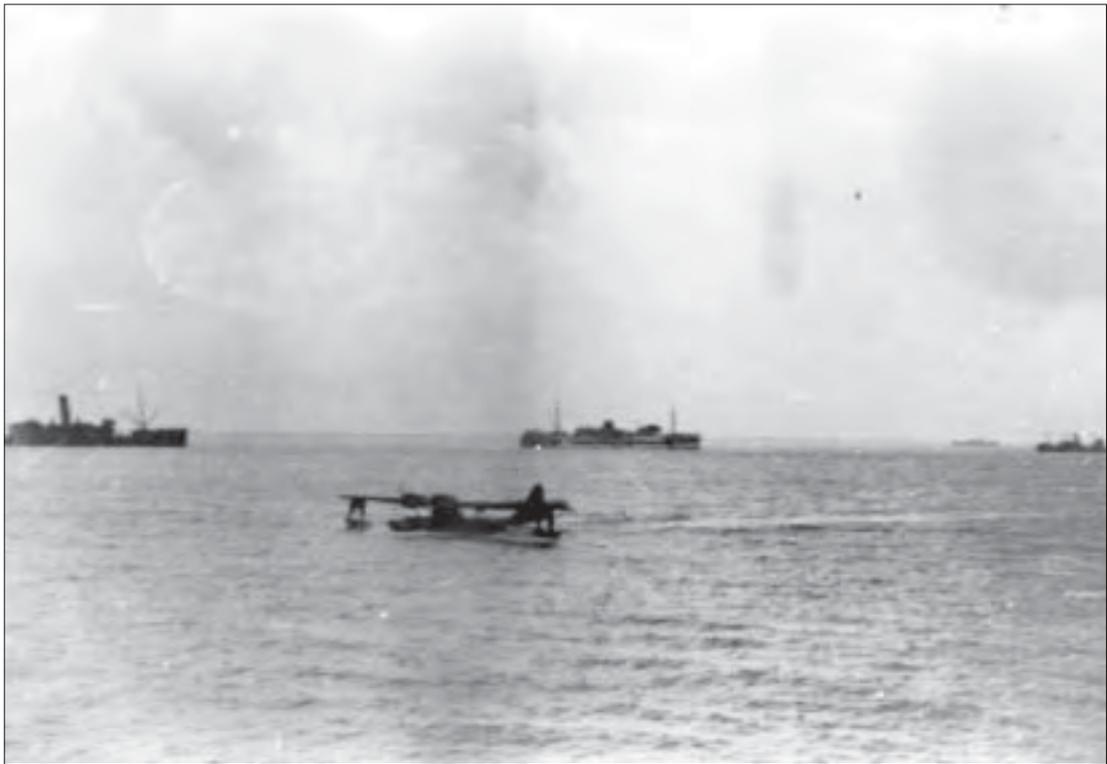


Photo 20. 'Darwin, NT. 1942-02. A Consolidated PBY Catalina Flying Boat taxis across the harbour. Shipping in the background includes (left to right) the transport Zealandia, the hospital ship Manunda and an American transport. The photograph was taken shortly before the Japanese air raid of 1942-02-19' (Australian War Memorial, Neg. No. 304966).

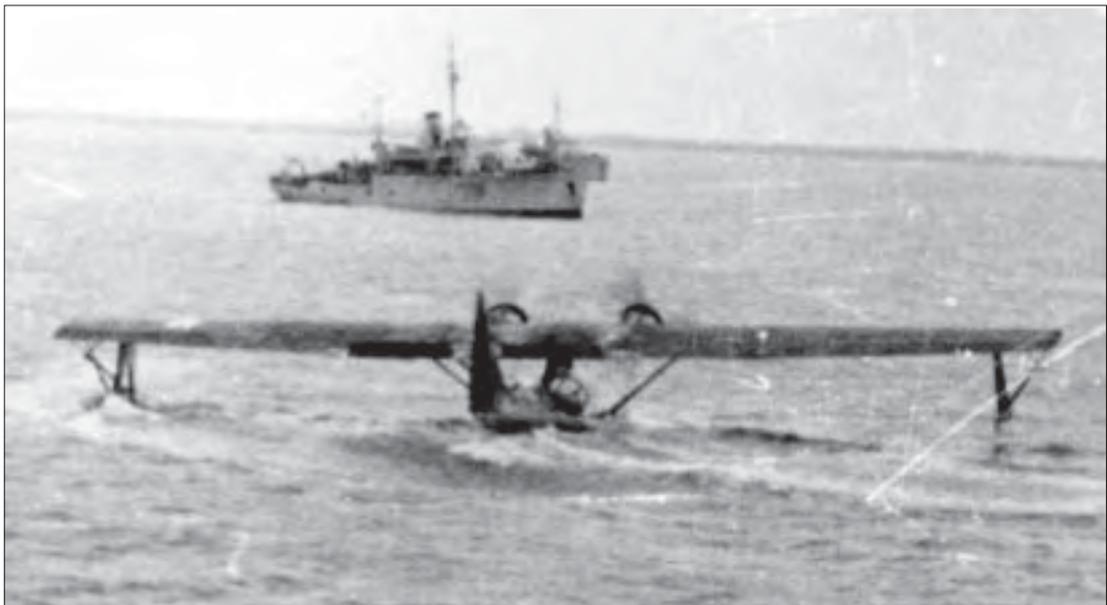


Photo 21 'Darwin NT. 1942-02. A US Navy Consolidated PBY Catalina patrol bomber turns towards two Australian corvettes' (Australian War Memorial, Neg. No. 304462).



Photo 22. 'Darwin, NT. 1942-02. A Consolidated PB4Y Catalina Flying Boat on the Harbour. Shipping in the background includes (left to right) the hospital ship Manunda, an American transport, the tanker British Motorist and the floating dock. The photograph was taken shortly before the Japanese air raid of 1942-02-19' (Australian War Memorial, Neg. No. 304965).

fabric. The rear part of the wing was all fabric, as well as the rudder and elevators. There were two great big gas tanks up forward. I was surprised to see us still flying when all the fabric burned off. The tail was also of fabric and it burned off on one side. It was very hard to fly at that point. I didn't have much control. I recognized that I had to land right away. I released the bombs because I was afraid they were going to explode, and of course there was the danger that the gasoline would explode. However, I managed to land downwind in the water.

The Japs attacked until they were satisfied that the plane was going down. They could see it going down because the fire was extending well past the tail. It was my good fortune that they had better things to do (Moorer 1986:56).

The Zeros could not dwell on the lone PB4Y and raced towards Darwin before the arrival of the bombers for the second attack (Moorer 1986:57). Meanwhile, the crew had survived the crash on the water and took to an emergency inflatable dinghy that had survived the attack free of machine gun holes. Moorer and his eight crew were soon picked up by the *Florence D*, which had witnessed the attack. The ship would also be attacked that day by a group of bombers and sunk off Rocky Point and Maloo on Bathurst Island (Conservation Commission of the Northern Territory 1992). Only one of Moorer's crew was subsequently killed during the attack on the *Florence D*. Moorer describes the death of AMM2c J. C. Shuler aboard the ship:

After we had been aboard about two hours, I was back on the fantail and looked up to see nine dive-bombers stacked up and coming right down on us. I told my crew to jump over the side. I knew what was going to happen. Only one boy failed to do so. I don't know whether he had gone up forward at time or what. But I know we never saw him again.

We had life jackets. As we jumped over the side of the ship [sic] was hit in the bow. The first bomb hit and blew all the ammo out, and then blew the bow off the ship. As I recall, the water was about two hundred feet deep in that area. When the bow was blown off, the ship went down and stuck in the mud. About half of it was exposed at forty-five degrees. It happened in just seconds. The two screws were still turning. Most of the Filipinos who were lost were in the engineering spaces.

The Japs bombed the hell out of the ship. They even bombed it after the bow end was in the mud and the stern was sticking up (Moorer 1986: 57).

The above not only describes PatWing-10's only casualty during the bombing of Darwin, but also provides a description of the area where the *Florence D* sank. This of interest to the maritime archaeologists who might in the future endeavour to locate what would be potentially an undisturbed WW2 shipwreck.

Moorer, with seven of his crew and about forty Filipinos, in two lifeboats, eventually made it to Bathurst Island. They reached Darwin after HMAS *Warrnambool* picked them up several days later (Powell 1992:94). While Moorer was still struggling on the water, the Zeros that had shot him down reached Darwin and began to cause havoc (Griffiths 1942; Edmonds 1951).

Moorer's mission to locate the Japanese carriers would not have been in vain, as the presence of the Zeros clearly demonstrated. They flew from four carriers: the *Akagi* ('Red Castle'), *Kaga* ('Increased Happiness'), *Hiryu* ('Flying Dragon') and *Soryu* ('Green Dragon') (Bradley, Dice and Griess 1984:45; AHSNT 1991:14; Powell 1992:75). The carriers, in the Timor Sea, launched 'thirty-six Zero fighters [and] seventy-one "Val" dive bombers' (Gill 1957:591; Powell 1992:76). The second wave of eighty-one 'Kate' level-bombers flew from Kendari (Gill 1957:591).

The Japanese attack force flew a route across Bathurst Island and towards the southern entrance of Apsley Straits (Fig. 15). After crossing Beagle Gulf and flying over the Vernon Islands, they



Figure 15. Route taken by Japanese aircraft on their way to bomb Darwin on 19 February 1942 (After Rorrison 1992:193).

reached the mainland near Cape Hotham. They then continued in a southwesterly direction and once at Noonamah, flew in for the attack from the south, up East Arm (Rorrison 1992:193).

Three of PatWing-10's aircraft (#4, #8 and #41) were moored in a line in East Arm. Their tender, the *Preston* was also in East Arm, anchored across the channel from them (Rorrison 1992:171). These aircraft had critically high engine hours and were grounded until spare parts could be obtained (Messimer 1985:244). Messimer (1985:248) states that #4 and #8 was moored next to #41. Whether #41 was the middle of the three aircraft will later be a crucial factor in identifying the location of the wrecks.

Ed Aeschliman and Tom Anderson were standing on a scaffold slung beneath the port engine on #41 when they heard the sound of approaching engines. They looked up and saw what they first believed to be reinforcements from an American aircraft carrier. Herb Casey was in the cockpit when the commotion began. Anderson was at this time counting the planes, which were in full view, but he suddenly stopped counting:

“Those aren’t reinforcements, those are Japs”. Anderson’s observation was underscored by three Zeros diving to strafe the three helpless PBVs.

The fighters were already firing when Aeschliman and Anderson dove into the water. Casey ducked back into the plane, dragged out the life raft, and launched it through the port waist blister. As he worked, bullets and cannon fire peppered the plane. There were now heavy explosions along the shore. Shrapnel and falling debris rained around the swimmers. Aeschliman and Anderson shed their life jackets and ducked beneath the surface as the fighters made another pass. When they surfaced Casey was in the raft. Quickly they climbed in. Urged on by the nearness of the now burning PBVs, the three men paddled hard to get away. Flaming gasoline, spreading across the water, was being swept aft of the planes by the swift ebb tide. Paddling against the current the three men slowly drew ahead of the planes.

The strafers came in again, the three men leaped out of the raft, and the raft flipped over. Caught in the fast running current, the men were swept past the planes, toward the sea.

By now the three men were widely separated. Swimming hard, Aeschliman made it to a clump of mangrove trees where he watched a P-40 pilot bail out and parachute into the grove some distance away. In the meantime Casey was tiring fast and calling for help. Hearing Casey’s calls, Anderson swam back and rescued his friend. A few moments later a motor whaleboat from the Preston came along and picked both men up. A few minutes later Aeschliman was picked up, and the boat headed toward the beach (Messimer 1985:248-249).

The P-40 Kittyhawk pilot Aeschliman had seen parachute into the mangroves was 1st Lieutenant Robert F. McMahon of the US Army 33rd (provisional) Pursuit Group (Messimer 1985:254; Northern Territory News 1992:1; The Sunday Mail 1992:37). McMahon’s aircraft, nicknamed ‘Barhootie the Cootie’, took off from the RAAF Station during the air raid and flew over East Arm to engage the Japanese (Raleigh 1943:215). McMahon was airborne for a short time, engaging one aircraft, without any results. McMahon vividly reconstructs the scene over the PBVs in a sketch, showing men swimming towards a raft, floating near one burning Catalina (Fig. 16). According to the details of the sketch, the fire was consuming the central wing section of the Catalina, which contain the fuel tanks.

McMahon’s drawing is annotated with ‘Getting a last good lick at a Mitsu...Zero’. Scrutinising the drawing of McMahon’s Zero, however, reveals that he has perhaps drawn another type of aircraft. The drawing shows a two-seater aircraft with a gunner sitting behind the pilot. Considering that Zeros were only a single seat fighter, McMahon’s drawing could possibly be

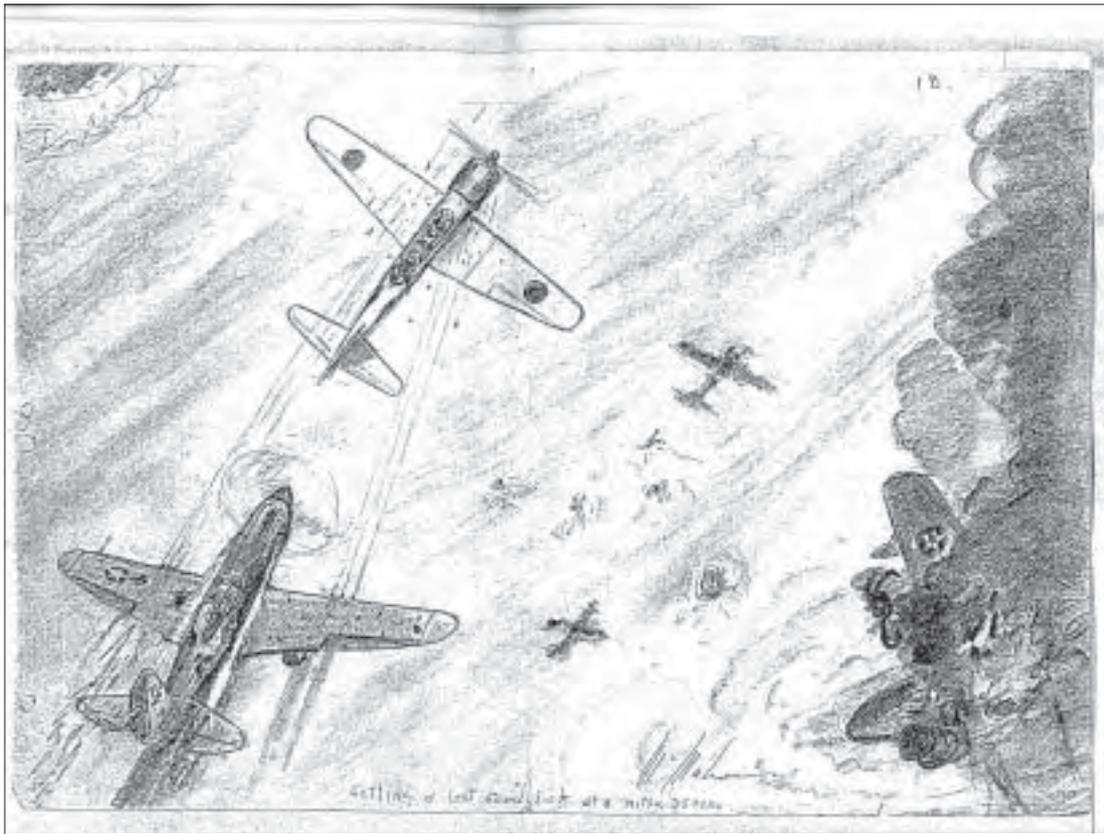


Figure 16. Drawing by 1st Lieutenant Robert F. McMahon: 'getting a last good lick at a Mitsu...Zero' (National Trust of the Northern Territory).

one of two other types of aircraft that are said to have attacked the Catalinas ie., either a Val or Kate dive-bomber (compare Photo 23 and 24).

Gill (1957:592) points out that the first bombs fell near Stokes Hill Wharf and that they were released from 14,000 feet by high-level bombers. Rorrison (1992:169) specifies that the first bombs were dropped by the Kates which had accompanied the Zeros in the first attack wave:

The first enemy bombs to detonate on Australian soil dropped from the racks of 27 Nakajima B5N Kates over Darwin harbour [sic]. The Kate, an ordinary, single-engine carrier-borne bomber, had a maximum speed of just 217mph. Yet it was an effective bomb platform. Flying impeccable formations three vees of nine staggered between 14,000 and 15,000 feet, some carried two 250kg bombs, others six 60kg bombs in their underwing and centreline racks, a lethal mixture of incendiaries and high explosives. Their target was the moored ships (Rorrison 1992:169).

It is, therefore, a valid assumption that McMahon had miss-labelled his drawing of the attack on the PBVs. Raleigh (1943) indicates that McMahon was shooting at either a Kate or Val and not a Zero: 'McMahon managed to roll over, was sliding back the hood that inclosed [sic] him,

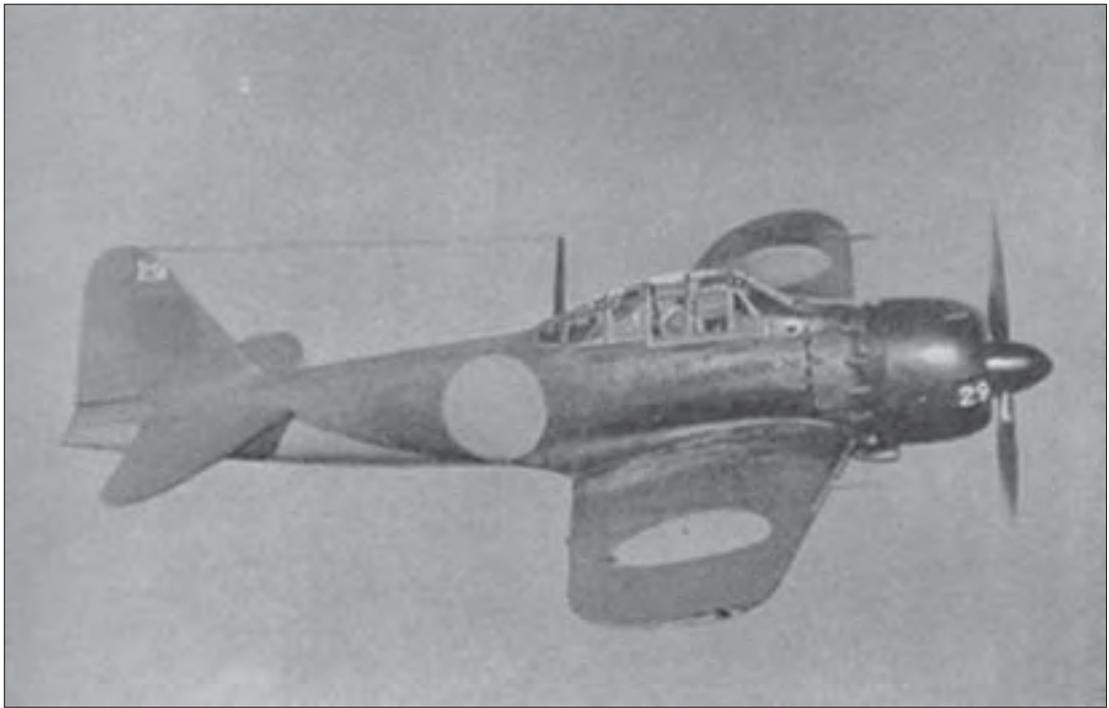


Photo 23. 'Zeke 52. Navy Type O fighter' (War Department 1944:75B).

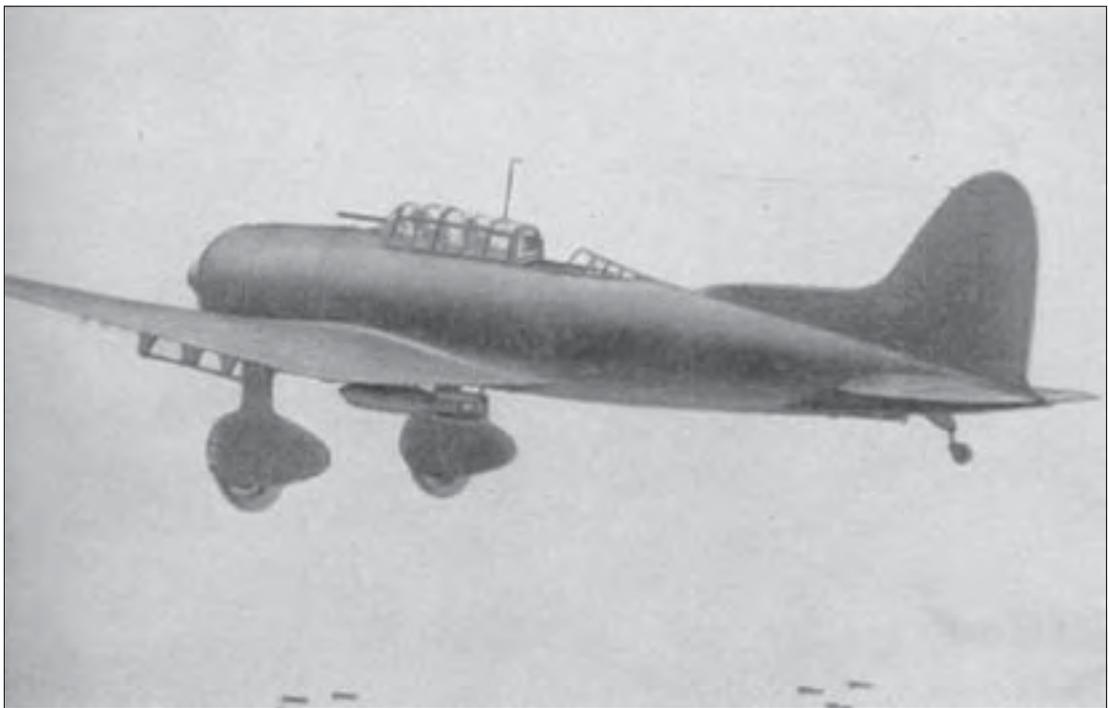


Photo 24. Example of a Japanese dive-bomber ca. 1942 'Val 22 - Navy type 99 dive bomber' (War Department 1944:72).

when a Japanese Mitsubishi dive bomber “an imitation of the Stuka” [German dive bomber] - swept beneath him’ (Raleigh 1943:215). There is one other source that provides an insight into how #41 actually sank. This is an account of events seen by Frank O’Beirne from the *Preston*.

It has generally been accepted that strafing sank all the USN aircraft (Messimer 1985:248; AHSNT 1991:20). The word has a German origin: strafen, which means ‘to punish’ (Hanks 1979). In the aviation sense of the word, strafing refers to an aircraft attack on a ground or aerial target with cannon and/or machine guns, excluding the use of bombs. Lieutenant Commander Frank O’Beirne, US Navy Commander, PatWing-10 was on the *Preston* during the air raid. He states that although #41 was subjected to four strafing attacks it remained afloat, but was ‘blown up by bombs dropped by a Jap plane’ (O’Beirne 1945). Presumably #4 and #8 had succumbed to strafing and did not require the further attention of the attackers. Considering that Zeros did not carry bombs, the plane that had bombed #41 must have been a Kate or Val. McMahon’s sketch, therefore, illustrates that at least one dive-bomber, as well as the Zeros, also attacked the Catalinas.

As a result of the first Japanese air raid on Darwin, the loss of #41 in 1942 marked the last Catalina PatWing-10 would lose in the Northern Territory and the end of the first phase of Flying Boat losses in Darwin Harbour, but not the last time the USN would use Darwin. VP-33, under the command of Pat-Wing 10, would continue to use Darwin as a staging point from Perth.

Kupang was bombed by VP-33, who operated from Darwin, on 12 and 14 December 1943 and Ambon on 11 January 1944 (Mueller 1992:22). The squadron, however, departed Australia on 2 February 1944, a month after their arrival, for Samarai (Mueller 1992:25). By mid 1944 Nos. 20 and 43 Squadrons (the latter from Karumba) had completed their move to Darwin to establish two permanent Operations Base Units (OBUs), one at Doctors’ Gully and the other on Quarantine Island in East Arm. The squadrons were under the direction of No. 76 Wing based at Doctors’ Gully, Darwin (Vincent 1981:67). Consequently, the second and third phase losses would be sustained by the RAAF, but under different circumstances.

4.4 A24-1 delivery flight to Australia

On 31 December 1940, F. B. Clapp, the Australian Government Trade Commissioner in New York, sent a cable-gram to the Prime Minister's Department notifying that the British designation for the PBY was, for brevity, to be officially changed to Catalina (Series: A1608/1, Item: K17/1/2 Part 1, National Archives). The Australians followed suite. Shortly afterwards, the RAAF was to receive its first of 253 Catalina Flying Boats, from Contract AUS 58 (Wilson 1992:63-64; Series: A1608/1, Item: K17/1/2 Part 1, National Archives of Australia). The following is an account of the operational life of the RAAF's first Catalina, A24-1 (ex-AH534, ex-VH-AFA) until its demise in Darwin Harbour.

A24-1 was meant for the Royal Air Force (RAF) as part of their initial order for Flying Boats from Consolidated. The first registration number for this aircraft was, therefore, a RAF number, AH534. However, the RAAF Flying Boat order was not ready by the time the Australians arrived to pick-up their aircraft. The Australian and British Governments then came to an agreement whereby the RAF would give one its Catalinas to Australia with the understanding that the RAAF would then give its first production scheduled Flying Boat from Consolidated to the RAF (Wilson 1991:22).

Until 7 December 1941, America was still neutral and as a result, the delivery flight of A24-1 to Australia had to be flown by an American crew and that legal title would be transferred to Qantas in Honolulu (Series: A1608/1, Item: K17/1/2 Part 1 and Item: K17/1/2 Part 2, National Archives of Australia). The aircraft also had to be marked with civilian registration and was subsequently given the letters VH-AFA (Photo 25). A Consolidated Company aircrew subsequently flew AH534 to Honolulu. These people were McMakin, Captain; Mitchell, Navigator; McFarlane, Radio Operator; Wallace, Flight Engineer (Series: A1608/1, Item: K17/1/2 Part 1, National Archives of Australia). Qantas crews, who were part of the Qantas Long Range Operations Division, would fly the rest of the Journey to Australia (Vincent 1981:12; Wilson 1991:22).

The Qantas crew waiting for their renamed Catalina VH-AFA in Honolulu, was initially made up of: Allan, Denny, Chapman, Bemrose, Clark, Richmond, and Rowson. The second Catalina,



Photo 25. 'The RAAF's first Catalina, A24-1, pictured at San Diego in early 1941 and still wearing its Royal Air Force serial number, AH534. For the delivery flight to Australia it was allocated the civilian registration VH-AFA' (Wilson 1991:22).

AH535 was to be delivered to the British in Singapore and crewed by Brian, Taylor, Nicoll, Jaques, Wright, Roughton, Tennant and Sloane. This crewing arrangement, however, changed when the delivery to Singapore was cancelled.

The final crew list for VH-AFA's flight to Australia is based on a letter from the Australian Prime Minister's office dated 20 January 1941. The letter stated that the actual crew for the first flight was to be:

Captain L.J. Brain, Manager, Flying Operations, of Qantas Empire Airways Ltd., will be the Captain in charge of the first flight, and Captain P.G. Taylor will act as Navigator. In addition to the Qantas crew of five, certain R.A.A.F. personnel are also being carried on the flight from Honolulu to Australia, Yours faithfully, R.G. Menzies (Series: A1608/1, Item: K17/1/2 Part 1, National Archives of Australia).

The other unnamed personnel were A.S. Patterson, Radio operator and D.H. Wright as Flight Engineer. The three unnamed RAAF personnel in the Prime Minister's letter were Allan, Bemrose, Flight Sergeant W. D. Richmond (1215) and Qantas reserve Captain O.D. Denny (Series: A1608/1, Item: K17/1/2 Part 1, National Archives of Australia).

AH534, however, departed from San Diego to Honolulu on 26 January 1941, with at least one Australian on board, Captain Patrick Taylor (Photo 26). The Catalina reached its destination on 27 January, after a distance of 2,371 nautical miles (4,392km) which required almost a full



Photo 26. 'A group of four RAAF men (left) and four from Consolidated Aircraft Corporation (right) pose in front of A24-1, in San Diego on 26 January, prior to its delivery to Australia. From the left: unidentified, Geoff Nicholl, P. G. Taylor. The rest are unknown' (Australian War Memorial, Neg. No. P02515.003).

day in the air (Wilson 1991:22). The next leg of the journey to Canton Island was delayed until early 29 January owing to bad weather. Canton was reached that evening. There is no further record of the flight after Canton Island, as records only show the details of the flight of the second Catalina, AH535. There is one document, however, a telegram sent by Captain Brain to Qantas Airways in Sydney, acknowledging that VH-AFA was in French Noumea: 'Frogs Legs tomorrow, home Sunday. Lester' (Series: A1608/1, Item: K17/1/2 Part 1, National Archives of Australia). VH-AFA was received at Rose Bay, Sydney, on 2 February 1941 (Riddle 1992:11).

The delivery flights of the first eighteen Catalinas to Australia by Qantas pilots represented achievements in long distance flights that were pioneering in aviation history. The delivery flight of A24-1 was only the third time the Pacific had been crossed by air (Wilson 1991:22). The first crossing was made by Charles Kingsford Smith, Harry Lyon, Charles Ulm and Jim Warner in 1927 (Smith and Davies 1980:34, 39). Their journey in the 'Southern Cross', began

from San Francisco and staged through Honolulu, the Phoenix Islands, the Fijian Islands, and arrived in Brisbane (Smith and Davies 1980:39).

The second crossing of the Pacific was again with Kingsford-Smith, but with only one other person, P. G. Taylor, in a single engine Lockheed Altair. They departed from Archerfield (Queensland) for San Francisco, via Suva and Honolulu. Their destination was reached on 20 October 1934 (McLaren 1958:17). This is perhaps why Taylor went on the third trip across Pacific in A24-1. He knew the route, but from the other direction ie., from Australia to America. There is no detailed log of the delivery of A24-1, except for a report by P. G. Taylor on navigation procedures (Appendix 3). Taylor was an accomplished Australian navigator. He held one of the few First Class Navigator's Licences. Of the eleven pilots who flew the early ferrying trips, he was the only one to hold the First Class Navigator's Licence. His experience was invaluable during the A24-1 delivery flight, as he knew 'Guba'; a Catalina hired from Richard Archibald to survey an alternative aerial route from Australia to England, in the event that Singapore might fall (Vincent 1981).

The crossing of the Pacific in A24-1 was made using a combination of navigation methods, including combination of dead reckoning, radio direction finding and astronomical recordings. Taylor recommended that navigators have a sound basis in each of these methods, as each has to be cross-checked to ensure their reliability. For instance, astronomical readings could not be done during daytime flights or during flights in bad weather. Direction finding signals were also suspect, but an invaluable aid nonetheless. For instance, direction signals received from both Honolulu and San Francisco consistently put the aircraft 150 miles north of its true position, which had been verified by solar fixes using sextant (Series: A1196/6, Item: 37/501/42, National Archives of Australia). As a result, it was considered essential that a sound basis of all three be available to the navigator on the trans-Pacific flights.

4.5 A24-1 Post delivery operations

From Rose Bay Captain Sims flew A24-1 to Melbourne, where technical specialists inspected it (Series: A10297/1. Item: Block 141, National Archives of Australia). Photo 27 shows a fitter



Photo 27. 'c. 1941. R. A. Pitman, an RAAF fitter, stands in the cockpit of the Catalina Flying Boat aircraft A24-1' (Australian War Memorial, Neg. No. P02684.002).

working on A24-1 and it was probably taken during the initial inspection of the aircraft in Melbourne. A24-1 was used thereafter for sea plane training in New South Wales until significant Catalina losses required it to be brought into front line service (Riddle 1992:8). On 14 March 1941 the aircraft was issued to No 11 Squadron at Port Moresby. A24-1 arrival at Port Moresby on 19 March, with the following crew:

Eric Sims	-	1st Pilot	Alan Whitsed	-	1st W/T
Norm Robertson	-	2nd Pilot	Harvey	-	2nd W/T
Mick Larkins	-	1st Engineer	Jack Dunne	-	2A
Unknown	-	2nd Engineer	Col Dun	-	Armourer

(Riddle 1992:11)

A24-1, together with A24-2, A24-3 and a number of Qantas Empire Flying Boats commenced the operations of carrying RAAF personnel and equipment to the AOBs (Advanced Operational Bases) and continued patrolling Australia's outer defence perimeter. On 14 August 1941, A24-

1 was allocated to No. 20 Squadron until engine changes had to be carried out at Rathmines on 2 September 1941 (Series: A10297/1. Item: Block 141, National Archives of Australia). After nearly two months of complete overhauls and repairs at Rathmines, A24-1 was eventually received back at No. 11 Squadron on 15 December 1941.

On 14 January 1942, A24-1 was recorded as having flown a reconnaissance of the Gilbert Islands, taking 100 photographs of nine islands. The aircraft was operating from Tulgai at the time and under the command of Squadron Leader Cohen (Hendrie 1988:148).

In February 1942, A24-1 grounded on a reef, but was still serviceable and was flown back to Rathmines for repairs. These repairs took over four months and upon their completion, A24-1 was allocated back to No. 11 Squadron at Port Moresby and received there on 29 July 1942 (Series: A10297/1. Item: Block 141, National Archives of Australia).

Upon its return to active service A24-1, under the command of Captain Harry Tamblyn, bombed Rabaul on 9 August 1942. After this time, it appears that A24-1 may have been flown back to Rathmines as it is recorded that the crew, who were sent on leave, were to return in A24-1 with Captain Clem Haydon who had recently finished his captain's course (Riddle 1992:32).

In September 1942, A24-1, flown by Clem Haydon, was back in active service. Together with one other Catalina (A24-25), A24-1 bombed Buin on 27 September 1942. This was Clem Haydon's first bombing run as captain (Riddle 1992:32). Two nights later A24-1, this time with a new captain Eddy Allison, attacked Buka aerodrome and returned back to Cairns after an eighteen hour return trip (Riddle 1992:32). On that same night A24-1 (flown by Captain Clem Haydon) together with A24-4 continued the attack with another raid on Buin (Riddle 1992:32).

Buin was bombed by A24-1 (with Clem Haydon as captain) and three other Catalinas on the night of 1 October 1942 (Riddle 1992:33). Captain Mike Seymour then flew A24-1 on an uneventful seventeen hour convoy patrol on 6 October (Riddle 1992:35). On 9 October A24-1

(with Mike Seymour as captain) was one of seven Catalinas that made up a strike force to attack Rabaul. Their objective was to act as path finders for the B17 bombers by lighting up the target with 500 incendiaries (Riddle 1992:34). On 12 October A24-1 (again with Mike Seymour as captain), together with five other Catalinas, bombed Buka (Riddle 1992:34). Towards the end of October A24-1 (Mike Seymour as captain) was involved in another bombing mission against Buin on 21 October. The target switched to Kavieng on 24 October. Captain Eric Townsend flew A24-1 on this occasion (Riddle 1992:34). Buka was the next target for six Catalinas. A24-1 was one of these and was flown by Captain Frank Chapman (Riddle 1992:34). Shipping in Buin, Faisi and Tonolei were attacked by the Catalinas on 29 October, including A24-1 flown by Captain Mike Seymour (Riddle 1992:34). Operations for October ended by another attack on the same targets, shipping in Buin, Faisi and Torrolei. A24-1, on this occasion, was again flown by Mike Seymour (Riddle 1992:34).

The operations record then indicates that A24-1 was not involved in further missions until 14 November 1942, when Kahili aerodrome at Buin in the Solomon Islands was attacked. Eight aircraft were destroyed on the ground and an ammunition dump was set on fire (Riddle 1992:35).

A24-1 is again recorded as having participated in a raid on Kahili aerodrome on 16 November 1942 (Riddle 1992:35; Honan 1989:48). Flight Lieutenant Seymour was the captain with Sergeant Honan as the co-pilot. A24-1 was part of a strike force consisting of aircraft from both 11 and 20 Squadrons (Honan 1989:48). Three large fires were started on Kahili and all the aircraft returned back to Cairns at 0700 hours the next morning after a sixteen and a half hour flight (Honan 1989:48). The next morning, 18 November 1942, A24-1 was used for a different operation, providing escort for Australian ships going to and coming from New Guinea.

The Catalinas were used for anti-submarine patrols for individual ships and convoys on a regular basis by late 1942. On 14 November 1942, A24-1 was recorded as having escorted the SS *Katoomba* enroute to Australia from Port Moresby (Honan 1989:47). A24-1 did another escort mission for the HMAS *Ballarat*, *Katoomba* and four other ships: *Balikpapan*, *Japara*, *Bantam* and the Liberty ship *John B. Ashe* (hull number 82) on 18 November 1942 (Honan 1989:48).

Escorts were also conducted for the HMAS *Benalla*, HMAS *Bunbury* and their convoy on 22 June 1943 (Honan 1989:88-89).

Honan (1989) details the operations of A24-1 on 18 November 1942 as having departed on a reconnaissance flight to search for Japanese ships in an area between New Guinea and New Britain known as Run M, otherwise referred to as the 'Milk Run' (Honan 1989:48; Riddle 1992:36). A24-1, however, developed an oil leak and had to return to Cairns. Repairs were carried out and the next evening A24-1 'flew another uneventful nineteen hours' (Riddle 1992:36). On 20 November 1942 Captain Mike Seymour then flew A24-1 to bomb Kavieng (Riddle 1992:35).

A24-1 was sent on a reconnaissance mission on 21 November 1942. A24-1, however, still had mechanical problems and departed for 1FBRD on 24 November 1942 for repairs (Honan 1989:49). After this, Captain Frank Chapman is recorded to have flown A24-1 on a bombing mission to Faisi on 29 November, presumably from Cairns (Riddle 1992:35).

After repairs at 1FBRD, A24-1 returned to Cairns. On 4 December Captain Frank Chapman flew A24-1 in an uneventful twenty-four hour patrol along the Milk Run (Riddle 1992:36). On 17 December Chapman again flew A24-1 in an uneventful sixteen hour Milk Run flight from Milne Bay to Cairns (Riddle 1992:37). The reconnaissance flights continued with another flight by A24-1 that same day, but this time operated by Captain Bill Clarke, who also made no sightings of the Japanese (Riddle 1992:37). Clarke later flew A24-1 on its next Milk Run reconnaissance mission from Milne Bay to Cairns on 29 December (Riddle 1992:37).

On 10 December, however, the monotony of the Milk Run for A24-1 was broken when it was assigned a mission to fly to a secret location code-named 'Augusta' (Honan 1989:49). 'Augusta' was Merauke, a village in Dutch New Guinea (Photo 28). Japanese reconnaissance aircraft had been sighted around the area and A24-1 was sent to locate their base on a daylight reconnaissance. Flight Officer (F/O) Bill Clarke was the captain for this mission and he alighted on the Merauke River at 1225 hours after a seven-hour flight from Cairns. From Okabo, A24-1 conducted

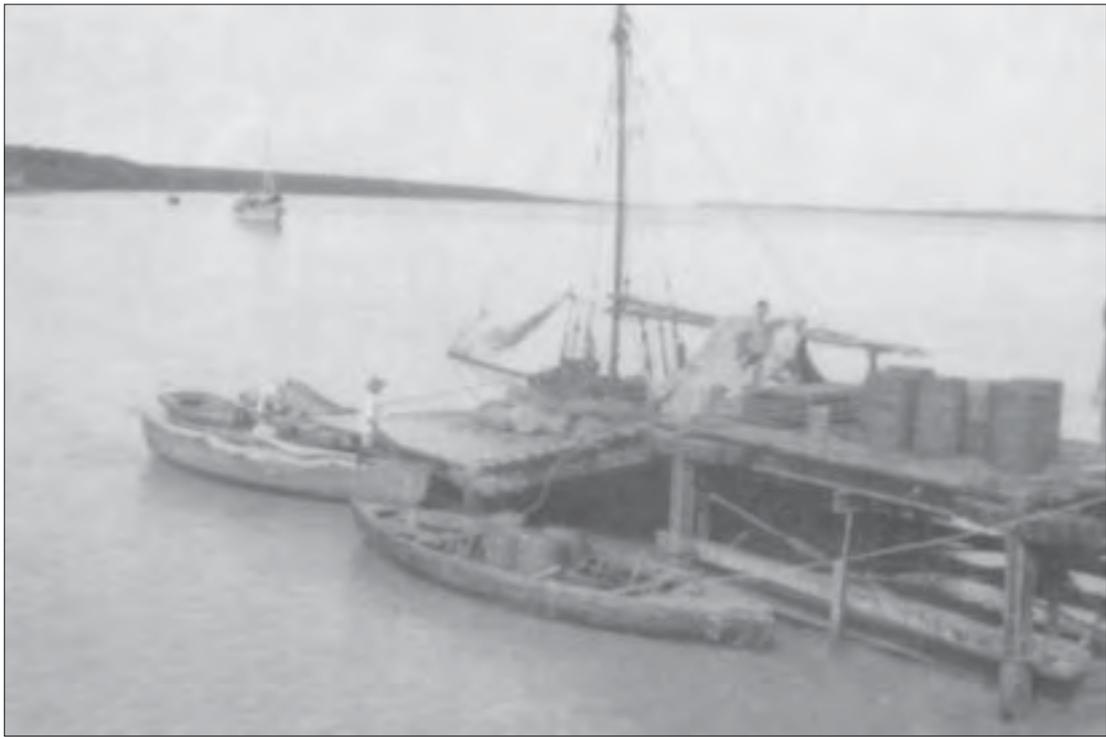


Photo 28. Area of operations for A24-1, late 1942 and early 1943, Merauke River landing with a canoe filled with drums of fuel for the Catalinas (Honan 1989:54-55).

searches for the Japanese to the west around Frederik Hendik Island, but found nothing and returned to its mooring on the Merauke River later that day (Honan 1989:50).

The next day, 11 November 1943, A24-1 went on a photographic reconnaissance flight to search for the Japanese westward along the coast. Locations such as the Moah River, Jar River and adjacent delta rivers were inspected, but found to be too shallow and unsuitable for shipping. Flamingo Bay was found to be a good location for shipping or an aircraft base, together with locations on the Torpedo Boat River and at Atabo, further west along the coast (Honan 1989:50). After this flight, A24-1 needed re-fuelling. This was conducted from barrels under difficult conditions on the swift Merauke River. A24-1 then took off for Horn Island near the tip of Cape York Peninsula and refuelled there also. Once this was done, A24-1 went on searching for the Japanese on a flight across the Arafura Sea towards the Wessel Islands on the same day, but found nothing and returned to Horn Island that evening. On the following day, A24-1 flew to Townsville. Searches for the Japanese continued for the rest of December 1942 (Honan 1989:51).

On 1 January 1943, A24-1 was in Cairns and flew to Merauke with Wing Commander Minchin. The aircraft had returned to Merauke to find a suitable evacuation point for Catalina operations. Minchin was taken by A24-1 to inspect the selected spot on 3 January 1943. A24-1 then returned to Merauke and after taking on passengers and the mail, flew to Cairns.

Captain David Vernon flew A24-1 from Cairns on 4 December and went into Milne Bay to bomb the Gasmata airstrip (Riddle 1992:38). On its return to Cairns, the aircraft was due for its 240 hours service and was flown to Bowen on 9 January 1943 (Honan 1989:52). But prior to its flight to Bowen, A24-1 sank a Japanese ship. This episode in the aircraft's history illustrates one of the successes of the night operations performed by Catalinas and is described below.

In early 1943, A24-1 continued shuffling between 1 FBRD and 11 Squadron for major repairs and maintenance. During operations while with 11 Squadron on 6 January 1943, A24-1 sank the passenger-cargo vessel *Nichiryu Maru* of 5,447 tons in position 6° 30' S, 149° E (Hendrie 1988:153; Riddle 1992:38). Squadron Leader (later Group Captain) David Vernon was the Captain of A24-1 (co-pilot was P/O T. Harrison) during this engagement, which he describes in detail, 50 years after the event in Minty's (1994:31-35) book *Black Cats* (Photo 29).

A24-1 was detailed with an unknown Catalina from 20 Squadron (piloted by Squadron Leader T. V. Stokes) to look for a Japanese convoy that was reported to be enroute from Rabaul to Lae (Hendrie 1988:152). The two aircraft were to track the convoy and report its movements. The unknown Catalina found the ships and signalled A24-1 to their position. Vernon, prior to meeting the Japanese ships, considered the possibility of an opportunistic bombing run on a Japanese air strip on Gasmata, which was along the course to the target. A24-1 dropped four high explosive bombs on edge of the airstrip and strafed aircraft on the ground, then continued on to intercept the convoy (Vernon 1994:32). The aircraft still carried four 250-pound anti-submarine bombs.

The initial plan was that once the Catalinas spotted the convoy, USAF bombers from Port Moresby would attack them. No word had come from operational control about a possible



Photo 29. Squadron Leader David Vernon who sank the Nichiryu Maru while in command of A24-1 (Vernon 1994:31).

attack, and the approaching dawn indicated to Vernon that they had to attack soon (Vernon 1994:33). Hendrie (1988:152) indicates that the American aircraft did arrive at the scene and were illuminating the convoy when A24-1 arrived there, but why these aircraft did not participate in the attack is unknown.

The convoy consisted of five merchant vessels steaming in a line with three naval escorts, one leading and one abeam on each side (Vernon 1994:33). They represented a formidable anti-aircraft screen, but surprisingly, when Vernon commenced his bombing run the ships had not noticed him. Flight Lieutenant George Leslie was A24-1's navigator/bomb aimer on this flight and

owing to intermittent low level cloud he had trouble getting a satisfactory aim on the ships. He instructed Vernon to bring A24-1 around for another run from astern, giving them the choice of six targets. The second to last transport vessel in the line was chosen. The ship was seen: 'exploding throughout its length, and one of our lookouts reported "Vessel struck by three of the four bombs"' (Vernon 1994:33). The ferocity of the explosions made the captain believe they had hit a ship carrying ammunition; the ship was actually carrying between 600 and 700 troops (Hendrie 1988:153).

The passenger-cargo vessel *Nichiryu Maru* exploded with the loss of all aboard except for six men who were later seen in a whaleboat (Vincent 1981:30; Riddle 1992:38). Beaufighter crews saw these survivors, together with four empty lifeboats the following day (Hendrie 1988:153). The IJN *Maikaze* picked up an unknown number of survivors on 7 January 1942 (Nevitt 1996). Four days later, the same convoy was attacked again by Vernon, who sank one merchant vessel east-south-east of Gasmata, but it is unknown whether he flew in A24-1 for this mission (Hendrie 1988:153).

A24-1's next mission was to bomb Gasmata again on 29 January 1942. Captain Bill Clarke flew A24-1 for this mission, which from Cairns to Gasmata and back took twenty hours (Riddle 1992:39).

Milk Run operations continued in early February 1943 with Captain Eric Townsend flying A24-1 on 1 February, without sighting the Japanese. Captain Norm Robertson flew A24-1 from Cairns on 7 February. Clem Haydon, flying from Milne Bay in A24-1 returned to Cairns on 11 February and Captain Jack Daniell operated A24-1 from Cairns on 12 February. All of these patrols, however, failed to find any Japanese shipping (Riddle 1992:40). Patrol periods by A24-1, however, were interspersed with bombing raids on Kahili on 2 February (Bill Clarke as captain), on 3 February (Frank Chapman as captain) and on 5 February (Norman Robertson as captain) (Riddle 1992:40). Buin was bombed by A24-1, under the command of Eric Townsend, together with three other Catalinas on 17 February 1943 (Riddle 1992:40).

A24-1 is recorded as having taken part in another raid against Ballale Island immediately south of Bougainville Island on the night of 19 February 1943, under the command of Squadron Leader Vic Hodgkinson, who provides an insight into the standard and non-standard armament used by the Catalinas:

The standard bomb load was eight 250lb GP bombs fuzed [sic] nose and tail. "Grass cutter" extensions were fitted to the nose fuzes [sic]. The appendage consisted of a 3ft metal rod having a small disc fixed to the forward end. On contact with the ground, the bomb exploded some three feet above, thus spreading the blast and shrapnel in all directions. Hence "grass cutter". In addition to this load we carried twenty 20lb bombs plus 25lb incendiaries. These were stowed inside the aircraft and fuzed [sic] and thrown out of the blisters by hand. There were also our own personal gifts to the Japs - beer bottles with razor blades inserted in the neck made a terrific noise and a supply of these helped to keep the enemy awake. To complete the load, crew armourers made their own devices. One of these consisted of a Mills bomb, the idea being that when the tennis ball hit the ground, it would bounce and pull the pin (Hendrie 1988:153).

Four Catalinas, departing from Cairns, successfully bombed the aerodrome on Ballale Island again on 20 February 1943. A24-1 was one of these Catalinas and it was flown on this occasion by Captain Clem Haydon (Riddle 1992:41).

On 21 February 1943, A24-1 returned to 1FBRD for a complete overhaul. Once A24-1 was operational again, it was allocated to No. 3 Operations Training Unit (3OTU) on 17 March marking the end of its combat role. A24-1 would now be used to train pilots in Flying Boat operations and despite being damaged at sea during a training flight on 22 June 1944, would survive WW2 (Series: A10297/1. Item: Block 141, National Archives of Australia).

Following the end of WW2, on 15 August 1945, a group of nine Catalinas were drawn from 3OTU to fly medical supplies and RAAF personnel to Singapore and to return with Australian prisoners of war. It was while operating in this role that Catalina A24-1 crashed on take-off and was abandoned on a mud bank in East Arm.

4.6 LOSS OF CATALINA A24-1

Wing Commander Keith Bolitho (No. 407017) of 3OTU was the captain of A24-1, which was the first to attempt to take off at 0800 hours (Photo 30). Weather conditions in East Arm were poor for a heavily laden Catalina to get on the step: light winds with little tidal movement. It was easier to get airborne if the aircraft had waves to leap into the air from, but being heavy with cargo and nine passengers, A24-1 eventually managed to fly after four unsuccessful efforts. Shortly after take off, Bolitho noticed a serious leak in the line leading to the oil pressure gauge (Series: A705/1, Item: 32/17/263. National Archives of Australia). He turned back to Darwin for repairs. After mooring the aircraft to a buoy, Bolitho instructed the engineer to top up the fuel tanks, for he anticipated another attempt once the weather had improved by the afternoon to take off without the trouble he had had that morning.

By 1600 hours, a slight breeze was blowing across the take off area and Bolitho thought that it was worth another try. Taking advantage of the crosswind he would attempt to take-off to the east. Figure 17 illustrates the take off and alighting paths for the Catalinas in East Arm in 1945. Judging from this and from the location of the wreck site of A24-1, Bolitho had chosen flare path 'C'. He received permission to take-off and with the crash boat in position at the eastern end of the run, A24-1 began taxiing to the northwest. A24-1 soon attained a speed of 65 knots



Photo 30. 'Cairns, Qld. 1944-01-12. Informal portrait of 407016 Squadron Leader W. K. Bolitho DFC of Mannum, SA, pilot, of No. 11 (Catalina) Squadron RAAF. Photographer: Flight Lieutenant John T. Harrison' (Australian War Memorial, Neg. No. NEA0316).

on the smooth water at full throttle and bounced into the air. The airspeed, however, was not enough to keep the aircraft flying and it dropped on to the surface, heavily. The aircraft bounced two more times into the air, but on the third bounce, however, A24-1 leapt too high.

Because the sea was still relatively flat, the captain had pointed A24-1's nose into the air at a steep angle to help break the water's grip on the hull. Thinking that he did not have the airspeed to keep flying after the third bounce, Bolitho quickly cut the throttles and realised that they would hit the water heavily. He could not accelerate

again since he had both hands on the steering yoke, trying to keep control of the aircraft and was, hence, unable to reach the throttles, which protruded down from the centre of the cockpit canopy.

The sound of tearing metal could be heard as the aircraft hit the water. The navigator substantiated the captain's fears after he had told him that they were holed and sinking fast. Bolitho then spun the aircraft around to see if the crash boat was close enough to take them in tow, but noticed they were sinking too fast and would not make the tow. He cut the engines and instructed Flight Sergeant Draper to assist with launching the four dinghies, all of which inflated without trouble. He dropped back down into the navigator's compartment, grabbed a few personal belongings and ordered the crash boat, which had come up along side by now, to take off the people still aboard. Nearly waist deep in water now, Bolitho jumped over board just as the aircraft sank at 1725 hours (Series: A705/1, Item: 32/17/263 and Series: A9845/1, Item: Box 11, National Archives of Australia).

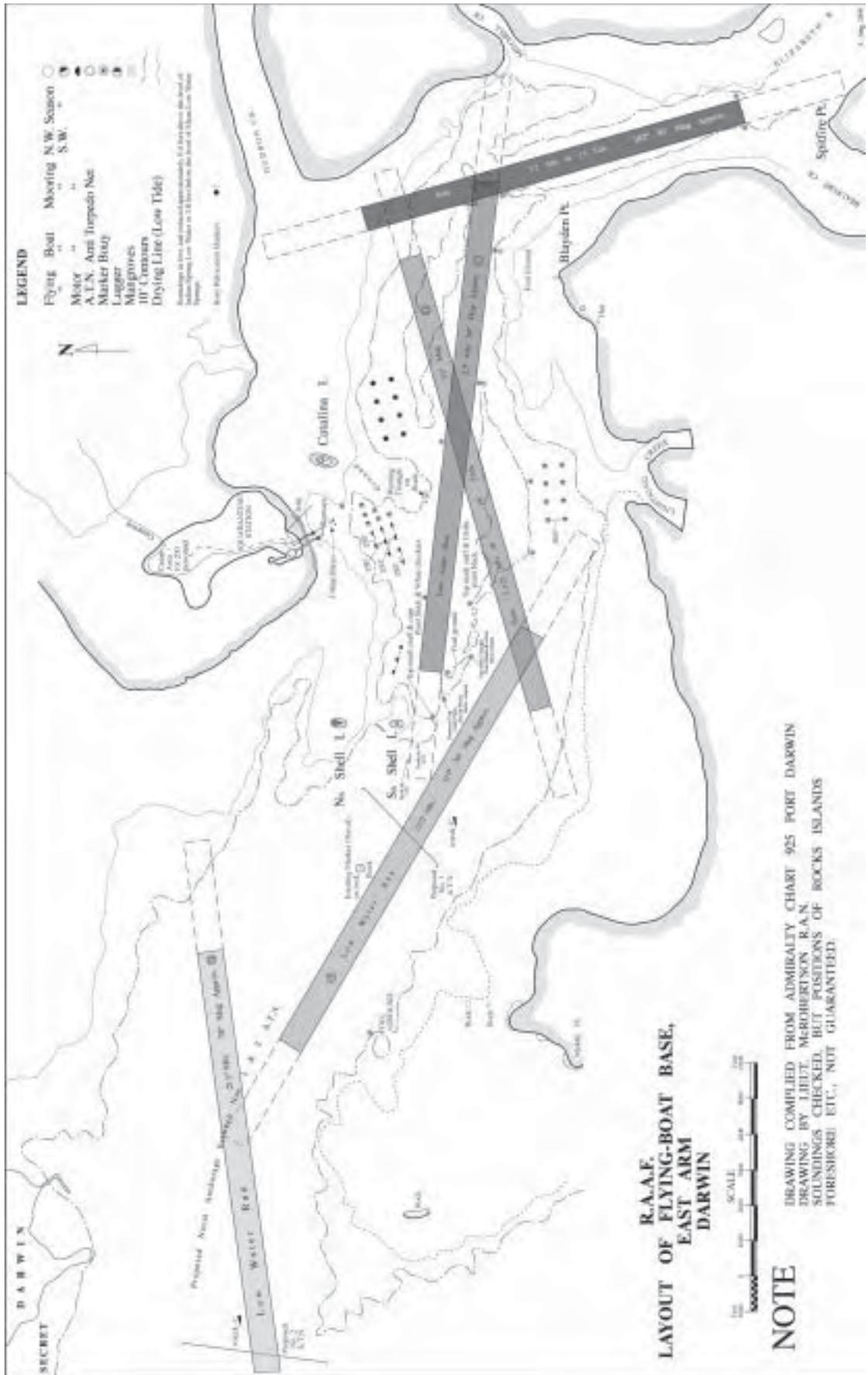


Figure 17. RAAF layout of Flying Boat base, East Arm, Darwin (Series: A705/7. Item: 171/6/218. National Archives of Australia).

In 1994 Andrew McMillan interviewed Catalina veterans and recorded their version of events on two of the four RAAF Catalinas lost. Jim Rodgers gives an account of the loss:

...our aircraft are overloaded sir. We can't possibly go like this. I pointed out to them that they weren't over loaded and Keith decided he'd show them that everything was alright and he promptly started bouncing his aeroplane. But he had a theory that if you didn't fly after your third bounce you weren't going to fly at all. And he's up about fifty feet in the air and he pulled his donks [engines] off and goes bang on the bottom and the whole bloody hull on the bottom just caves in (McMillan 1994a).

The aircraft quickly sank in shallow water, after stopping. Alic Emslie, No. 20 Squadron leader, goes on to say what was salvaged:

And he sunk out in the area there and we got the crash boats out and we got them off alright, but the aeroplane was nearly under, and all their cargo was on board...Anyway we got the panniers out of the thing and that night we managed to beach the aeroplane and I put the doctor and my Squadron Leader duty officer on to make sure this was salvaged properly, and they got down there and the doctor said "Oh these instruments are bugged, they've been under salt water." And all the airmen were hopping in and souveniring them, and I had to get the bloody things back. The army were pretty annoyed about it all. I got 'em back, the blokes were pretty good (McMillan 1994a).

Bill Smart, photographed A24-1 shortly after it sank (Photo 31), and relates that he had removed the radio and radar equipment in a two-hour operation before total immersion took place (Dermoudy Research Files, MAGNT).

A Court of Inquiry to determine the cause of the accident was held on 15 September 1945 at No. 43 Squadron, Doctor's Gully. The other Court of Inquiry records to have survived relating to the loss of the RAAF Catalinas is the report on the accident to A24-69, but as will be explained further on, there are no such records for the loss of two other RAAF Catalinas: A24-205 and A24-206.

Bolitho was the first witness in court. His statement, however, does not indicate directly why he changed his mind and dropped the aircraft back down on the water after that third bounce (Series: A705/1, Item: 32/17/263. National Archives of Australia). Perhaps he stuck to his

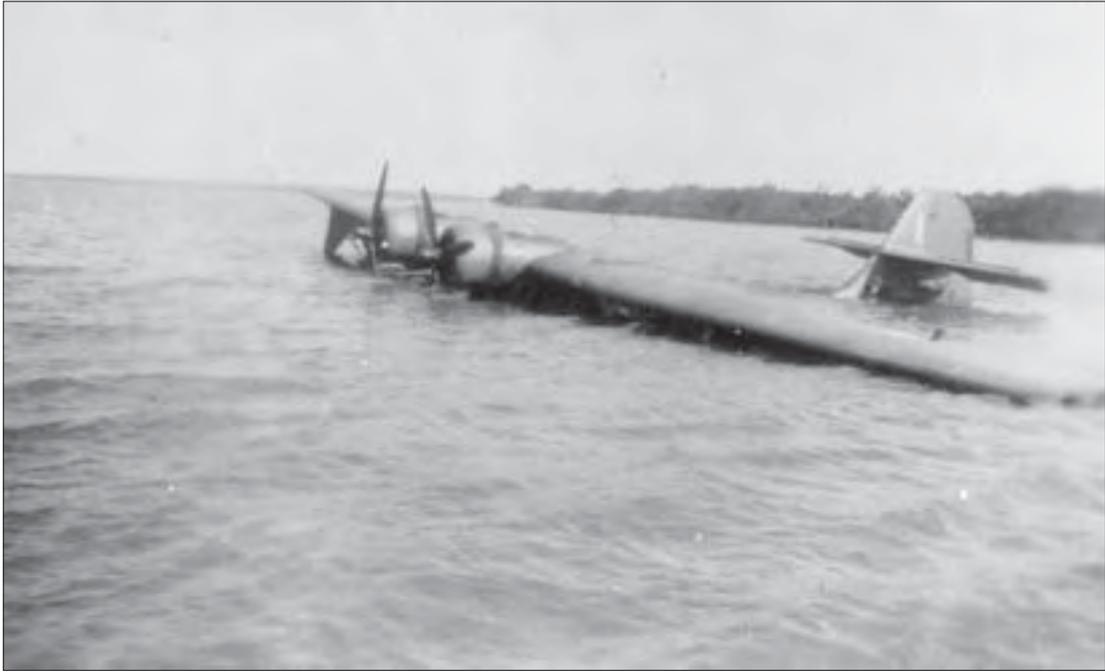


Photo 31. A24-1 shortly after a take-off crash. The machine is yet to be hauled to its current location (Bill Smart via Peter Dermoudy research files, MAGNT).

theory that if you were not flying by your third bounce, you were not going to fly at all. The following witness accounts point to the cause of the crash as pilot error.

Bolitho had committed himself to a west-east direction for take-off, for no explicit reason. This presents a problem, insomuch that if the aircraft does not fly by the end of the run, it would run out of surface water to take off from and crash into the mangroves at the end of the run. If Bolitho had decided to take off in the other direction, east-west, he would have had ample room.

The reef in East Arm was not known to Bolitho, which may explain his choice of which direction to take off from. It was also almost low tide at the time of the crash and he would not be able to see the reef even if it was just below the surface, because of the murky water. Squadron Leader Alexander Emslie (No. 548), who knew Darwin Harbour well, stated that the west-east run was in deep water the whole time, and that A24-1 could not have sunk by hitting a sand bar (Series: A705/1, Item: 32/17/263. National Archives of Australia). Faced with the poor take-off conditions at the time ie., the water was smooth, the only way to have got the aircraft to bounce was if the bouncing was initiated by the pilot. With the mangroves at the end of the run

coming up fast, Bolitho may have thought that he would not make it and cut his engines, but at too great a height (Series: A705/1, Item: 32/17/263. National Archives of Australia).

The teletype operator in No. 20 Squadron Signals Office was LAC John Rushbrooke (No. 443692) and he monitored the radio communications between the crash boat and A24-1 when the accident occurred. Each aircraft in the group to fly to Singapore that day had a call sign. A24-1 had 'K' for King and the crash boat was known as 'Boozing'. The following describes the actions of the pilot in light of instructions given from 'Boozing':

At approximately 1630 hours, I heard K for King call Boozing requesting take-off instructions. Boozing asked King to standby for a moment while he got them from the Duty Pilot. Boozing then called King and told him to take-off to the West, and there was very little wind. K for King said he would like to take off to the East as he thought he would get a better run that way. Boozing repeated his first instructions to take off to the West as what breeze there was was [sic] from the West. King then said he would make an attempt to take off to the East. Boozing then warned him of a reef which was at the end of the run. King requested the position of the reef. Boozing gave him its location. King then said "I am now taking off". There was then silence for several minutes and the next thing heard was "Quick, quick, crash-boat", which came from King. Boozing said, "King from Boozing over" and there was no reply (Series: A705/1, Item: 32/17/263. National Archives of Australia).

The location of the reef is an important consideration as it has bearing on which take-off route the captain took. Even though Bolitho was told about the reef, the information he had received about its location was ambiguous. He was only told that it ran out 150 yards off southern point off shore. Which southern point off shore they were referring to, the captain did not know (Series: A705/1, Item: 32/17/263. National Archives of Australia).

Flight Lieutenant Peter Balston (No. 406767) of No. 76 Wing indicates that Bolitho had had fair warning about the reef and that he had received additional instructions from the Duty Pilot, on the crash boat, to take off to the west, between a wreck (presumably the *Kelat*) and an island (South Shell Island). Bolitho insisted that he would get more of a head wind if he took off to the east. He was eventually authorised to do so, after his third request, and given clear instructions on how best to avoid the reef. He was to keep 'closer to the last aircraft in the line of buoys than to the southern tip' (Series: A705/1, Item: 32/17/263. National Archives of Australia).

Squadron Leader George Llewellyn Grendon (No. 2930), Commanding Officer of No. 2 Flying Boat Maintenance Unit (2FBMU), examined the aircraft on 4 September, after it had been towed to its present location. He could, however, not make an accurate assessment of the damaged area that had torn on impact, because there was one foot of water in the hull. The bilge was also considerably silted up. Grendon did make some observations of the hull above the water and noted that three stringers had fractured between stations 4.75 and 5, immediately below the chine on the starboard side. He also stated that 'there was also a hole in the planing bottom immediately between those two stations extending from the chine to approximately 2 feet above the keel' and that 'no other external damage was found' (Series: A705/1, Item: 32/17/263. National Archives of Australia).

A24-1 was selected for the trip to Singapore because it had the most robust hull out of the old Catalinas. It nevertheless needed some rivet replacement before the trip, but generally speaking, the aircraft was fully serviceable. The reason why it was abandoned, and not repaired, is indicated by Grendon's assessment of the crashed aircraft, lying forlorn on the mud in East Arm. Despite the fact the airframe was old, it would not have been economically viable to salvage the aircraft 'due to rapid corrosion of aluminum [sic] alloy components and structure caused by alternative immersion in salt water and exposure to air on the tide changes' (Series: A705/1, Item: 32/17/263, National Archives of Australia).

On 20 September 1945, A24-1 was allocated to 2FBMU for conversion to components. It is fitting to end the document history of A24-1 here, with an anecdotal account of its idiosyncratic nature. Roma Honan, widow of the late Robert Honan, said that her husband had flown many Catalinas and that A24-1 was his favourite: 'Robert flew that aircraft on many missions and told me that it was the best Catalina he had flown, it had no peculiarities like most of the Flying Boats. He was sorry to hear that the aircraft was lost on take off from East Arm' (Honan, R. 1998, pers. comm., 13 May). Honan (1989) explains what were those peculiarities inherent in the other Catalinas that he had flown:

We were sorry to have lost the use of A24-1, which had a certain nostalgia about it as it was the first Australian Catalina and, besides which, it flew without the tendency to fly on what was called the “hump”. Some of the aircraft tended to deceptively raise their noses, of their own accord, and thereby lose airspeed. A24-1 was number one in all respects (Honan 1989:54).



Photo 32. Remains of A24-1 abandoned in mangroves in East Arm, Darwin ca. 1974 (Photo: Aviation Historical Society of the Northern Territory).

4.7 A24-69 operational history

Catalina A24-69 (BUAERNO 34056 and C/N 61123) (Wilson 1991:63) was delivered to Australia from San Diego on 15 December 1943 and received at 2FBRD. Two days later, the aircraft flew from No. 2 Flying Boat Repair Depot at Rathmines (2FBRD) to No. 1 Flying Boat Repair Depot (1FBRD) on Lake Boga. The aircraft was officially renumbered with its RAAF designation, as A24-69, upon its arrival on Lake Boga on 17 December 1943 (Series: A10297/1. Item: Block 141, National Archives of Australia). A24-69 was allotted to No. 43 Squadron on 22 January 1944. This Squadron was the first unit to operate all three PBV-5, PBV-5A and PBV-5A (M) models. The squadron's PBV-5As were officially the strength of No 6 Communications Unit but attached to No 43 Squadron for air sea rescue duties (Vincent 1981:66). A24-69 also took part in an air raid on Malang airfield when the RAAF Catalinas had reverted to their bombing role, harassing Japanese airfields (Vincent 1981:81).

The aircraft changed squadrons on 9 February 1944 when it was assigned to 11 Squadron at 1FBRD. A24-69 first flew to Lake Boga for modification from amphibian to Flying Boat prior to its new allocation. Two photographs of A24-69 are shown undergoing these modifications at 2FBMU (Photo 33 and Photo 34). Photo 33 is dated to 31 August 1944, relatively late in A24-69's career. Photo 34 is not dated, but was probably taken on the same day and from a different angle. Only temporary modifications were carried-out, however, and the aircraft was received at 11 Squadron on 18 February 1944. Shortly afterwards, the aircraft met with its first accident on 21 February when it collided with a fuel barge at an advanced naval operations base, causing extensive damage to the starboard wing pontoon, to the pontoon hydraulic mechanisms and to the mainplane. This necessitated the aircraft's return to Lake Boga for repairs on 12 March. The repairs were completed by 14 April and A24-69 was received back at 11 Squadron (Series: A10297/1. Item: Block 141, National Archives of Australia).

On 28 May 1944, A24-69, still in an unmodified state, was scheduled to return to Lake Boga for its 240-hour service. The aircraft was to be reallocated to 11 Squadron on completion of its service on 1 June 1944. The aircraft was due for another service on 26 June and was allocated back to 1FBRD, but this was delayed when operations at 1FBRD could not accommodate the aircraft into its busy schedule. A24-69 was then allotted to 2FBRD instead, but for some reason, was shuffled back to 1FBRD for its service and modification to a PBV-5A(M) on 20 July 1944. Conversion of the amphibious gear to Flying Boat was a major modification, which required approximately 1,500 hours for each aircraft and was the largest single job undertaken by 1FBRD (Vincent 1981:66).

The last note on the Aircraft Status Card for A24-69 prior to its loss in Darwin Harbour states that it was allotted back to 1FBRD from 11 Squadron on 13 December 1945. No mention is made of it returning back to 11 Squadron for its final flight from Cairns to Darwin (Series: A10297/1. Item: Block 141, National Archives of Australia).



Photo 33. *A24-69 at Lake Boga, Victoria, 1944 August 31. (Australian War Memorial, Neg. No. P0448/212/039).*



Photo 34. *'Catalinas under repair at Lake Boga - A24-70 is in the foreground and A24-69 the first PBV-5a to be delivered to the RAAF is the background' (Col. Reg Marr OAM DFC QC RL - RAAF Photo via Gaunt and Cleworth 2000:82). Note: unfortunately a poor reproduction, but the photograph most likely was taken on the same day as Photo 33, by the same photographer who would have been standing on the wing of A24-70 to photograph A24-69.*

4.8 Loss of A24-69

On 19 August 1945, A24-69 was received back at 11 Squadron. No further notes were made of the aircraft's movements until 13 December when it was scheduled to return to 1FBRD for another service. The aircraft was then recorded to have burst into flames and sank at its moorings at Darwin on 14 December 1945 (Series: A10297/1, Item: Block 141, National Archives of Australia).

A24-69 was on transport duties from Cairns with 11 Squadron at the time of its loss and was due to return there the next morning. The Aircraft Status Cards do not mention this transport duty, but the Court of Inquiry held shortly after the accident, records the function of the aircraft at the time of its loss.

The Inquiry was held at No. 112 Air Sea Rescue Flight (112ASRF), East Arm on 21 December 1945. In total, nine witnesses gave evidence as to what had happened to the aircraft. Several key witness accounts are recounted below, relating to the possible cause of the loss of the aircraft and more importantly, from an archaeological perspective, how it sank.

The first witness at the inquiry was Sergeant Bryan Coskey Pierson, Fitter 11A-A/G., of No. 11 Squadron Rathmines. Pierson stated that he and Flying Officer Marsh had boarded the aircraft at 2030 hours on 14 December, which was moored, according to the statement, '600 yards from the jetty, with the intention of sleeping on board' (Series: A705/1. Item: 32/17/270, National Archives of Australia). The necessary compartment lights were switched on and Pierson climbed on top of the navigator's compartment to sleep. It was a wet season evening and it was cooler sleeping out side on top of the roomy PBY wing, instead of upon the bunks inside the stuffy hull. At 2250 hours he went into the engineer's compartment and switched on the sight gauge light, situated behind the engineer's seat, beneath the gauges. The auxiliary power unit (A.P.U.) was also activated, fearing that the lights would drain the aircraft's batteries. Ten minutes later, at 2300 hours, Pierson noticed smoke coming out of the engineer's window and went back inside the aircraft via the navigator's hatch to notice flames and smoke coming from the fuel sight gauges.

Marsh found a fire extinguisher for Pierson to use, however, it did not have any effect. They then decided to leave, since the fuel tanks were directly above the fire and could explode at any moment. The inflatable dinghy was deployed and both men jumped into the water. The men drifted away, clinging to the half submerged dinghy that had only partially inflated. They eventually managed to get into the dinghy and attempted to let off the distress signal flares, but they would not work properly either. The flares were not necessary for the aircraft by now had erupted in flames and would be seen from the jetty:

We were drifting well away from the aircraft and about quarter of an hour after having jumped into the water I saw the aircraft burst into flames. We were picked up by the crash boat about five minutes later (Series: A705/1. Item: 32/17/270, National Archives of Australia).

Sergeant Pierson's account of the fire indicated that the aircraft was lost due to inadequate fire fighting equipment on board. The second witness was Flying Officer Eric Marsh (412820) Pilot, of No. 11 Squadron, RAAF Rathmines. Marsh's statement collaborated with what Pierson had said, but he adds further details. While drifting from the aircraft, he noticed a glow on the engineer's panel and that the fire seemed to have subsided a little. He decided to swim back and try and save the aircraft, but hearing the dinghy inflate after only having swum ten yards away, changed his mind (Series: A705/1. Item: 32/17/270, National Archives of Australia).

The third witness was Corporal Constable Jeffery (No.156534), Motor Boat Crew of Marine Section Darwin. He was the duty coxswain of Crash Boat 08-36 on the night of the fire and he provides a second angle on the sequence of events preceding the sinking of the aircraft. He too had seen the flickering light in the engineer's compartment. His boat was about 500 yards away and knowing that people were aboard, he went to investigate the ominous glow, but before getting much closer, the aircraft had burst into flames. He had spotted the aircraft's problem too late to alert the fire tender. In fact, there was none. A fire tender was sent to Darwin Harbour in response to the A24-69 disaster, shortly after the incident.

Jeffery went over to the still floating aircraft and circled for survivors, who might have jumped over board or had taken to their dinghy. He first grabbed a coat to act as shield against the fire

and went up close to the hull to see if there was anyone still inside or clinging to the hull and noticed that the fuel tanks were well and truly alight and that the aircraft would soon sink. A green light from the second boat involved in the search for survivors soon indicated to Jeffery that the two men had been picked up. Jeffrey stayed at the site and monitored the aircraft until it sank and ensured that burning fuel on the surface of the water did not reach any other aircraft moored in the area. Jeffery also stated that ten minutes had elapsed from when he saw the light on A24-69 to the time it took him to reach to aircraft. One engine on the crash boat was undergoing maintenance and as a result, the vessel could make only six knots. He then estimated that the aircraft was on fire for fifteen minutes (Series: A705/1. Item: 32/17/270, National Archives of Australia).

The crew of A24-69 was picked up by LAC Palmer Raymond Henry (No. 145595), Fitter Motor boat Crew of Marine Section, from Work Boat 011-67. Henry was about six minutes away from the aircraft and reached the scene in Work Boat 011-67 before Jeffery. Once at the scene, Jeffery ordered Henry to change boats. Henry was to search, in the crash boat, a wide circle around the aircraft for anyone who might have jumped, while Pierson went close up to the hull in the work boat.

Henry picked-up the two men, who were found safe only a short distance away. He took them to the jetty and then returned to the site to help ensure that floating debris and burning fuel did not endanger nearby aircraft. He saw A24-69 sink and describes the burning wreck as having broken in half prior to sinking (Series: A705/1. Item: 32/17/270, National Archives of Australia).

W/O McKenzie James William (No. 81571), 1st Class Coxswain of Marine Section Darwin heard a call over the P.A. system, at the base on Quarantine Island, for a fire tender. He proceeded to the jetty and saw a burning aircraft about 300 yards away. He obtained a bomb scow and assisting in monitoring the burning wreckage with the other two boats that were on site already. McKenzie estimated that fifteen minutes had passed since hearing the alarm to the sinking of the aircraft. While under questioning, McKenzie's statements pointed to the lack of fire fighting facilities, which in part attributed to the loss of the aircraft. The following are the statements that were made in court; questions are by the Court and answers by McKenzie:

- Q- What facilities are available for fighting fires in Aircraft on the water?
- A- No fire float is held, although one is on establishment, and the only other apparatus available are the extinguishers on the crash boats and work boats.
- Q- Do you, as O.C. Marine Section, consider the present facilities for ensuring the safety of Aircraft and crews adequate?
- A- For crashes not accompanied by fire, yes. But facilities for handling any outbreak of fire, no (Series: A705/1, Item: 32/17/270, National Archives of Australia).

A24-69 was under the command of Flight Lieutenant Douglas Stewart McVicar (No. 207863) pilot of No. 11 Squadron RAAF Rathmines. McVicar was ashore at the time of the fire and did not go out to the scene. His account of events adds little to what has been mentioned already, but he does provide background information such as the aircraft's purpose for its trip to Darwin as transport duty of personnel and equipment. But of specific interest to archaeologists is a list of what was lost with the aircraft. The RAAF had lost, apart from the aircraft itself, an engineer's tool kit, one set of spark plugs and two dinghies. As for personnel items, two pairs of overalls, one pair of trousers, dividers, a parallel rule and a Douglas protractor. McVicar also mentions that divers from the Marine Section had recovered other unspecified items. This is significant, as it is the only reference to any salvage having undertaken on the Catalinas (Series: A705/1. Item: 32/17/270, National Archives of Australia).

4.9 A24-205 operational history

A Catalina (BUAERNO 44224, ex-RAF JX614) was received at 2FBRD on 4 January 1945. The aircraft was designated its RAAF serial number, A24-205, on 6 January and flew to Lake Boga the next day. By 20 January A24-205 (Photo 35) was received at 20 Squadron, which had been based in East Arm since late 1944 (Powell 1996:199).

A24-205 operated with the squadron until 17 May when allotment to 1FBRD was requested to effect major hull repairs and its 240 hours service. The cause of the damage is unknown, but A24-205 was received at 1FBRD on 26 May where it remained until 5 June and returned to 20 Squadron on 3 July 1944 (Series: A10297/1. Item: Block 143, National Archives of Australia).



Photo 35. 'The PB2B-1, A24-205 coded RB, of No 20 Sqdn at Darwin 30 January 1945. It crashed on take-off 9 August' (Hendrie 1988:161).

The aircraft's service history indicates that it was one of three that participated in the last mine laying operations by Catalinas of the World War II on the 30th July 1945:

A24-202 under Flight Lieutenant Hal Healy, A24-205, Flight Lieutenant Kev Hammer and A24-307 under Squadron Leader Alec Emslie returned to Darwin on the 31st (Aviation Historical Society of the Northern Territory 1992:67).

The full crew list for the operation was as follows: F/Lt. Kevin Hammer (captain), 2nd pilots B. White and F.A. Lucas, F/Lt. Allan Thompson (navigator), F/Lt. Stan Guilfoyle (1st wireless operator), F/Sgt. Ross Coulthard (2nd wireless operator), F/Lt. Clem Clemesha (1st flight engineer), F/Sgt. Alex Bennet (2nd flight engineer), Sgt. Jack Ward (Air/frame fitter [11A]) and Sgt. Wally A. Speed (armourer) (Gaunt and Cleworth 2000:200). Photo 36 shows some of the crew on top of A24-205.

On 4 August 1945, A24-205 was allotted to return to Lake Boga for its 720 hours service to have both engines changed. Repairs to the planing surfaces were also to be done at 1FBRD. This order was, however, cancelled and the work was to be done at 2FBMU instead. A24-205 was received at 2FBMU on 9 August. That same day A24-205 ran aground during a take-off accident, the cause of which was attributed to pilot error (Series: A10297/1. Item: Block 143, National Archives, Series: A2408/1. Item: 32/17, National Archives of Australia).



Photo 36. 'Crew sitting on the mainplane L to R: Clem Clemesha, Kevin Hammer, Val Lucas, Wally Speed, Stan Guilfoyle, Jack Ward, Alex Bennet' (Gaunt and Cleworth 2000:200).

The damage sustained to the aircraft, however, was relatively minor. Damage was sustained to ten percent of the fuselage and to fifteen percent of the starboard mainplane. The port outer mainplane, however, was extensively damaged. It is also indicated that after the accident the water was too high to recover the aircraft that same day, and that it was left until the next suitable high tide (Series: A10297/1. Item: Block 143, National Archives of Australia).

2FBMU carried out temporary repairs on 13 August, four days after the accident. The repairs were satisfactory and on 21 August 1945, A24-205 was allotted to 1FBRD for repairs and inspection. 1FBRD received A24-205 on 6 September 1945. A survey report was subsequently received on 10 October recommending the scrapping of the aircraft. On the 20 November, three months after the accident, RAAF approval was given 'to convert [the aircraft to components] at a RAAF mechanical salvage unit' (Series: A10297/1. Item: Block 143, National Archives of Australia).

Interpreting what is written on the Aircraft Status Cards is problematic, in that the nature of the salvage often varied considerably from what was recorded. Conversion to components of a written off aircraft could mean the mere removal of the compass, sextant, radio equipment etc.,

rather than the complete break-up of the aircraft wreck. The later references to A24-205 having been converted to components at 1FBRD could simply have meant that the approval to convert to components was given from 1FBRD, but not at 1FBRD. In other words, A24-205 could have been written off on paper only, and that its wreck was abandoned in Darwin Harbour.

4.10.1 The flight accident of Catalina A24-205

The accident occurred in the morning on 9 August 1945. A24-205 went to take-off, but ran aground in East Arm, fortunately without loss of life or injury. The pilot was Flight Lieutenant J. G. Granger, but no other information is provided (Series: A10297/1. Item: Block 143, National Archives). A further source entitled 'Aircraft Accident Data', indicates that seventeen RAAF passengers were on board. A list is also provided in the document for the flight crew, but what transpired on the morning of the crash is unknown (RAAF Historical and Archives). The flight crew consisted of:

Pilot - 2nd:	F/O R. L. Priestly
Navigator:	F/O M. L. Judge
	F/Sgt K. F. Coggin
W/T. Operator:	F/Sgt R. O. Lenny
	F/Sgt J. T. Cocks
Others:	F/Sgt S. R. Archibald
	D/Sgt C. E. Thomas
	D/Sgt B. O. Burrows

Unfortunately, the Court of Inquiry Records for A24-205 and also for A24-206 have not survived the intervening years, since these would have had detailed accounts of what occurred on the morning of the crash. Those records were not transferred into the custody of either the RAAF Historical & Archives, or the Australian National Archives of Australia (Angel, M. 1998, pers. comm., 11 September; Mcfarlane, L. 1998, pers. comm., 3 November).

4.10.2 The fate of A24-205

The Operations Records Book of the 2FBMU stationed at the RAAF Flying Boat Base (FBB) in East Arm (Fig. 18 and Photo 37) contains important information on how the Catalina wreck sites can be identified (Series: A9186/16, National Archives of Australia). This record provides contradictory evidence as to the accepted fate of A24-205 in East Arm (Lewis 1991; 1992; 1995; DPIF 1992; Acer/Vaughan 1994).

2FBMU was stationed at the FBB in 1945. The unit was formed at 1FBRD (Lake Boga) on 20 July 1944 and commenced its move to Darwin on 1 October. Once in Darwin, the unit was initially based at Doctor's Gully FBB until accommodation and workshops were built on Quarantine Island at the new FBB site. The delays caused by the encroaching Wet Season, the lack of suitable building materials and machinery, postponed the unit's move to the FBB until the end of March 1945 (Series: A9186/16, National Archives of Australia).

The unit kept the Catalinas in operational service. They were also responsible for repairs to damage caused by the Japanese or from flying accidents. The unit's Operations Record Books state that when the crash occurred on the northern shoreline of East Arm, 2FBMU was ordered the scene of the accident, arriving there at 0700 hours. They managed to beach the aircraft and patch the holes in the hull, but efforts to refloat the Flying Boat were hampered by the evening high tide being lower than the morning. As a result, the people in 2FBMU had to wait until the next morning to get the Flying Boat afloat again. They left the Catalina in the care of the guards and returned to the FBB at 2100 hours, after what was recorded to have been a very long and exhausting day's work (Series: A9186/16, National Archives of Australia).

The second attempt to float the aircraft was made the following day, 10 August 1945 as documented in the 2FBMU Operations Record Books:

An early start was made on A24-205. The Commanding Officer, Engineer Officer and a party of 45 airmen had breakfast at 0630 hours and commenced the job of floating before 0700 hours. With a tide a few inches higher than that of the previous morning the aircraft was floated. The repairs made, under difficult conditions, to the hull proved successful and the A24-205 was drawn up on the slipway at 0815 hours (Series: A9186/16, National Archives of Australia).



Figure 18. RAAF Flying Boat Base on Quarantine Island, East Arm ca. 1945 (Series: A431/1. Item: 48/1068, National Archives of Australia)



Photo 37. The RAAF Flying Boat base on Quarantine Island, East Arm showing remains of the jetty and buildings in 1961 (Photo: Lands Collection PHI39/1848, Northern Territory Library).

The engines on A24-205 were changed after the damage sustained in the accident was repaired, which also indicates that A24-205 was not abandoned. The subsequent flight of A24-205 out of Darwin is related in 1FBRD's Operations Record Books which states that A24-205 arrived from Rathmines (2FBRD) on 5 September 1945 at 1500 hours with Squadron Leader Brian Monkton as pilot (Series: A9186/16, National Archives of Australia; Freeman, B., 1998, pers. comm., 19 August).

4.11 A24-206 operational history

Once again, as with previous Flying Boat deliveries from the United States, a PB2B-1 (BUAERNO 44217, ex-RAF JX611) was received at 2FBRD, Rathmines, on 8 February 1945. The aircraft was officially renumbered A24-206 the following day (Series: A10297/1. Item: Block 143, National Archives of Australia). The same day the aircraft was numbered, it flew to 1FBRD where it was the subject for a photographic session, resulting in the only known photographs of the aircraft (Photo 38, Photo 39 and Photo 40). A24-206 was then allotted to 43 Squadron and received there on 9 March 1945 (Series: A10297/1. Item: Block 143, National Archives of Australia).



Photo 38 *'Canadian built PB2B-1 Catalina A24-206 on a low pass. RAAF Ferry crews took delivery of these aircraft at San Pedro California' (Ethel Pfeiffer Collection via Freeman 1995:223).*



Photo 39. *'A24-206, February 1945, after arrival from the US and its conversion to a Black Cat. Note the Radome above the cockpit which provided improved radar reception' (Australian War Memorial, Neg V71 via Freeman 1995:224).*



Photo 40. *'A24-206 taxis across Lake Boga prior to delivery to No. 43 Squadron' (Vincent 1981:117).*

In April 1945 A24-206 was involved in air sea search operations for missing B-24s and a Catalina. Pilot Officer Spaulding and Flight Lieutenant Lucas in A24-206, together with two other Catalinas were involved in the search that unfortunately failed to find any survivors (Series No. AWM64, National Archives of Australia). In the same month, the Catalina, with Squadron Leader Monkton, Flying Officer Abbot and Wing Commander Shorter, was involved in sea mining operations. Hainan Strait was successfully mined on the night of 14 April 1945 by A24-206 and three other Catalinas (Series No. AWM64, National Archives of Australia). Later on the night of 17 April 1945, A24-206 flown by the same crew as on the night of the 14th, together with one other Catalina mined the approaches to Hong Kong (Series No. AWM64, National Archives of Australia). April continued to be a busy month for A24-206. Together with one other Catalina, A24-206 departed Darwin to mine Hainan Straits on the 20th, again with the same crew: Monkton, Abbot and Shorter. The mainplane of A24-206 on this mission, however, was damaged by the premature explosion of a mine (Series No. AWM64, National Archives of Australia).

After having been in operation for only a few weeks after its delivery to 43 Squadron, A24-206 had its second mishap when it collided with a barge. No mention is made of this incident in the Aircraft Status Cards except that the aircraft was allotted to 2FBRD for repairs on 30 April, but actually received at 2FBMU on 2 May, who did the work in East Arm (Series: A10297/1, Item: Block 143, National Archives of Australia).

The collision incident occurred on 16 March and is related in detail in another historical record, called Aircraft Accident Data (RAAF Historical Records 1945). Under the command of Flight Lieutenant R. T. Gill, A24-206 collided with a moored boat shortly after leaving its mooring buoy:

(brief description) (a/c collided with moored boat soon after leaving buoy. Combination awkward wind + tide conditions + inexperience of pilot). A/c left buoy using port motor and starboard drougue [sic], shortly developed a swing to port which took the a/c undesirably close to some moored barges. The starboard motor was started and a/c headed for open water. Another unexpected swing placed the a/c in a position where it was impossible [sic] to avoid a collision with a barge. Engines were stopped before collision (RAAF Historical Records 1945).

The aircraft was plagued by troubles when on 18 May, less than two weeks after being received by 2FBMU, another accident occurred. Another premature mine explosion caused 10 percent damage to the starboard wing. Casualties were registered (No. 582), but who these people were is unknown (Series: A10297/1, Item: Block 143, National Archives of Australia). This incident, however, may relate to the event that occurred on 20 April. It probably took until May for the Catalina to be repaired.

Following repairs at 2FBMU, A24-206 was allotted to 20 Squadron on 24 May and received by them on 15 June 1945. Five days later on 20 June, the second accident occurred, but this time A24-206 sank in 10 fathoms of water (Series: A10297/1, Item: Block 143, National Archives of Australia).

4.12 Loss of A24-206

Unfortunately, unlike the detailed Court of Enquires for the accidents to A24-1 and A24-69, no such documents survive or, perhaps, never existed for the fatal accident that occurred to A24-206. Fortunately, one source of information as to what happened to the plane has been recorded. The participants of the event are still with us. Andrew McMillan interviewed the first pilot of A24-206 in 1994. The following is a transcript of an interview with Alic Emslie who witnessed the accidental explosion of a depth charge, which destroyed A24-206:

We'd just been out on a job in it and when we came back and landed and they'd refuelled it and we were almost to the jetty when we heard this terrific crunch. They'd been loading depth charges on it and they had two on one side, they were fitting one to the other side when some clown in the cockpit pressed the release button and dropped the depth charges off. Of course when they went down and reached their depth, up they went. One dropped straight through the bomb scow. It killed I think three fellows on the bomb scow and then others were concussed in the water, a couple drowned (McMillan 1994b).

Vincent (1981:122) lists two armourers killed, LAC R. L. Graham and Corporal W. A. Strang. These men are interred in the Adelaide River War Cemetery (Photo 41 and Photo 42). Graham and Strang were the only service personnel killed on Catalinas in Darwin Harbour throughout the war.



Photo 41. The head stone of R. L. Graham at the Adelaide River War Cemetery (Photo: Jung 2000).



Photo 42. The head stone of W. A. Strang at the Adelaide River War Cemetery (Photo: Jung 2000).

4.13 Results

Several key historical sources have been identified for the USN and RAAF Catalina Flying Boats reported to be lost in Darwin Harbour's East Arm. The two sources relating to the USN Catalinas are the PatWing-10 War Diary and the Aircraft History Cards. These were used as the primary reference source for reconstructing their service histories and origins.

The primary references for the USN were found to be incomplete and at times not up-to-date. For instance, PatWing-10 aircraft: #4, #8 are marked as 'Stricken' on their Aircraft History Cards on 31 March 1945, not at the time of their loss. This demonstrates the time lag between actual events and when those events were recorded. It appears that the participants were perhaps too busy fighting to keep accurate records.

Study of the primary references to PatWing-10 has revealed specific details relating to the technical details of the Catalinas and the squadron designation changes each aircraft had undergone. Specific details relating the Catalinas lost in Darwin Harbour, however, were found to be patchy.

The gaps that this creates have been filled, in part, by secondary references. Together with the primary historical data, principal works such as Messimer's *In the Hands of Fate - The story of Patrol Wing Ten* (1985) have been analysed to create a chronology of events relating to the service lives of the crews and aircraft that were lost in East Arm. This was the case with the RAAF Catalinas too, whereby primary data was augmented with a critical review of secondary sources to reconstruct their operational service lives.

This review of the historical data, however, did not locate specific information as to where the Catalinas were lost. For instance, exactly where in East Arm each Catalina was lost has not been recorded.

The historical data states the cause of the Catalina losses, indicating that wreck site formation factors may be evident in the archaeological record. For instance, it is now understood that

USN Catalinas #4 and #8 sank due to having been set on fire by incendiary cannon shells. The last USN Catalina to sink was #41, but the cause of its sinking was different. It would not sink and was said to be bombed as well as strafed.

The causes of the RAAF Catalinas losses were also due to different circumstances. One Catalina caught fire, two crashed on take-off and one was blown up in a depth charge explosion. Understanding the causes of their loss will enable archaeologists to determine how these Flying Boats sank ie., how the wreck sites were formed.

This assessment of the historical sources has also uncovered previously unknown material relating to how the Catalina wreck sites can be identified. As a result, only six and not seven Catalinas are argued to have been lost in East Arm. In light of the historical analysis, of the two Catalinas that crashed on take-off, A24-1 and A24-205, it is the former that entered the archaeological record, whereas the latter underwent a transformation back into a cultural system.

4.14 Conclusion

This chapter has compiled a history of the Catalinas that were lost in Darwin Harbour. While much has been written on Catalinas, this thesis has, for the first time, detailed the individual service lives of each of the Catalinas lost, which indicates the important functions that these Flying Boats performed during and shortly after WW2. The archival information is also essential in determining the modifications that were undertaken. To the unwary, these modifications could skew archaeological interpretations. For example, A24-69 was originally an amphibious Catalina with a retractable undercarriage. The undercarriage, however, was removed and the machine was converted back to strictly a Flying Boat that relied solely on water for take offs and alighting. Archaeologists, as a result, should not expect to find wheels on the wreck site of A24-69, but evidence of the modification from amphibian to Flying Boat.

This chapter has also detailed the accounts of loss, which will be used to assist in the interpretation of the archaeological material found at each wreck site. The way each Catalina sank has profound

implications on how the archaeological material is interpreted. Given that four were lost to fire and one due to an explosion of a depth charge, there should be evidence for these events on the wreck sites.

Archival research has also added to our understanding of how many and which Flying Boats were lost. Previously, seven Flying Boats were believed to have been lost, but this research has shown that this number must now be revised to six. One Catalina, A24-205, that was believed to have been lost is now discounted as a possible Darwin Harbour wreck site, since there is now conclusive evidence that this machine did not sink, but ran aground and was subsequently flown to Lake Boga and converted to components there.

This research also provides data, which allows assessment of the historical significance of the Catalina wreck sites. This has important implications for their nomination as heritage places under the *Northern Territory Heritage Conservation Act* (Northern Territory Government 1991). Some Catalinas, like A24-69 and A24-1 were visitors that were lost while attached to squadrons not based in Darwin. Others such as A24-206 and the USN Catalinas were lost while on active duty, in either semi or fully operational serviceability. It is evident from this historical overview that all of the Catalinas that were lost in Darwin Harbour had an association with the Northern Territory, in that they were either frequent visitors or actually stationed in Darwin.

CHAPTER 5: ARCHAEOLOGICAL SURVEYS

5.1 Introduction

This chapter presents the survey method and the results of an archaeological survey of the five located Catalina Flying Boat wrecks in East Arm. The survey of these sites aimed at recording the diagnostic features of the type of aircraft and any evidence for site formation processes that may indicate how they sank. Identification of the attributes exhibited by each of the wreck sites should indicate the type of Catalina, unless there are more than one type found. For instance, the historical record shows that there were two PB4Y-1 models lost. The fieldwork will determine if either of these two are amongst the located wrecks and if so, a different approach will need to be adopted to determine the specific identity of those wreck sites. This different approach, it is argued, will require excavation and will be discussed later in Chapter 7.

In mid 1942, The Royal Australian Navy made feasibility assessments of the shipwrecks sunk during the first air raid in Darwin Harbour (McDonnell 1995). Divers provided information on exactly what caused the ships to sink. This information was necessary to plan the refloating of several vessels. Similarly, such information is of importance to archaeologists identifying the Catalina wreck sites, for if they were to determine the factors that caused each of the aircraft to be lost, it would then be possible to reconstruct the events that resulted in their loss. For example, a depth charge explosion beneath one of its wings destroyed A24-206. Is there any evidence of such a cataclysmic event at any of the located sites? A24-69 caught fire and so did the USN Catalinas, one of which also, it is said have been bombed (O'Beirne 1945). As a result, wreck site recording should determine if there is there any trace of fire damage or bomb damage on any of the located wrecks.

5.2 Survey method

The primary aim of the fieldwork survey method was to develop a consistent wreck site recording technique that identified attributes indicative of Catalina type. A general understanding of the

layout of the assemblages at each wreck site was also required to record wreck site condition and to explain some of the site formation processes that may aid in identifying their origin.

Environmental and other constraints of working in East Arm dictated the nature of the survey method. The visibility and the large variations in tidal movement are two constraints that significantly affect diving operations (Baker, Anuskiewicz and Garrison 1998). Considering these adverse conditions, a deconstruction model was chosen as the best method for developing an overall view of the extent of the archaeological material at the Catalina wreck sites.

The deconstruction model is a process of disassembling an airframe line drawing with archaeological data. The wreck site plans were developed by omitting the lines for the structural elements that were missing or altered on the wreck sites. Wings, engines and other wreck site features were measured in relation to the hull. This provides a technique for determining the overall distribution and extent of major structural elements that indicate what may have happened to each of the Flying Boats as they descended through the water column.

Figure 19 presents the line work of a PB5Y-5 Catalina, used for developing the wreck site plans. These lines are not indicative of every detail on the wreck site, but show the expected layout of an intact aircraft. The orientation of the fuselage of each of the Catalina wreck sites was determined by obtaining a compass bearing of the hull axis. This bearing was taken from the cockpit at every wreck site. In this way, the axis of the hull is related to north, providing a base line to which other elements of the wreck site can be referred. The surveying equipment consisted of a compass, a fifty-metre tape measure, a writing slate with waterproof paper and pencils.

Specific wreck site attributes that reflect the type of Catalina Flying Boat at each wreck site were noted and added to the site plan, once an overall layout of the wreck site had been obtained. For example, if a wreck site has engines, the engine type was recorded. The results are that an initial understanding of the archaeological material at each of the wreck sites is developed within a relatively short number of dives. The dates and times of the wreck site visits are documented in Appendix 4.

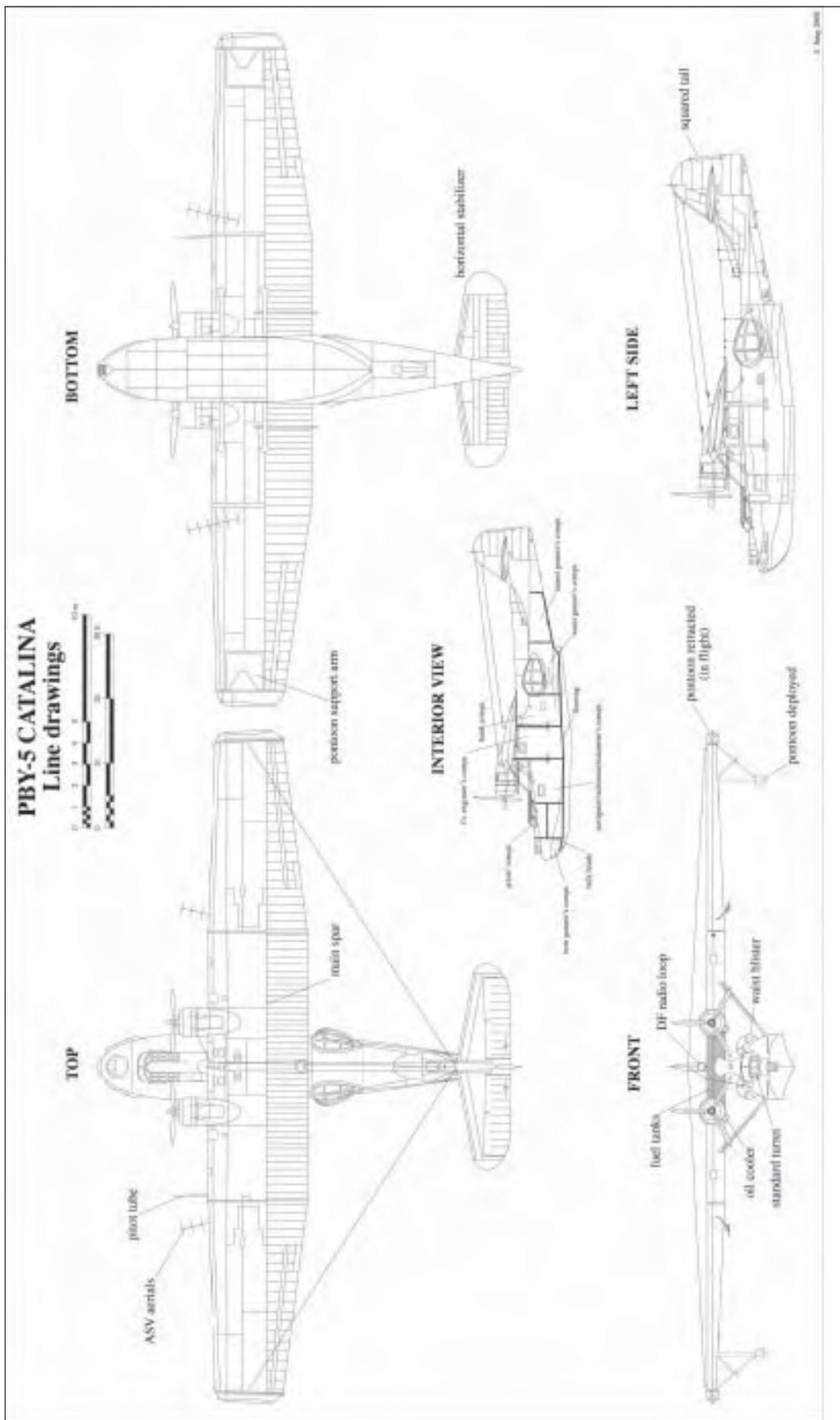


Figure 19. PBY-5 Catalina line drawings (After Knott 1981; Scarborough 1985).

A simple method is the key for working high profile wreck sites in difficult conditions. High profile shipwreck sites have hulls and or superstructures extending above the sea floor. Most common of this site type are those of iron steamships and later steel hull vessels (Riley 1988a:191). According to one theory used to explain their deposition, vessels tend to settle on the sea floor up to their water line (Riley 1988a:191). The sediment supports the hull in much the same way as if the vessel was afloat. The result of the wrecking event is that much of the vessel is still exposed above the sea floor, presenting a high profile. The sunken vessel's hull forms a baseline for survey work. Heights or Z coordinates are then measured using the sea's surface as a datum (Riley 1996).

The Catalina Flying Boat was a mass produced war machine and its morphology is illustrated in the historical record and exhibited by operational examples. Surveying of the five wreck sites aimed at distinguishing differences between physical attributes and the spatial distribution of structural elements between wreck sites, rather than recording the morphology of the 'Catalina Flying Boat' *per se*. Drawing a plan of a Catalina is nothing new, but a site plan of a wrecked Catalina is. Drawing of the intact wreck site elements could be extrapolated from the model drawing represent by Figure 19. All that had to change was the orientation of structural elements and the deletion on the drawing of what is not on the wreck site. A historic aircraft wreck inspection form is included in Appendix 5. This form was standardised in order that consistency could be maintained in the type of wreck site data being recorded.

Unlike an unknown shipwreck, where details of its construction may not have survived (such as builder's plans etc.), the historical record on Catalina Flying Boats contains a plethora of construction and modification plans. The existence of Catalinas in operational service today also means that archaeologists do not need to turn to the archaeological record to determine what a Catalina Flying Boat looked like, or what it was like to travel in one, for instance. Archaeologists, as a result, have a body of information to draw upon, which provides data on the appearance of the Catalina Flying Boat. The unknown factor in Darwin Harbour is how the Catalina wreck sites vary from each other and what exists at those locations today.

With a mental template of what the Catalina wreck sites should look like, anomalies in the archaeological material can be identified. For example, knowing what the right side up of a wing looks like is essential for recognising an upside down wing and useful in trying to reconstruct the break up of an aircraft during its descent to the bottom of the sea.

The site plans produced according to this deconstruction method are very much an artistic impression of the condition of each of the wreck sites. Surveying in poor visibility should not affect the accuracy of measurements taken, but the time to do the work. To have accurately recorded the Catalina wreck sites in East Arm would not have been feasible given the number of sites being investigated and the resources available. By using a de-construction method, however, wreck site recording will determine: a) what is missing; b) what is out of place; and c) what are the diagnostic attributes in the archaeological record.

5.3 A24-1 wreck site description

After Wing Commander Keith Bolitho crashed A24-1 in shallow water, the aircraft was towed to a mud bank in East Arm to facilitate the salvage of the medical equipment and other items from the wreck. Of all of the Catalinas lost in Darwin Harbour, this is the only one that was brought up upon a mud bank. As a result, the wreck is exposed at a spring low tide below 2.5 metres. The wreck site, to the east of Blayden Point, is highly visible enroute to the Elizabeth River from the Quarantine Island boat ramp. The wreck site previously resembled an articulated aircraft and was clearly discernible throughout the ages to any passers by. The wreck site was broken up and scattered by Cyclone Tracy on 25 December 1974 (Photo 43).

Even though A24-1 has always stayed in the public eye, an assessment of the surviving remains has not previously been made. How much of A24-1 did Cyclone Tracy leave behind? Wreck inspections were carried out with the aim of recording the extent of the surviving material resource (Fig. 20).

The bow of this Catalina points to the water's edge, indicating that it was towed/dragged tail first into the mangroves. The bow section is disconnected from the rest of the fuselage behind



Photo 43. Aerial photograph of the main wreck site of A24-1 and debris field (Peter Dermouidy Collection, MAGNT n.d.).

it, by a break through the cockpit (Photo 44). While the rest of the fuselage is lying flat just behind the bow section, the bow has instead of settling flat like the cockpit area, developed a list to port at an angle of approximately 40° (Photo 45). The starboard side hull of the forward section is clearly visible, whereas the port side is lying on the mud (Photo 46). The upper portions of the forward section have gone, revealing the internal workings of the cockpit area and the navigator's section (Photo 47). Internal hull stringers and ribs can be seen in the cockpit, together with other structural elements such as the No. 1 bulkhead leading from the cockpit though to the gun turret. The cockpit area also has the control yoke, but no steering wheels were seen (Photo 48). Other internal features were seen such as the pilot's foot rests (Photo 49), masses of wiring and a number of instruments and gauges. The flight instrument panel, however, was not found.

The cockpit canopy has been destroyed and no trace was found. All of the perspex in the gun turret was also missing, except for a panel in the bombardier's window at the bow. This window would have had a protective roll-a-door cover, but this was not seen.

The perspex frames of the gun turret are recognisable, despite the corrosion that has occurred. The turret's frames are weakened, but they remain relatively intact showing that it is a standard

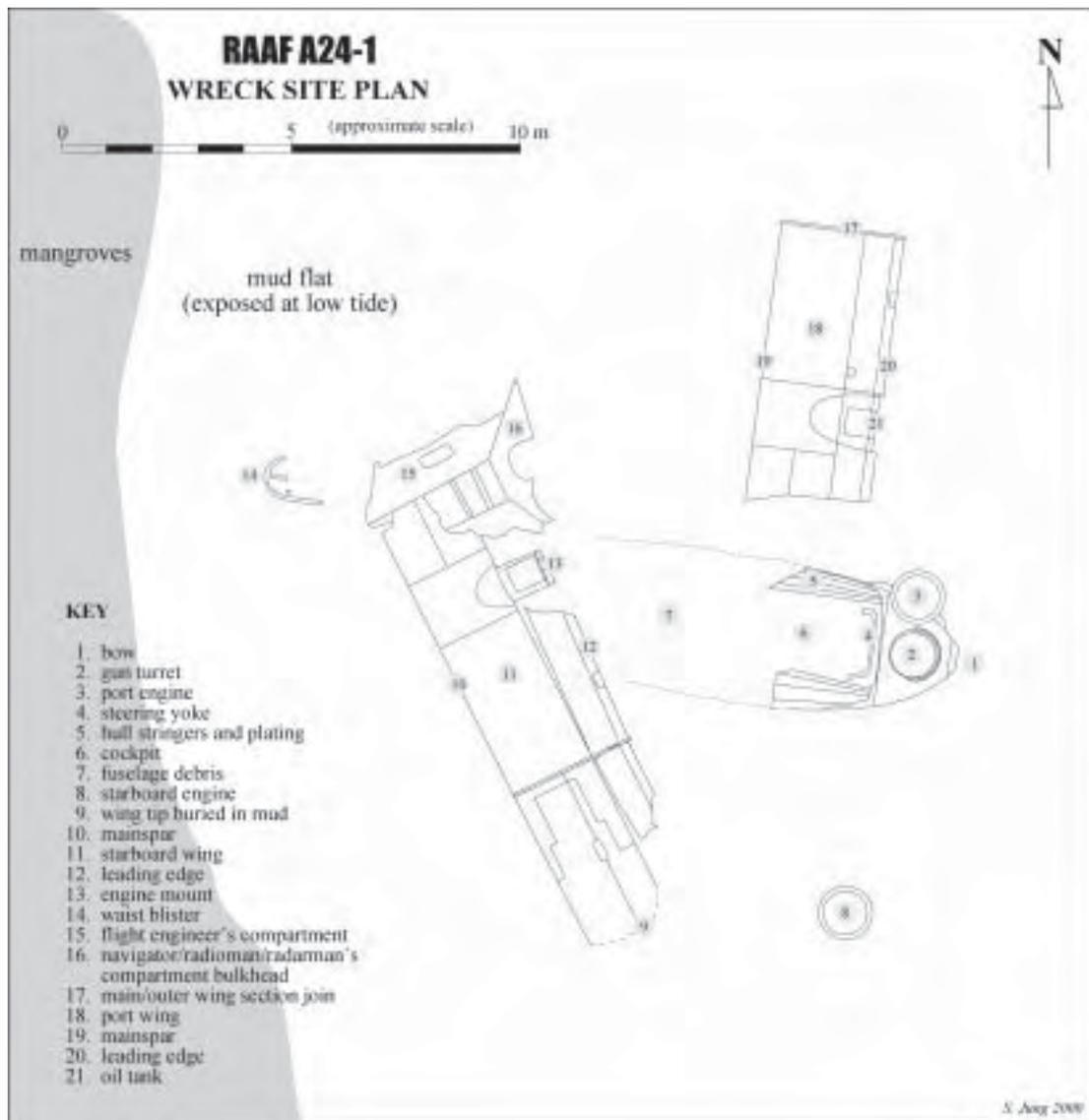


Figure 20. A24-1 wreck site plan.

turret and that it faces to starboard. Resting against the port bow is what is assumed to be the port engine.

The photograph of the wreck site prior to Cyclone Tracy shows that the engines had fallen off their mounts and that they had come to rest straight down from where they were mounted on the wing (see Photo 32). The aircraft had settled on its starboard wing and as a result, the starboard engine fell straight down into the mud a few metres below the wing. The port engine was higher up off the mud because of the aircraft's list to starboard, but when it did fall off its mount, the engine came to rest straight down against the navigator's compartment.

Since the cyclone the port engine appears to have crept down the mud bank and forward along the port side of the hull (Photo 50). At the time of the site inspection, it was located next to the gun turret. Since the initial wreck site inspection for this study in 1998, its exhaust collector ring was removed to be used in the restoration of a Catalina as a static display at the RAAF Amberley air base (RAAF Warrant Officer Doggit, D. 2001. pers. comm., 3 July). Photo 51 shows the same engine in August 2000 minus its exhaust collector ring.

The starboard engine appears to have moved down the mud bank and to the right of the fuselage, slowly moving away from the wreck site (Photo 52). Like the exhaust collector ring on the port engine, the exhaust collector ring for this engine has also been removed for the Catalina restoration project (Photo 53).

Both engines are lying face down. As a result, neither of the propellers could be seen. The propellers could quite possibly be under the mud, but no probing around the engines was carried out to test this.

To the rear of the cockpit area is the detached flight engineer's section. No. 3 bulkhead can be seen with the hatch way going into what would have been the galley area. The navigator's compartment is also the radio operator's compartment and on this bulkhead is attached a mass of electrical instruments (Photo 54 and 55).

The Catalina wing has four basic sections. These are the leading edge containing the landing light, centre section, trailing edge and outer section. Running through the wing is a main spar to which the trailing edge is attached. The wings at all of the sites in this study will be discussed and compared using these four basic descriptions.

The centre section of the starboard wing is attached to the wing pillar, but only a few aluminium sections are supporting it and it is likely that the wing will eventually collapse altogether. The upper surfaces of the wing are corroded, but relatively free of marine growth. The extent of corrosion is minimal and despite occasional rust patches, the wing's surface features can be

identified. Their hinges having corroded away, many of the inspection hatches, for instance, have lost their covers. Apart from where there would have been holes in the original structure, the wing's surface is structurally sound.

As seen in Photograph 56, the starboard wing tip appears to be buried in the mud and no pontoon was seen. The leading edge of the wing is also cracked and is becoming separated from the main spar (Photo 57). The trailing edge was missing, except for a number of ribs.

The port wing is on the port side of the fuselage and lies flat on the mud. The leading edge is attached and the opening for the port landing light can be seen (Photo 58). The outer wing section is missing, together with its pontoon (Photo 59). Like the starboard wing, the port wing is also missing its trailing edge (Photo 60). Pieces of the wing surface, however, were found behind the wing in the mangrove line. The remains of the port wing, as a result, represent about half of the complete wing, whereas there is about two thirds of the starboard wing still intact.

The fuselage aft of the main plane, including the tail section, has disintegrated. Some sections of bottom hull plating from amidships were seen together with remains of the waist blisters. What appeared to be the starboard blister lies amongst the hull plating behind the main plane (Photo 61). The port blister frame was found about ten metres away from the fuselage, upside down with broken frames pointing upward (Photo 62). None of the perspex in either of the blisters was found.

The other remaining elements of the aircraft were found behind the main wreck site twenty metres away in the mangroves (Photo 63 and 64). This is where sections of the tail were found including what appeared to be the rudderpost. It is not possible to discern the straight edge tail that this model would have had, owing to the poor condition of the surviving tail sections.



Photo 44. Main wreck site of A24-1 as approached by boat at spring low tide (Photo: Jung 1998).



Photo 45. Bow of A24-1 with gun turret. The port engine leans, face down against the fuselage. Note the exhaust collector ring on the engine. Scale in 20cms (Photo: Jung 1998).



Photo 46. David Steinberg standing at the bow of of A24-1. Scale in 20cms (Photo: Jung 1998).



Photo 47. View from inside the navigator's compartment, looking forward through the remains of the cockpit of the A24-1 wreck site. Scale in 20cms (Photo: Jung 1998).

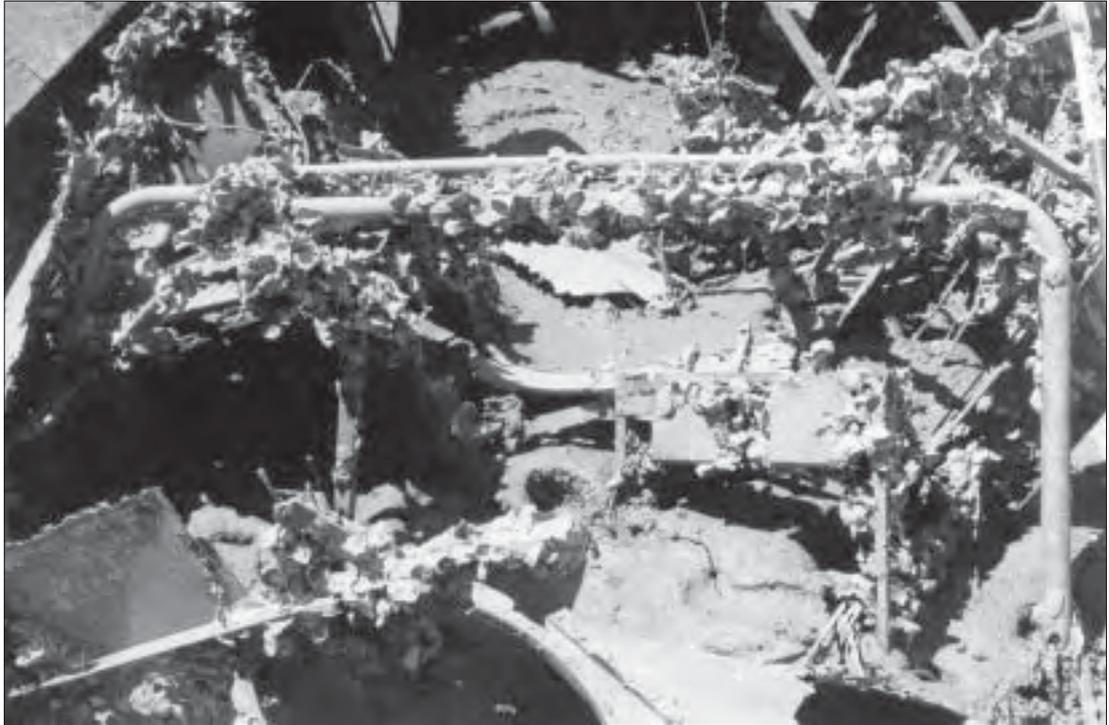


Photo 48. Control yoke, without steering wheels, inside the A24-1 wreck site cockpit (Photo: Jung 1998).



Photo 49. Captain's rudder control pedal inside the A24-1 wreck site cockpit. Scale in 20 cms (Photo: Jung 1998).



Photo 50. Port bow view of A24-1 with port engine resting against the bow gun turret. Note exhaust collector ring attached to engine. Scale in 20cms (Photo: Jung 1998).



Photo 51. Port engine resting against the bow turret of A24-1. Compared with Photo 48, the exhaust collector ring was removed recently for a museum display. Scale in 20cms (Photo: Jung 2000).

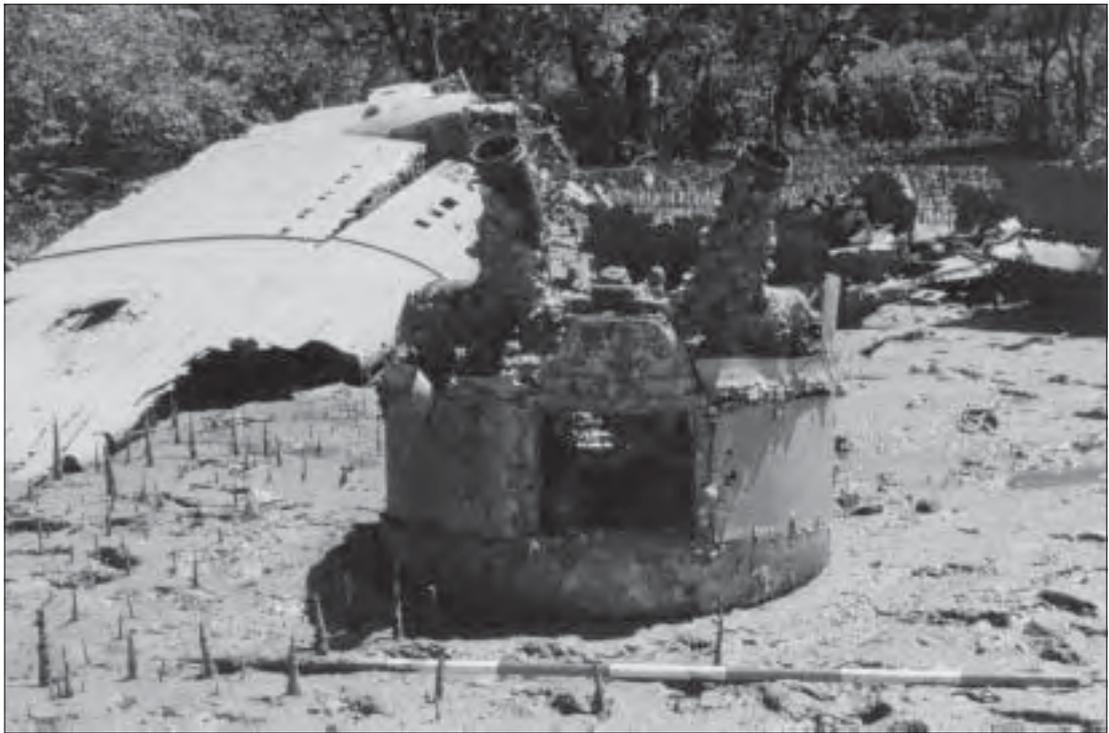


Photo 52. The starboard engine, lying face down at the A24-1 wreck site. Note the exhaust collector ring on the back of the engine. Scale in 20cms (Photo: Jung 1998).

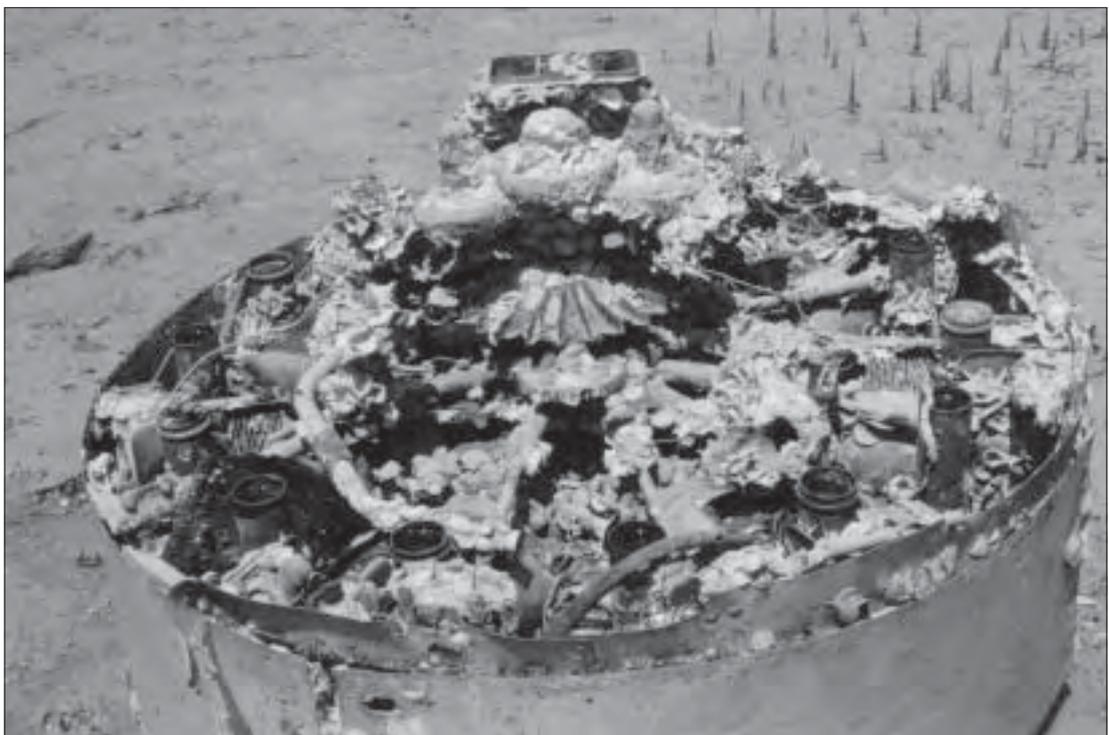


Photo 53. Back of starboard engine of A24-1. Compared with Photo 52, the exhaust collector ring was removed recently for a museum display (Photo: Jung 2000).



Photo 54. No. 3 bulkhead, cockpit side, at the A24-1 wreck site. Scale in 20cms (Photo: Jung 1998).



Photo 55. Rear view of the flight engineer's section, or wing pillar at the A24-1 wreck site. Scale in 20cms (Photo: Jung 1998).



Photo 56. The starboard wing at the A24-1 wreck site. Scale in 20cms (Photo: Jung 1998).



Photo 57. The leading edge of the starboard wing of A24-1. The starboard engine fire wall is visible in foreground (Photo: Jung 1998).



Photo 58. Port engine fire wall on the A24-1 wreck site. Scale in 20 cms (Photo: Jung 1998).



Photo 59. Port wing tip, showing break point of the central wing section from the outer wing section. Scale in 20 cms (Photo: Jung 1998).



Photo 60. Rear of the port wing of A24-1. The engine cowling rises along the leading edge (Photo: Jung 1998).



Photo 61. Waist blister in the hull debris behind the starboard wing at the A24-1 wreck site. Scale in 20 cms (Photo: Jung 1998).

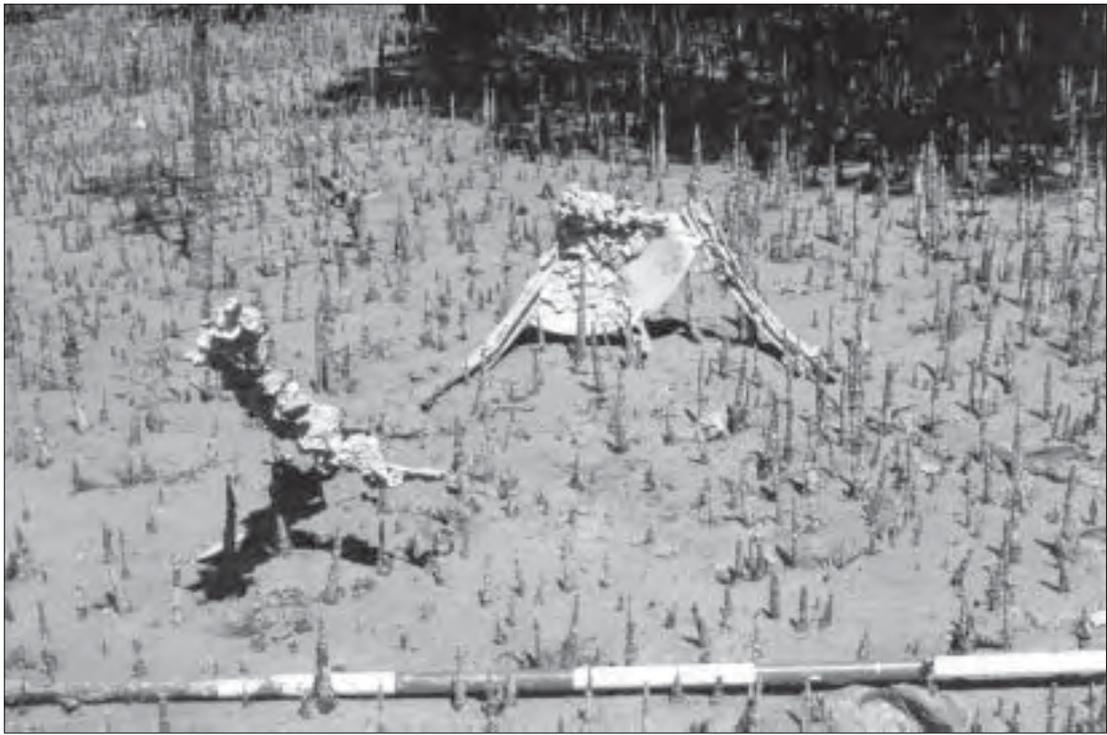


Photo 62. Waist blister frame at the A24-1 wreck site lying behind the port wing. Scale in 20 cms (Photo: Jung 1998).

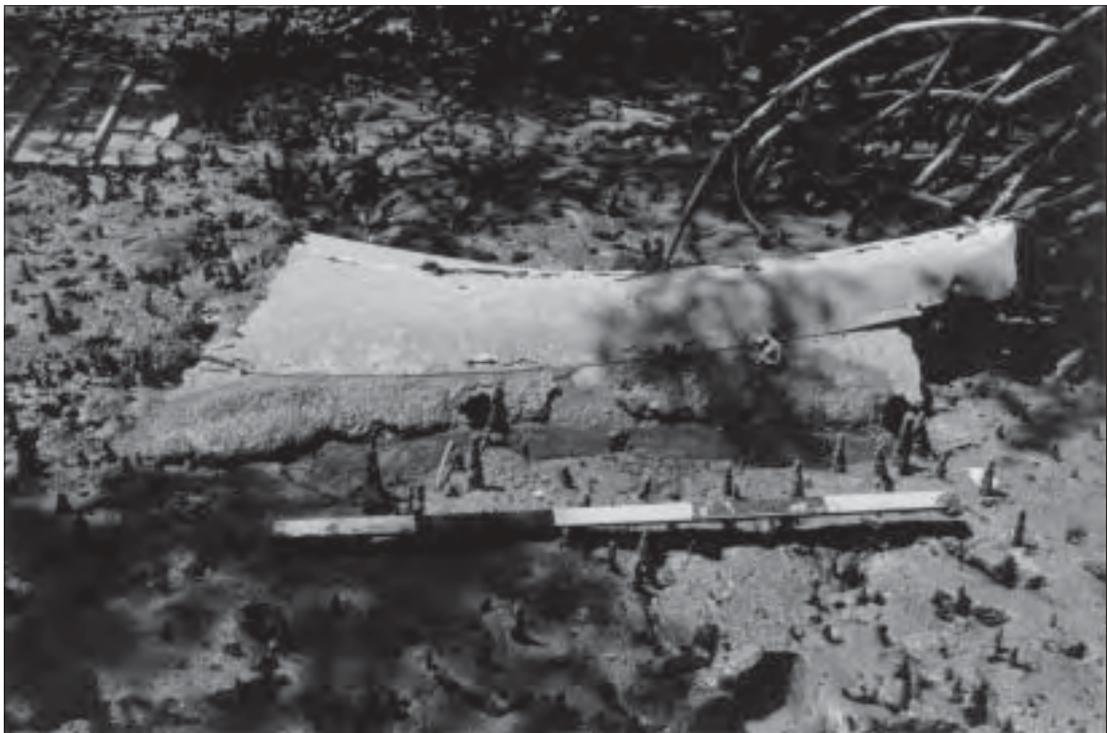


Photo 63. Rear fuselage section of A24-1 in the mangroves behind the main wreck site. Scale in 20cms (Photo: Jung 2000).



Photo 64. Horizontal stabiliser section of A24-1 in the mangroves behind the main wreck site. Scale in 20cms (Photo: Jung 2000).

5.4 Catalina 2 wreck site description

When Cosmos Coroneos (MAGNT) inspected Catalina 2 in 1995 he wanted to verify if an aircraft wreck was at that location. He found the wreck of a Flying Boat at the reported location for Catalina 2. A description of the remains, however, was not made and neither was there any surveying and recording undertaken. There is now evidence identifying this site. This evidence comes from the artefacts raised in 1994, which were not known to Coroneos when he inspected the wreck site (see Chapter 2). But because these objects were raised without contextual reference and because no report of the previous activities at this wreck site had been produced, an archaeological assessment of the wreck site was still necessary. The wreck site is still officially unidentified. The provenance of artefacts said to have been raised from the wreck site would be more significant, if the archaeological data corroborates their story.

A wreck inspection carried out on 3 April 1998 at the Catalina 2 wreck site determined that most of the forward section of the fuselage was structurally intact and recognisable (Fig. 21). Wreck inspections were also carried out in 2000, which determined that the wing was lying in two sections on the starboard side of the fuselage. The remaining engine was located near the



Figure 21. *Catalina 2 wreck site plan.*

starboard wing. These four sections are the major surviving structural elements at the wreck site and will be discussed below.

Figure 22 is of a side scan sonar image taken of the Catalina 2 wreck site. It was obtained by Jeremy Green and Corioli Souter (WA Maritime Museum), Silvano Jung (NTU), David Steinberg (MAGNT) and David Boston (Skipper - Barefoot Marine's *Barefoot 1*). This and other images of the wreck were recorded on 29 August 1998. The side scan sonar image corroborates the position of the wings, forward section of the fuselage and the flight engineer's compartment drawn in Figure 21.

The section of the fuselage forward of the wing pillar is entirely exposed and survives relatively intact. Corrosion has created holes in the thin outer surface in many places, but the shape of the



Figure 22. Side scan sonar image of the Catalina 2 (WA Maritime Museum 1998).

aircraft's original structure is discernible. This section is on a list to port at approximately 20°. The vertical rounded frame of the gun turret at the bow, was seen and identified as a bug-eye type. The opening for the guns faces to starboard, although no guns were found inside the turret (Photo 65). A forty-four gallon drum is attached to the top of the fuselage just behind the gun turret. This was put there by salvors in 1994 in their attempt to move the fuselage to another location (Lewis 1995).

The cockpit canopy was not found, but the recovery of the engine throttles (see Fig. 3) suggests that other elements of the canopy might have collapsed inside the hull. The cockpit area inside the hull, however, is well preserved with identifiable bulkheads and controls. No paint work or identification markings have survived on any of the aircraft's external surfaces.

The control yoke is attached to its mounting, but no steering wheels were found. Divers removed the flight instrument panel in 1994, leaving behind a mass of jumbled wiring. Despite the number of artefacts recovered, many instruments could still be found in the cockpit, some still in their original mountings.

The cockpit floor was buried in sediment and could not be seen. The external hull itself is exposed all the way to the keel, indicating that sedimentation rates were higher inside the



Photo 65. Bug eye turret, Catalina 2 viewed from the fuselage looking forward. Note the round opening to the right where the twin machine guns would have protrude. Compare with Photo 14 and Fig. 12 (Photo: Jung 2000).

fuselage. Given the strong ebb and flow of the tide outside of the wreck, the site structures are swept clear of sediment, but sediment is trapped inside. Approximately a quarter of the forward section of the fuselage was filled with sediment. The doorway to the navigator's compartment presented an arch as it protruded from the sand, indicating that the depth of sediment was approximately 30-50 cm. Beyond the navigator's compartment bulkhead the fuselage continues past the navigator's window on the port side. A break occurs in the fuselage at this section, between Nos. 2 and 3 bulkheads, separating the flight engineer's compartment from the rest of the aircraft.

The flight engineer's compartment has separated from the bow and had turned 90° to the centre line of the fuselage. The waist section was missing, together with the tail section. This section, as a result, constitutes a large piece of the wreck, although it is considerably twisted and mangled. A number of instruments were also seen on the bulkheads, covered in barnacles and other marine growth.

The port wing is missing the trailing edge section, exposing a mass of ribs and stringers attached to the main spar. The trailing edge on the Catalina wing was fabric covered. The covering not only functions as a streamliner, but also gives this wing section strength. Without the supporting covering the trailing edge ribs would have lacked lateral strength and it appears that this is a common site formation process on this type of aircraft wreck, as both A24-1 and Catalina 2 lack trailing edges on any of their wings.

Both wings were found on the Catalina 2 wreck site lying separate from each other by a break occurring in the centre section where the fuel tanks would have been. The port wing is lying upside down on the port side of the fuselage. Its wing tip pontoon is still in the deployed position and points towards the surface of the water. This pontoon is well preserved, with all of its struts and telescopic hydraulic arm holding up the pontoon. This pontoon stands proud off the sea bed by about three metres. There is approximately 70% of the original wing left, with the greatest amount of damage done to where it once would have met with the fuselage at the centre section.

The starboard wing is lying right way up, but faces in an opposite direction to the port wing; the two leading edges, for instance, have turned almost 90° in relation to each other. The starboard wing is also situated to port in relation to the centre line of the fuselage. The surviving elements of the wing comprise the leading edge, most of the central section and the outer wing, including the wing tip and pontoon. The starboard wing is supported off the sea-bed by its pontoon, but only to a height of about 30 to 50 centimetres. The pontoon struts have given way under the weight causing the wing to collapse upon the pontoon. Nevertheless, the space between the sea-bed and the wing is sufficient enough to provide a home for numerous fish species seen there.

Another distinctive feature of the starboard wing is the state of preservation of its leading edge. ASV aerials were found on the leading just at the edge of where the outerwing joins the central wing section (Fig. 23). ASV aerials are a diagnostic feature of PB5Y-5As. Earlier USN Catalina types did not have these and later RAAF types were radome equipped.

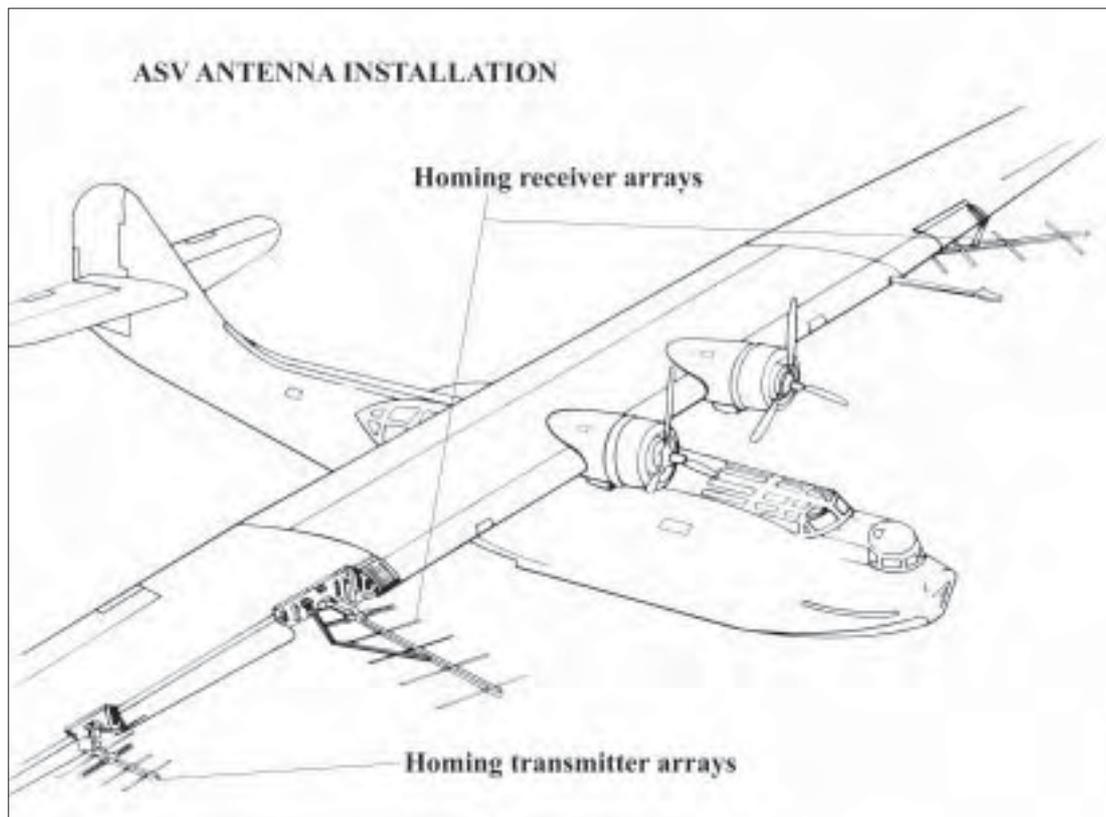


Figure 23. *ASV antenna installation. The starboard wing receiving array is visible on the Catalina 2 wreck site (Scarborough 1983:32).*

One engine remains on the wreck site. The RANR Dive Team 11 removed the other engine, together with its propeller in 1994. An engine specification plate was also removed from the site, prior to the RANR disturbance and this is identified as the starboard engine. A correlation was found between the engine number on the plate and the number in Court of Inquiry Records. The plate was recovered from the raised starboard engine. The port engine's location on the wreck provides additional information on the nature of the aircraft breakup sequence.

The remaining engine on the wreck site was found detached from the mainplane and lying behind the trailing edge of the starboard wing. Its propeller was removed by Cullen Bay Dive Shop. The engine cowling, despite a thin dusting of sediment and patchy marine growth, was recognisable, but its external surface features, such as the oil cooler nacelle were not seen. The propeller spline was found indicating that the engine had come to rest facing the trailing edge of the starboard wing. The port engine's location on the port side of the fuselage is also further evidence of the wing's collapse during its descent.

5.5 Catalina 3 wreck site description

A striking feature of the Catalina 3 wreck site is the wing (Fig. 24). Unlike the wrecks investigated so far, this aircraft has a virtually complete wing, except for the outer section of the starboard wing. This wreck site was reported by Lewis (1992) as the most intact Catalina in the harbour. The following presents a description of the wreck site, which indicates that previous interpretations of how this machine sank were incorrect.

The aircraft's wing is tilted forward slightly. Wing struts, a feature of the Catalina's early development as a bi-plane, still supports the wing. These struts could only be seen on the starboard side, as the port side of the aircraft has acted as a sediment trap, resulting in the near burial of the hull, up to the bottom of the wing.

The wing struts are entirely exposed on the starboard side of the hull and *in situ.*, attached to the fuselage and to the underside of the wing, forming a triangle shaped overhang. This side of the aircraft appears to be in the tidal currents scour zone, with a corresponding higher rate of sedimentary deposition on the port side of the forward section of the fuselage. The starboard wing outer section has broken off just after where the struts join the wing, leaving a mass of twisted metal at the end.

Examination of the starboard wing's leading edge showed that it had no distinct features such as ASV aerials or oil cooler openings. The landing light opening, however, could be seen, but missing its lens. The wing tip pontoon was not seen, but it is likely to be buried as the port wing sits only less than half a metre above the floor. Its trailing edge was also missing, like the wings at the Catalina 2 and A24-1 wreck sites.

The forward section of the fuselage is structurally intact. The hull rests on its chine with a list to port of approximately 35°. A comparable feature of the fuselage at this site is that the section aft of the mainplane has broken away, scattering a debris field trailing behind the wreck site. The hull forward of the wing is virtually intact, except that the cockpit canopy, like the other wreck sites inspected so far, was missing, allowing a view inside the cockpit. The interior of



Figure 24. Catalina 3 wreck site plan. Note the separation of the starboard outer wing tip that lies approximately forty to sixty metres away from the main wreck site.

the cockpit has filled with silt almost to the windscreen level, but lying on the surface could be seen one of the pilot's seats. The control yoke, together with the pilot's wheel, was found there, but not *in situ*. The wheel was loosely attached to the yoke by cables. Forward of the cockpit the bow turret has suffered a similar fate to the aircraft's canopy. The entire turret had been removed or had disintegrated, leaving a hole where it should have been. Silt also filled in the forward gunner's/bombardier's compartment. But, regardless of the absence of gun turret, another striking element of the bow is equally of interest.

Forward of the gun turret on the port bow is an encrusted protrusion. This is a mooring bollard (otherwise known as a snubbing post or mooring post), which was manually attached and detached depending on the procedures by the crew to make the aircraft ready for flight, or to tie up to a buoy, or drop anchor. The bollard was always removed before flight. Its presence on the wreck site can only mean that the aircraft was moored when it sank.

Mentioned previously was the presence of propellers on the wreck. Both propellers and engines were seen semi attached to their mounts on the wing. The orientation of the engines is virtually true to how they would have been on the intact aircraft, but for one important feature. The engines are at a different angle to the fuselage and are not parallel with the keel of the fuselage as per normal. The angle of the engines suggested that the wing is at a different angle to the keel also.

Examination of the wing where it meets the fuselage indicates what has happened to the wing. The wing pillar containing the flight engineer's compartment, was not seen. It was obscured by the wing's leading edge, which is resting against the top of the navigator's compartment. The whole wing has pivoted downwards. From this it can be extrapolated that the keel is broken at No. 4 bulkhead. As a result, the keel must be broken. This type of damage was not evident at the other wrecks investigated.

Attached to the engines are the propellers, with two of their three blades protruding from the mud. The third blade on each propeller and their spinner hubs could not be seen, since these were buried in mud. The two blades protruding out of the mud, however, allow an examination of their tips, which were reported to be bent.

The exposed blades were found to be straight. Lewis (1992:45) had described the propellers on the aircraft as having been bent, but further inspection of the wreck site shows that not all of the blades are bent, as would be expected if the propellers were turning (ie., the aircraft was in motion) when they hit the water.

Like the previous sites, this aircraft is broken through the gun deck and is missing significant sections of its tail. Aft of the main plane rises the tail's only identifiable element, the horizontal stabiliser. This is leaning against the aft fuselage tip, which has a triangular cross section where it has broken from the rest of the fuselage.

On the second visit to the site the missing outer starboard wing section was found approximately forty to sixty metres away in a northerly direction from the main wreck on bearing 240° from

the cockpit. The wing section, however, was missing its pontoon. A debris field was also found around this wing section, including pieces of what was tentatively identified as the pontoon and a tangled bundle of rope with a metal eyelet spliced in one end. These artefacts could be part of the mooring arrangement. Alternatively, they might not be associated with the Catalina as it is unlikely that mooring rope would have survived the intervening years since the sinking.

5.6 Catalina 4 wreck site description

Cosmos Coroneos and Bob Ramsey inspected Catalina 4 in 1995 with an underwater video camera. They recorded some of the diagnostic features useful in identifying this site. This field work aims to verify what Coroneos and Ramsey had recorded on video and to determine any other additional diagnostic features of the wreck they may have missed. Figure 25 shows a wreck site sketch plan developed for Catalina 4, illustrating the main wreck site features discussed below.

All the wrecks investigated so far, have had their wings broken. The mainplane on this wreck site is also broken. It was previously believed that only the port wing had survived, but wreck inspections in 2000 discovered the starboard wing just off the starboard bow. Both wings are, therefore, on site. The port wing is the only wing, found in Darwin Harbour that is supported by its pontoon. It towers above the seabed and provides shelter to many fish seen there (Photo 66).

The port wing is approximately 15 metres long by 2.4 to 4.2 metres wide. The trailing edge is missing. The wing is well preserved towards the tip but deteriorates towards the fuselage, with the skin missing and the air frames visible. At one point, at the centre of the wing, the leading edge is cracked. There is also a large hole in the centre of the wing, approximately 1.4 metres in diameter and five metres back from the wing tip (Photo 67). The wing lies flat on the seabed beyond this point to where it meets the fuselage. As a result, the overhang created by the wing pontoon does not extend back to the fuselage, but intersects the seabed where the hole occurs. A similar type of break also occurs on the starboard wing, with a distinctive hump in what would otherwise have been a flat surface.

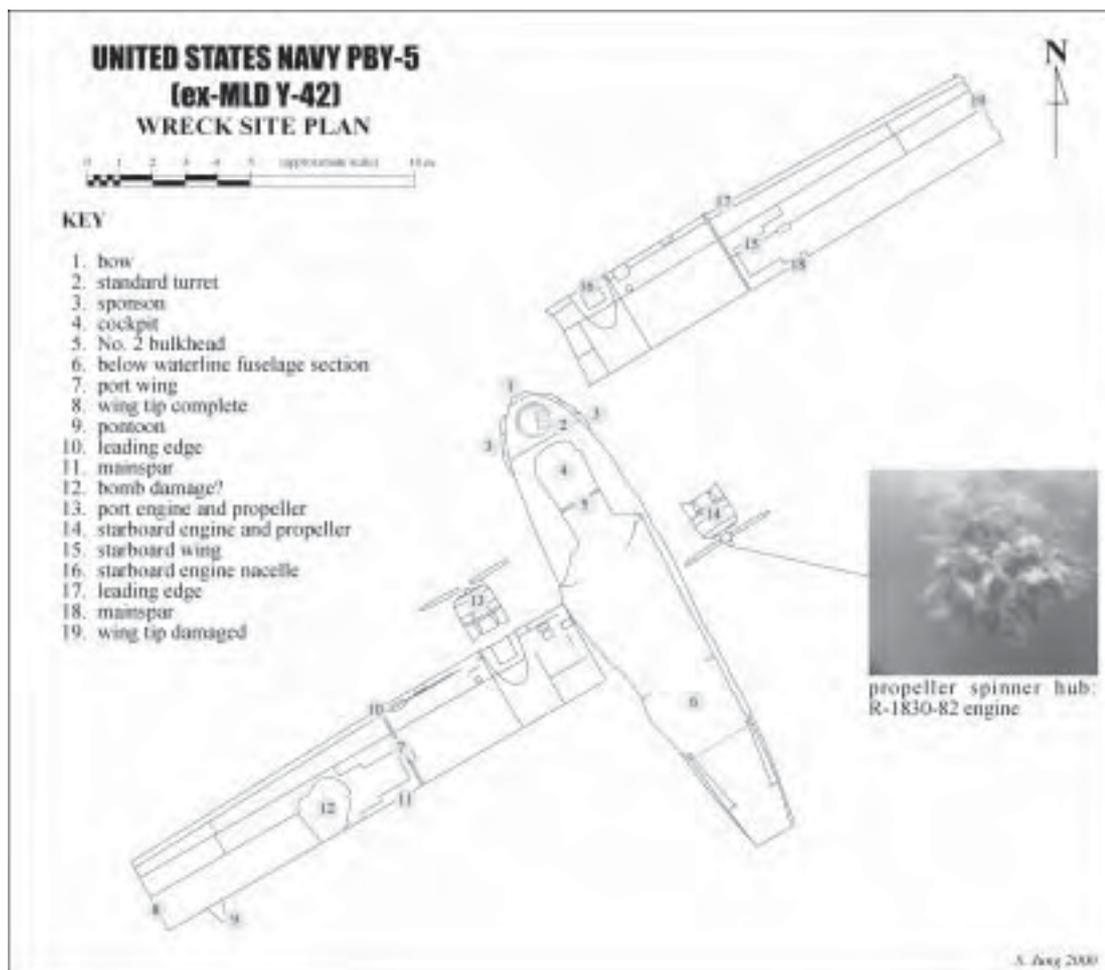


Figure 25 Catalina 4 wreck site plan.

The starboard wing has come to rest approximately one metre forward and off to the side of the starboard bow and is perpendicular to the fuselage. Its leading edge faces forward, and like the port wing, is missing its trailing edge. Unlike the spectacular overhang created by the port wing, the starboard wing is flat on the seabed, except for a hump near the wing tip.

Both engines are still on site, although they have collapsed from their mounts. The starboard engine is on the starboard side of fuselage, but it is turned around and faces towards where the tail would have been. The port engine is buried in sediments with only one propeller visible. However, all of the propeller blades are visible, together with the spinner hub, on the starboard engine.

On the starboard engine propeller is a small diameter propeller spinner hub, 300 mm in diameter, which is consistent with later model engine/propeller configurations found on PB5-5s and subsequent types (Photo 68).



Photo 66. The deployed port wing pontoon on Catalina 4. Note the float actuating and support struts (Photo: Coroneos 1995).



Photo 67. Bob Ramsey inspects the hole in the port wing on Catalina 4 (Photo: Coroneos 1995).



Photo 68. Spinner hub on Catalina 4 starboard engine propeller (Photo: Coroneos 1995).

A gunner's turret was recognised by the circular opening on top of the bow. Like the turret on A24-1 and Catalina 2, this turret also points to starboard. The turret is a standard type with the opening for a single machine gun (Photo 69 and Photo 70). The glass of the gun turret itself is gone, leaving empty spaces between the turret struts. Furthermore, there was no evidence of the machine gun that would have been fitted inside the turret, but ammunition was seen around the site.

The cockpit is visible behind the gun turret and is distinguished by a large opening just above the point where the port wing joins the fuselage. The cockpit was found filled with sediment (Photo 71). Examination of what could be seen inside the cockpit did reveal that the flight instrument panel had been removed or had disintegrated.

The aft section of the fuselage is recognisable by the bottom aluminium panels, which taper off towards the tail. The sides and top of the fuselage in this section have disintegrated, with only

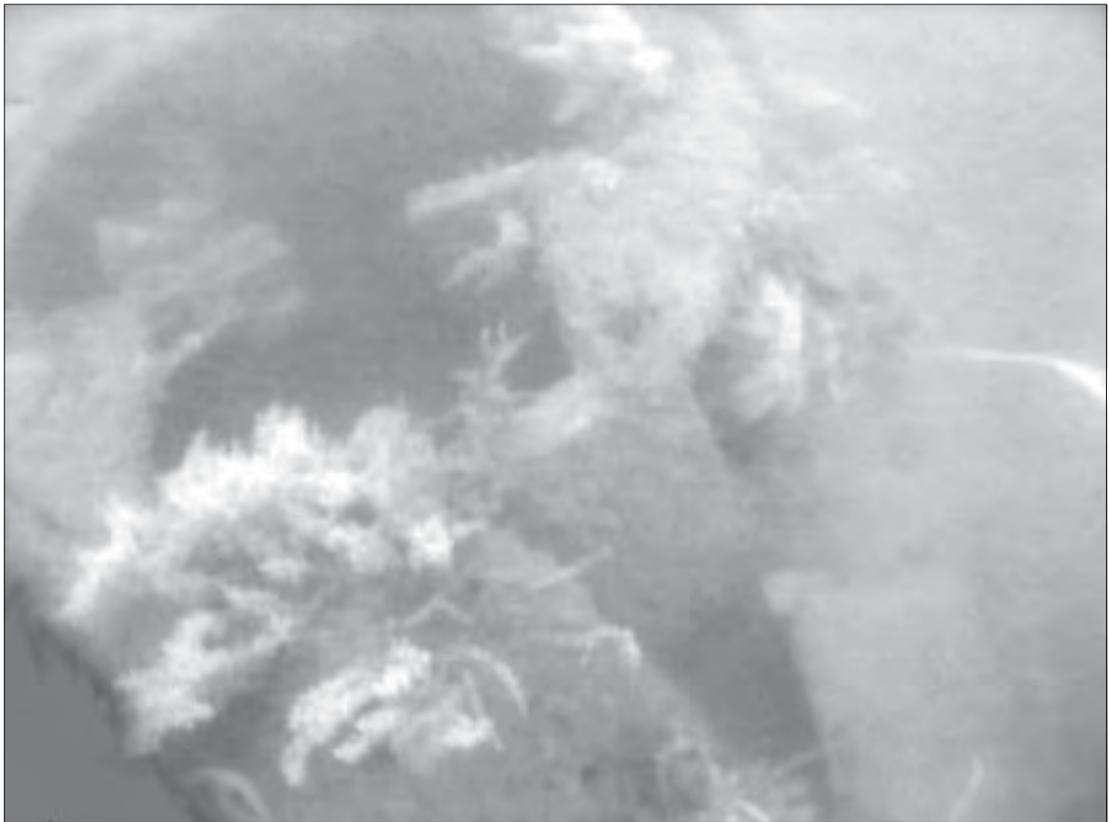


Photo 69. Top view of the standard turret on the Catalina 4 wreck site, showing the straight edge lip characteristic of this type. Compare with Photo 13 and Fig. 11 (Photo: Coroneos 1995).



Photo 70. Starboard bow view of the standard turret on the Catalina 4 wreck site (Photo: Coroneos 1995).



Photo 71. The sediment filled cockpit of Catalina 4. Note the mangrove sticks bottom left (Photo: Coroneos 1995).

the floor panels and outer hull buried in the mud, which probably accounts for their preservation. The tail itself was not found.

5.7 Catalina 5 wreck site description

The deposition pattern at the Catalina 5 wreck site is similar to that seen at Catalina 2 and Catalina 4. The mainplane occurs on the main wreck site in two sections (Fig. 26). The port wing has separated at the central wing section where the fuel tanks would have been, and was found on top of the starboard wing. It rests upside down on the starboard side of the aircraft overlapping the starboard wing. Like the other wrecks seen so far, the bow section of the fuselage is relatively intact. The starboard engine was clearly visible resting upon the navigator's compartment and apart from the port engine near the fuselage, few structurally recognisable elements have survived. These, however, represent a number of diagnostic features that suggest that this is an early model Catalina. The following describes the layout of the material remains and details the diagnostic features that are unique to this wreck site.

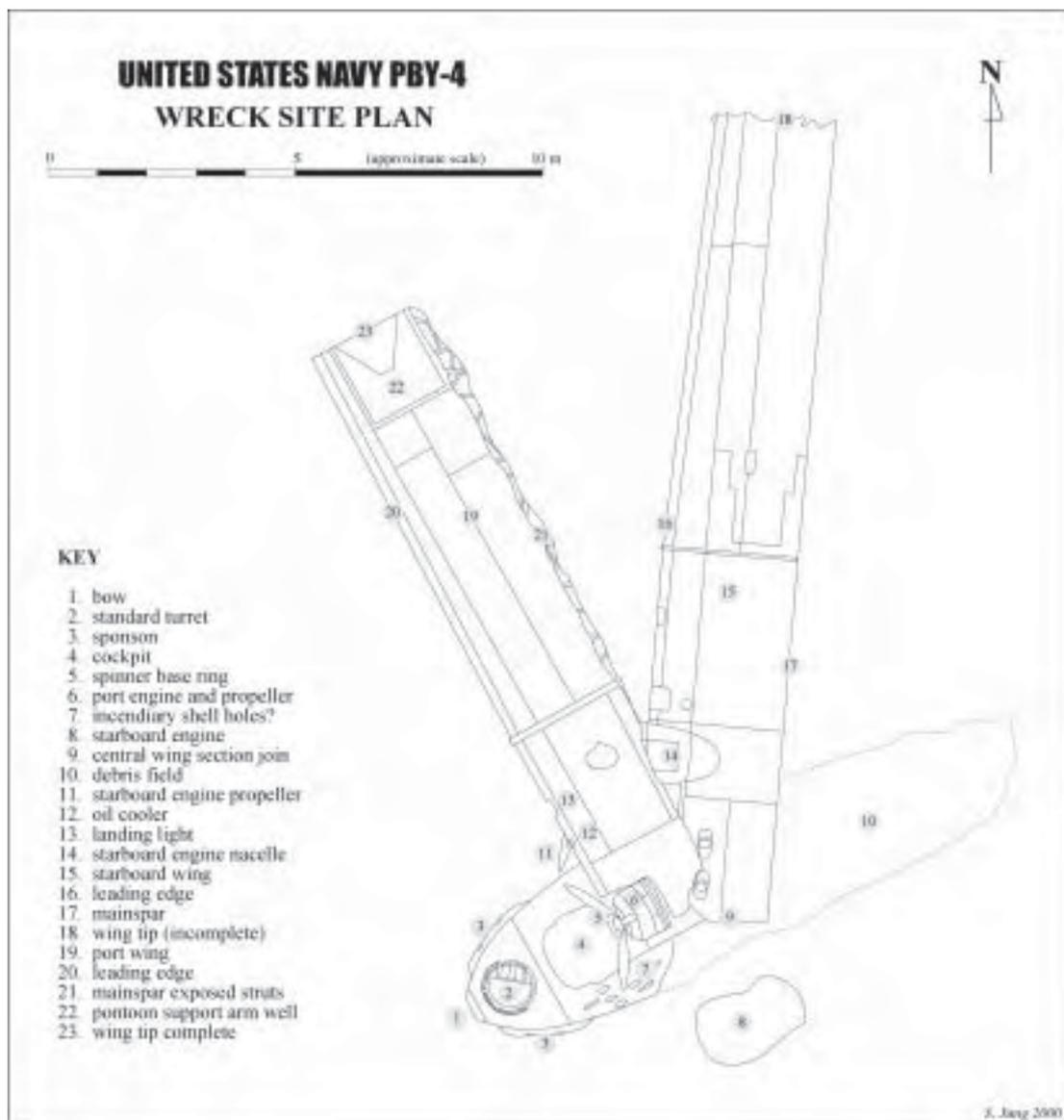


Figure 26. Catalina 5 wreck site plan.

The type of oil cooling system for the engines is evident on the port wing. The leading edge of the wing has a clean round opening, 280 mm in diameter, inboard of the landing light. Nowhere else on any of the other sites is this feature evident. There is nothing left of the landing light except a hole in the wing where the lens would have been, but the light provides a useful reference point on the wing's leading edge by which the round opening can be measured and interpreted.

The oil cooler on the port wing is for a Pratt and Whitney R-1830-72 engine. Only these types of engines had oil coolers on the leading edges of their wing, outboard of the engines.

The port engine is inverted, which suggests that it turned while still attached to the wing. It has subsequently broken from its mounts. The box-shaped air intake, which would have been on top of this type of engine, was not seen. Despite this, the most obvious of the diagnostic features of the power plant is the propeller that is still attached to it (Fig. 27).

The spinner hub on the Catalina 5 port engine propeller is missing. Although the spinner hub itself is gone, its mounting base ring has survived, which shows that it would have had a soup bowl shaped spinner. It is a diagnostic feature of the Pratt and Whitney R-1830-72 engine. Soup bowl shaped spinner hubs were only fitted to this type of engine.

The engine in the navigator's compartment is paradoxically, the port side power plant. A massive concretion of marine growth has almost entirely covered the starboard engine - on the port side

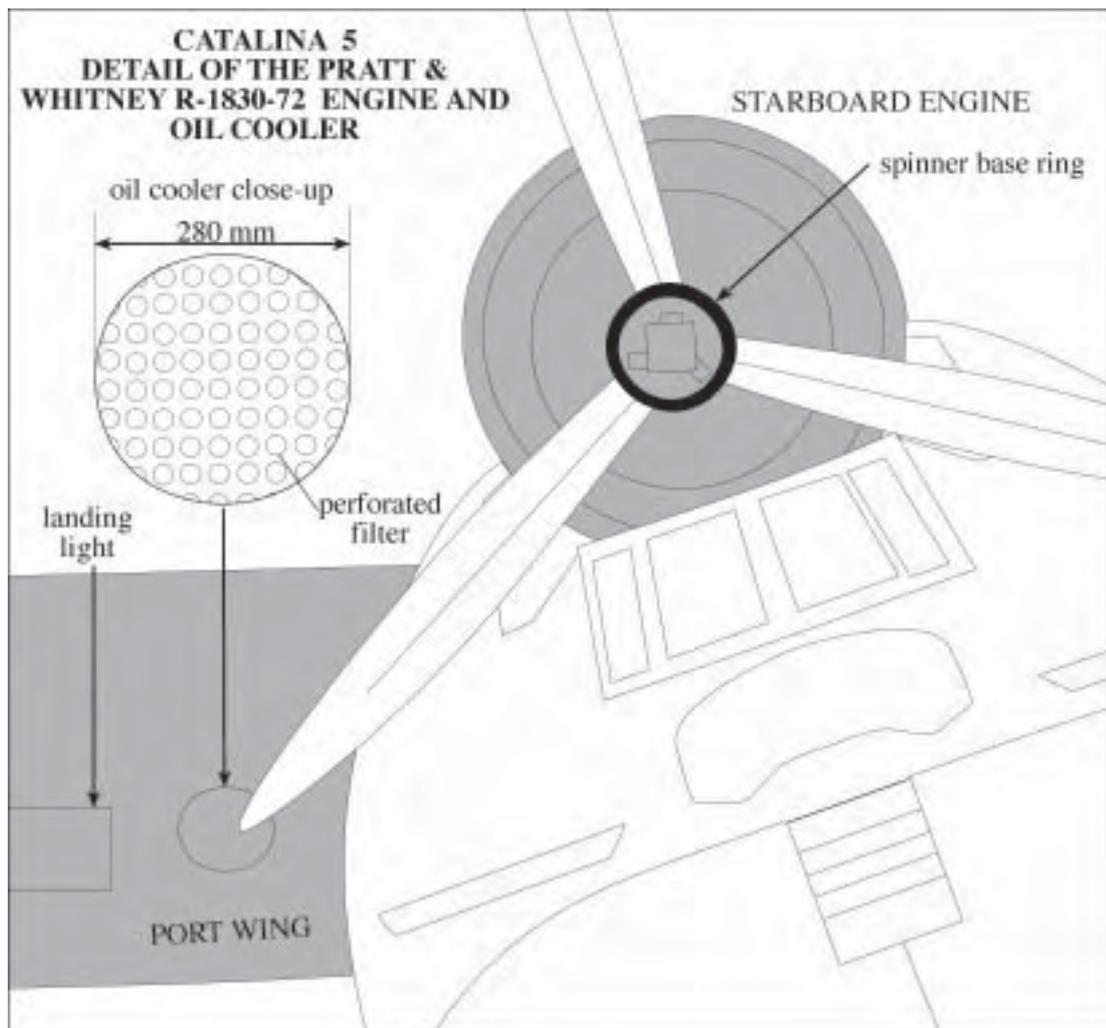


Figure 27. Catalina 5 showing details of the Pratt and Whitney R-1830-72 engine on top of the navigator's compartment (see also Fig. 34).

of the fuselage. Only one blade of its propeller was seen under the starboard wing. As a result, only the port engine and propeller are of any use in determining the type of power plants on this wreck site, since only these can be seen clearly.

The surviving fuselage section forward of the mainplane has survived on all of the wrecks seen so far. The fuselage lists to starboard in the direction of the wings. Like the bow of a ship, this section has a great deal of structural integrity, except for the fragile sections of the canopy. This has disintegrated, together with the perspex panels in the forward gun turret. The gun turret frames themselves have survived and show that the turret is the standard type. The turret, like the turrets at the other wreck sites, is turned to starboard.

The nose of the aircraft was investigated carefully for any evidence of the mooring or snubbing post such as the one seen on the Catalina 3 wreck site. A coral encrusted protuberance, which is thought to be a snubbing post, was seen at the location on the bow where it would have been, but it was not as clearly defined as on the Catalina 3 wreck site.

Aft of the gun turret, the cockpit area is filled with sediment, whereas the area around the hull is exposed as far down as the keel. The wreck is swept clear of sediment by the strong currents that swirl past the surviving structures. This affords an excellent view of the exterior of the forward hull section, revealing the classic lines of the Flying Boat.

The mooring walks could be seen on the exterior of the hull, but these are now becoming very fragile as they could easily be moved and would almost break off if forced to. Like the other wrecks, no paintwork or markings were evident despite the hull only being covered in patches with marine growth. The fuselage's aluminium skin is also holed in many places.

The hull aft of the galley section and the tail section were not seen. A debris field extends behind the galley section with some upright members of what would have been the waist gun deck position. A radial survey was carried out with a twenty metre length of rope attached to section of the fuselage amid-ships. The search aimed to find traces of the tail section, but

nothing was found. The tail section has either completely disintegrated or has settled further away from the main wreck site.

The port wing has been mentioned above in some detail, but a general description of both wings is warranted in order to determine what has happened to the wreck. The wreck site is at first confusing. Both wings are piled on top of each other, but considering the problem with fuel tanks in the centre section of the wing, it is not inconceivable that the wreck's current layout reflects the causes that resulted in the aircraft's sinking rather than post depositional disturbance.

The break in the wing occurs in the central section where the fuel tanks would have been. Both sections of the wing have settled on the starboard side of the fuselage. Whereas the starboard wing lies upright and relatively in its correct position in relation to the line of the fuselage, the port wing has come to rest upside down in front of the starboard wing at an angle to the fuselage. Unlike the well preserved pontoon on the port wing of Catalina 2, no pontoon was found on this wreck site, apart from a mass of tubes that were part of the hydraulics needed to retract and deploy the pontoon. The pontoon was deployed at the time of the Catalina's loss.

The starboard wing tip is missing and no pontoon was found either. Like the wings seen elsewhere on the other Catalinas wreck sites in the harbour, the trailing edges on the Catalina 5 wings have not survived and only masses of ribs and stringers could be seen along the rear of the mainspar. The oil cooler could not be made out on the starboard wing as that section of the leading edge where the oil cooler would have been, is damaged beyond recognition.

5.8 Fieldwork results

Diagnostic attributes of Catalina type were recorded on all of the wreck sites. These are compared with the wreck sites in Figure 28. Most of the wreck sites have several unique diagnostic attributes. The condition of the wreck sites, however, meant that not all of the diagnostic attributes identified in Table 6. could be found. For example, no gun turret was found on the

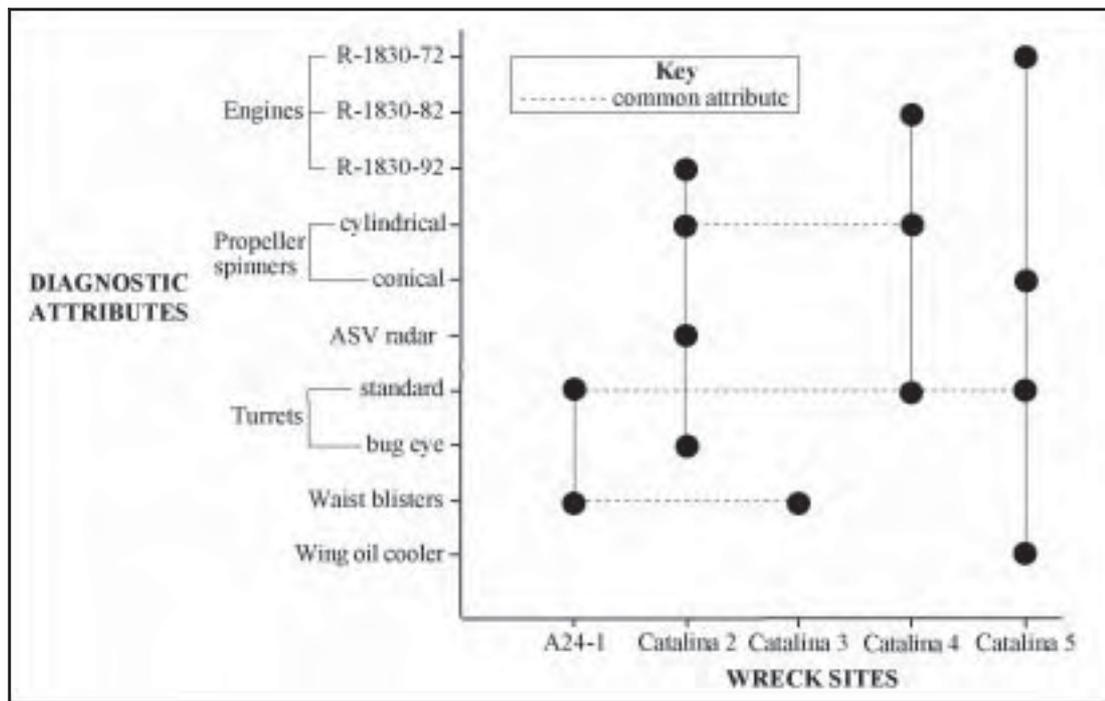


Figure 28. Comparison between wreck sites and diagnostic attributes.

Catalina 3 wreck site. As a result, Figure 28 only compares the diagnostic variables that were seen on the wreck sites.

The A24-1 wreck site was found to have two diagnostic attributes. Both of these, however, are not unique. A standard turret and waist blisters were found on the wreck site. Standard gun turrets are also found on Catalina 4 and 5. Evidence of the port and starboard waist blister was found on the A24-1 wreck site. A waist blister was also found on the Catalina 3 wreck site. As a result, this wreck site, on account of its morphology, could possibly be that of a 28-5MNE Catalina lost by the USN. The USN loss of a 28-5MNE Catalina, however, was in deep water and only A24-1 was recorded to have been abandoned on a mud bank. This wreck site can only be that of A24-1.

Catalina 2 has four diagnostic attributes. One of these diagnostic features is in common with Catalina 4. Both have cylindrical shaped propeller spinners, characteristic of later Catalina types. The other four diagnostic attributes, however, are unique to this wreck site.

Catalina 4 was found to have three diagnostic attributes, one of which is in common with Catalina 5 and A24-1: the standard type turret. One other was common with Catalina 2: the cylindrical propeller spinner and the third is unique to this wreck site. An assumption, however, is made regarding this unique attribute as the R-1830-82 engine. If the spinner hub is cylindrical and the turret on the wreck site is a standard type, it then is a valid assumption that the engine attached to the propeller would be later than a R-1830-72, but not earlier than a R-1830-92. The R18-30-92 engines are also associated with later types of Catalina that were fitted with bug eye gun turrets. Therefore, the starboard engine should be an R-1830-82, which was fitted on PBV-5s or 28-5MNEs Catalina types. This could not be tested in the field on account of the condition of the engines being covered in marine growth.

Catalina 5 has four diagnostic attributes, one is common to Catalina 4 and A24-1: the standard gun turret. The other three attributes are unique to this wreck site, which suggests that it is an early Catalina type.

Only one diagnostic attribute was evident on Catalina 3; a waist blister, which is common to Catalina A24-1. No blisters or sliding hatches were seen on the other Catalinas. As a result of a lack of a unique diagnostic feature, this wreck site could possibly be that of a 28-5MNE type or PBV-5. Evidence to suggest an identity for this wreck site, however, was found in its layout, which is unique in comparison to the other Catalinas.

Figure 29 shows a comparison between the wreck site layouts. This graphically displays an anomaly in their layout. Three of the submerged wreck sites (and A24-1) had broken wings lying near their fuselages. A large section of the Catalina 3 wing was found well away from the main wreck site. An examination of the remaining central wing section indicated that this wing did not burn. Its fuel tank sections were relatively intact. Three Catalinas are recorded to have been lost due to fire, whereas one was lost in an explosion. The archaeological evidence was, therefore, found to correlate with historical data relating to accounts of loss. Wreck site layout, as result, is an important clue in identifying the wreck sites.

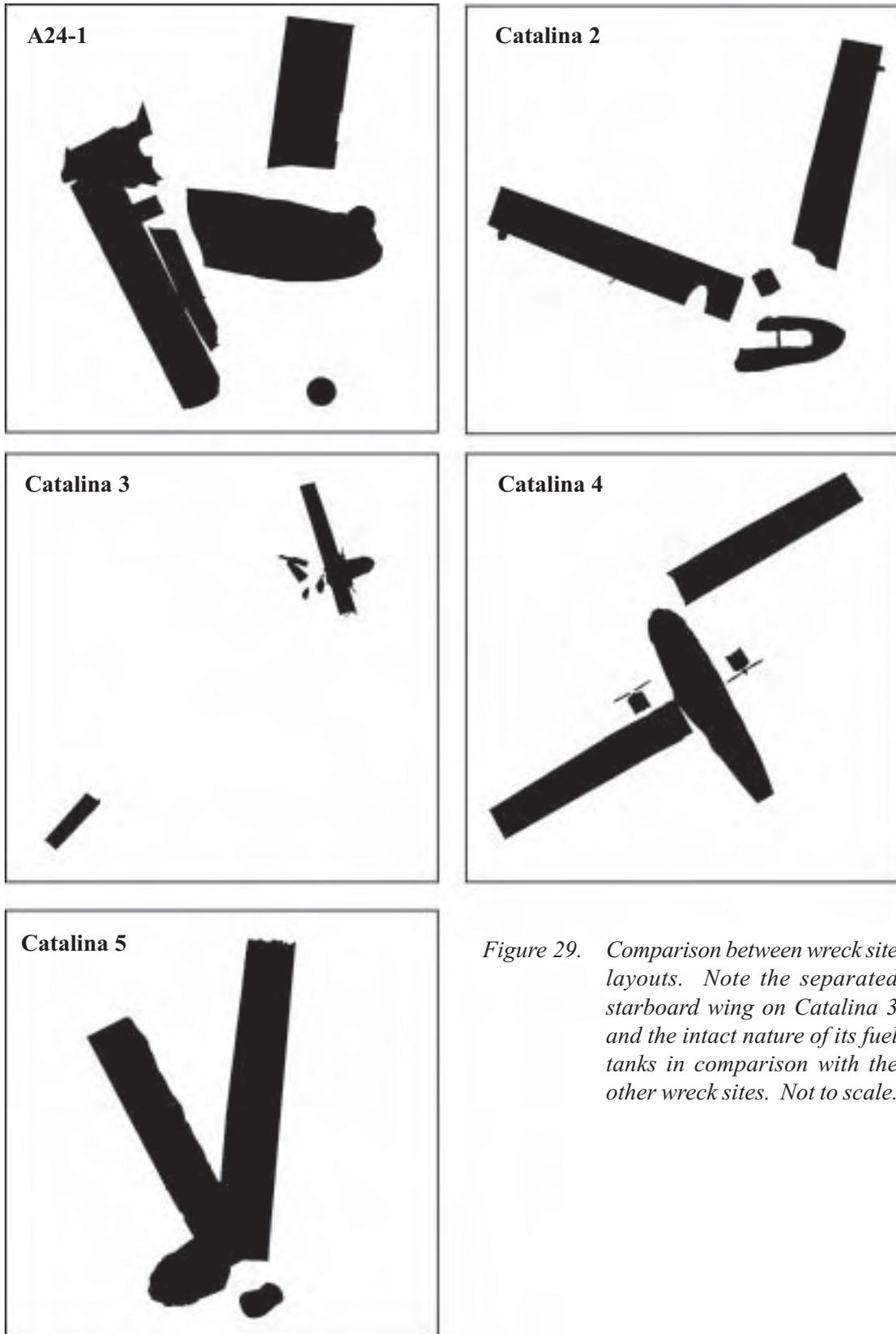


Figure 29. Comparison between wreck site layouts. Note the separated starboard wing on Catalina 3 and the intact nature of its fuel tanks in comparison with the other wreck sites. Not to scale.

5.9 Conclusion

This chapter has presented the results of the archaeological survey of the Darwin Harbour Catalina wreck sites. Despite nearly sixty years of immersion in salt water and the impact by sports divers since the advent of SCUBA, there are diagnostic attributes still visible on the wreck sites. These diagnostic attributes are important clues in their identification.

On the basis of the archaeological data, it is evident that the remains of a PB5Y-5 were found at the A24-1 wreck site. A PB5Y-5A(M) was found at the Catalina 2 wreck site; a 28-5MNE type was found at the Catalina 4 wreck site and a PB5Y-4 at the Catalina 5 wreck site. Despite it being in the best condition of all the wreck sites, the Catalina 3 wreck site did not have any uniquely diagnostic attributes that could be recorded without excavation. For instance, its propellers were buried, hence could not be seen without excavation, and its gun turret was missing.

The layout of the Catalina 3 wreck site, however, was found to be unique, which correlates with the historical account of a PB2B-1 machine sinking after an explosion from underneath, while on its mooring. All the other Catalinas, with the exception of A24-1, caught fire, which has been determined, in all of these cases, to have burnt out the fuel tanks in the central wing section, resulting in the subsequent collapse of the wing into two sections.

Given that examples of all the Catalina types found in Darwin Harbour have been located, the identification of the unlocated wreck site must be a PB5Y-4. A problem, however, was found with using diagnostic attributes to identify the Catalinas, in that wreck site identification is determined by recording Catalina type. This works, as long as there is only one example found. Two PB5Y-4s were recorded to have been lost, but it is unknown which of the two has been found.

CHAPTER 6: RESULTS AND ANALYSIS

6.1 Introduction

This chapter presents the results of the historical and archaeological research and analyses their outcomes. These results enable a reconstruction of events to be made, used here to explain the anomalies seen in the wreck site layouts. This will then allow some conclusive statements to be made regarding the identity of each of the located wreck sites.

Determining the events that occurred at each wreck site links historical data with the archaeological evidence. This in turn will allow some assessments to be made regarding the historical and archaeological significance of each of the wreck sites and their location.

6.2 How the Darwin Catalinas sank

Site formation process is a key indicator of how the wreck site spatial distribution can be understood. The extent of damage seen on Catalina 2, Catalina 3 Catalina 4 is similar, but different to what was recorded at Catalina 5. The damage to A24-1 is clearly post depositional, whereas the damage seen on the underwater wrecks is argued to have occurred at the time of their loss. McCarthy (1997) indicates that the dispersal of aircraft elements and their condition (ie., separation of wings from fuselages) is related to the depth of water the Flying Boat sinks in. This is useful to explain the nature of the Darwin Harbour Catalina wreck sites:

Those [Flying Boats] which come to rest in shallow water will sink upright, while those in water deep enough to allow it, will sometimes invert due to the weight of the engines up on the wings (McCarthy 1997:11).

This clearly explains what happened to the wings on Catalina 2 and Catalina 5 wreck sites, which both have inverted wings. Catalina 3 and Catalina 4 wings have settled upright. All of the Catalinas, however, have a broken wing. Three wreck sites have a break occurring through their central wing sections, while the break in the wing on one wreck site, Catalina 3, occurs past the wing struts on the starboard side, leaving its central wing section and fuel tanks intact.

Photo 72 and 73 show what happens to a Flying Boat's wing once the fuel tanks have caught fire.

Although these photos were taken of a Short Empire Flying Boat in Malta, it clearly demonstrates the collapse of wing integrity once the fuel tanks begin to burn fiercely. Four of the Darwin Harbour Catalinas are recorded to have burnt. Therefore, what the Darwin Catalinas indicate is that, generally, those wreck sites that have a broken wing, through the central wing section, must have caught fire. This enables the reconstruction of the loss event at each wreck site.

6.2.1 Catalina 2 wrecking sequence

Catalina 2 sank as a result of the disintegration of the fuselage, aft of the mainplane. Once the fuselage broke up, the hull filled with water and sank, independently of the wing (Fig. 30). The clue as to how this could have occurred is in the layout of the wing.

The central section of the wing has disintegrated. It is significant that the aircraft's fuel tanks were an integral part of the central wing section. The reason why the fuel tanks, hence the central wing section, on Catalina 2 have disintegrated is because the fuel they contained caught fire, which spread to the gun deck, separating the tail section. What caused the fuel tanks to catch fire is difficult to determine. The nature of the fire that caused the loss of this Flying Boat is, however, consistent with the historical account of the loss of A24-69. The USN Catalinas were the only other Flying boats lost due to fire. The diagnostic attributes on the Catalina 2 wreck site indicate that it is not of one of these earlier USN Catalinas, since none of those, for example, had a bug eye turret.

6.2.2 Catalina 3 wrecking sequence

A different breakup pattern was observed at the Catalina 3 wreck site. Whereas the wing at the Catalina 2 wreck is separated at the central section, the wing on Catalina 3 is broken at its outer starboard wing section. The fuel tanks did not burn and the wing and flight engineer's section



Photo 72. 'Marsaxlokk Bay, Malta, c. 1941-04/05. A smoking, badly damaged Sunderland aircraft of No. 10 Squadron RAAF after an enemy air raid on the RAF Flying Boat Base at Marsaxlokk Bay' (Australian War Memorial, Neg. No. P0869/105/003).



Photo 73. 'Marsaxlokk Bay, Malta, c. 1941-04/05. A Sunderland aircraft of No. 10 Squadron RAAF burning in the water and exuding huge billows of smoke after an enemy raid on the RAF Flying Boat base at Marsaxlokk Bay' (Australian War Memorial, Neg. No. P0869/105/004).

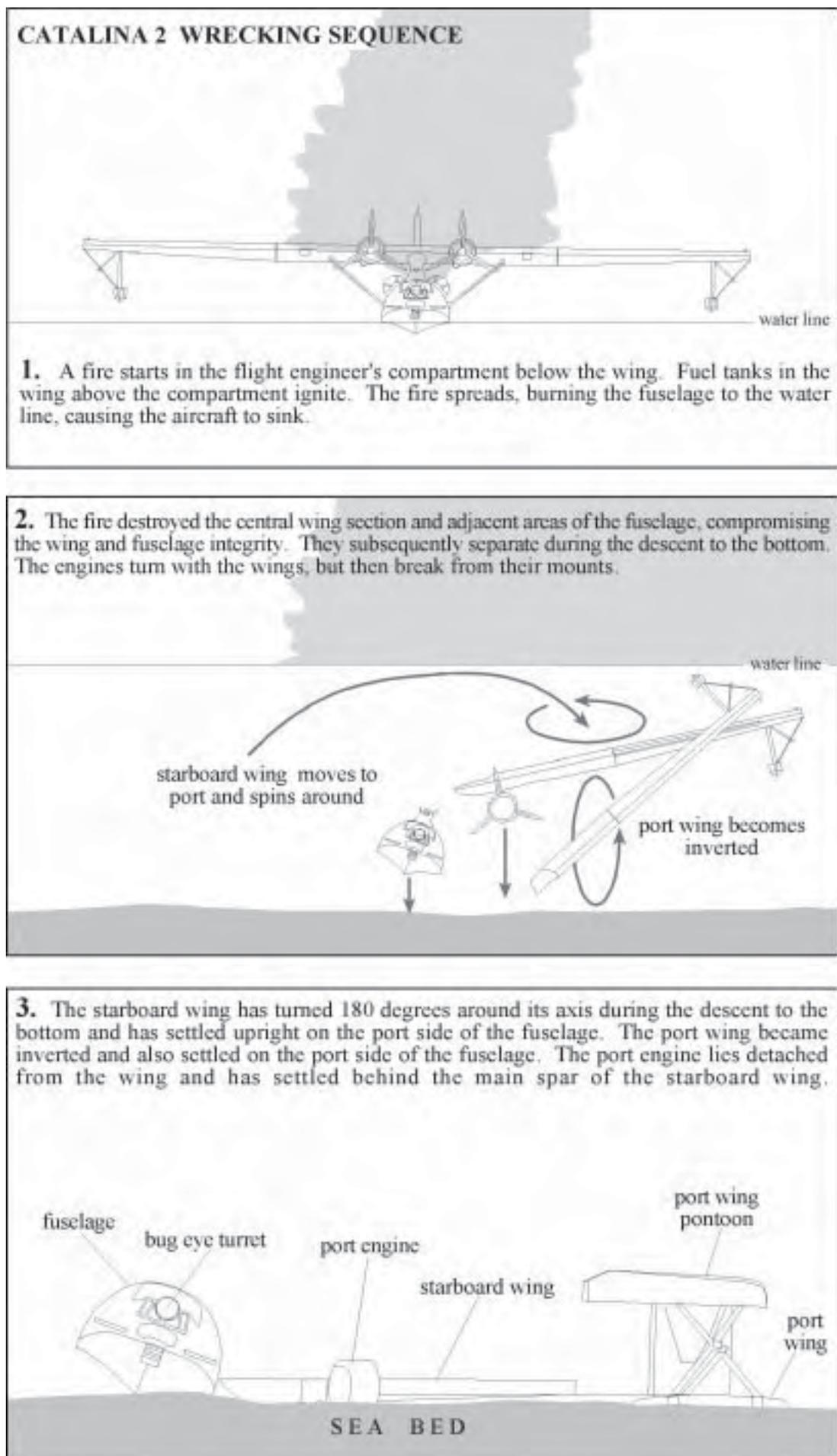


Figure 30. Wrecking sequence of Catalina 2.

survived relatively intact. The parasol wing can be seen on the wreck site, but its orientation relative to the fuselage suggests the Catalina had sustained its fatal blow in this area. The keel of the aircraft is broken with the entire navigator's compartment, together with the wing pillar and the attached wing slump forward and downwards at approximately a 20° angle. The wing's leading edge rests upon the cockpit roof. Once the keel had broken, the hull must have filled with water very quickly and been dragged to the bottom by the unbalanced port wing (Fig. 31).

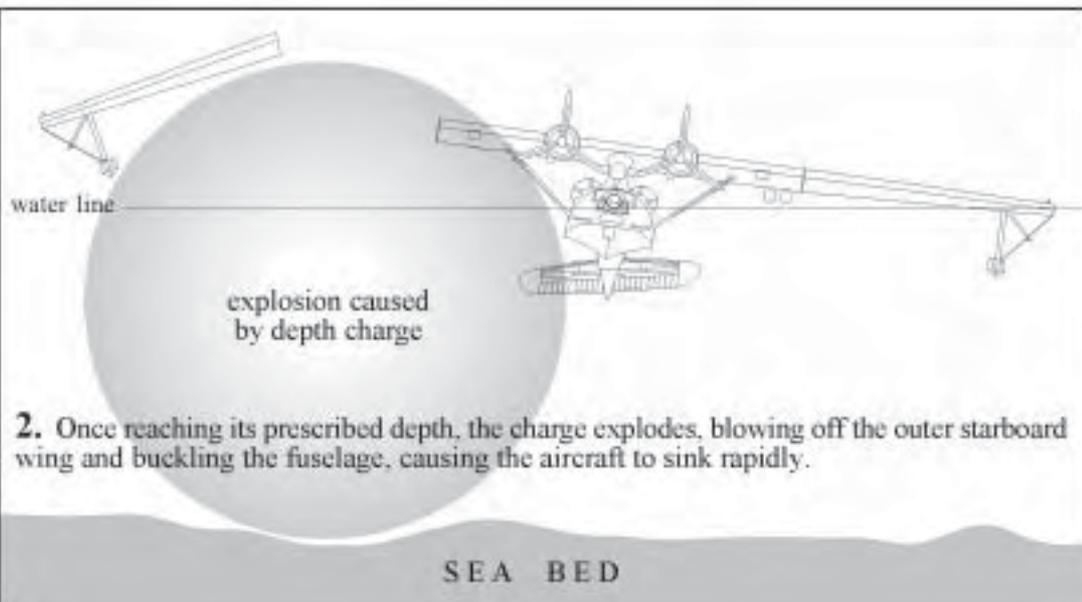
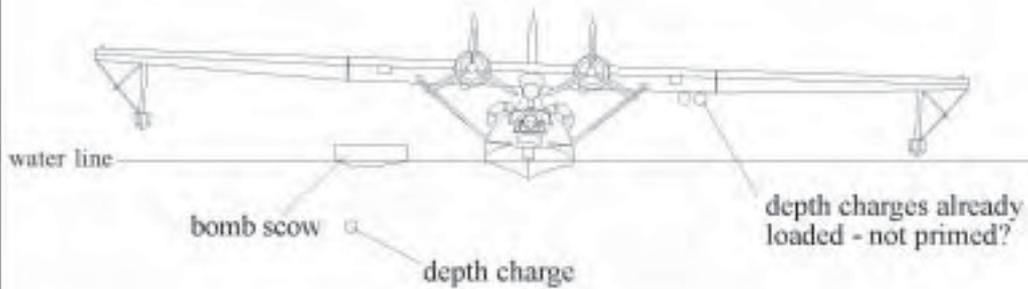
An external explosion, beneath the starboard wing, could explain why this damage occurred, which would account for the spread of significant sections of the Catalina over a wide area. The Catalina 3 wreck site has previously been labelled as A24-205. This identification, however, appears to be wrong. Lewis (1992:45) describes certain attributes of the wreck that led him to believe that it was A24-205. The archaeological data recorded at the Catalina 3 wreck site, however, indicates that what he saw has been misinterpreted.

Lewis (1992) saw bent propellers at the wreck site, which led him to believe this could only have occurred if the aircraft had crashed during take off. One aspect common to all of the Catalinas lost in Darwin Harbour is that they were moored when they sank, excluding the flight accident of A24-1. The single bent propeller blade on each engine at the Catalina 3 wreck site can be explained by the combined weight of the wing, wing pillar and engines pushing them beneath the wreck once they had settled to the bottom. This also explains why not all of the propeller blades were bent, as would be expected if the propeller blades had hit the water while the engines were running. There is also evidence at the bow, which indicates that the aircraft was moored at the time of its loss.

A mooring or snubbing post was located on the port bow of Catalina 3. These were used to facilitate mooring the Catalina (Fig. 32). The mooring post held the lizard rope that was attached to the pendant line, which in turn was made fast to the keel. The lizard line was used to retrieve the pendant line from the bottom of the keel and was, hence not intended to moor the Flying Boat from, but to act as a facilitator in the mooring process. Photo 74 and 75 shows the lizard line attached to the mooring post, but in this instance the Catalina is tied to a buoy (not seen)

CATALINA 3 WRECKING SEQUENCE

1. A depth charge is accidentally dropped from the wing, crashing through the bottom of the bomb scow below it.



2. Once reaching its prescribed depth, the charge explodes, blowing off the outer starboard wing and buckling the fuselage, causing the aircraft to sink rapidly.

3. The port and central wing sections sink intact. The entire wing, however, slumps forward of the broken wing pillar and comes to rest on top of the fuselage. The engines break, but do not entirely separate from their weakened mounts and are driven into the mud by the weight of the wing now on top of them.

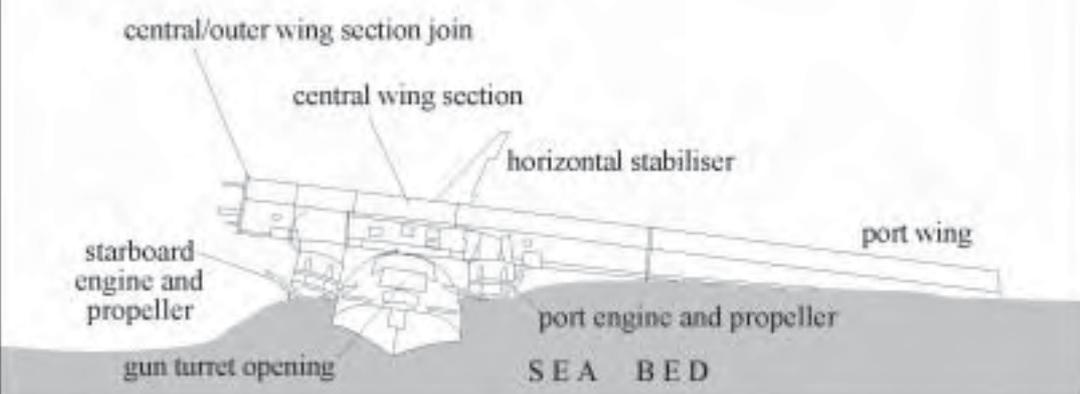


Figure 31. Wrecking sequence of Catalina 3.

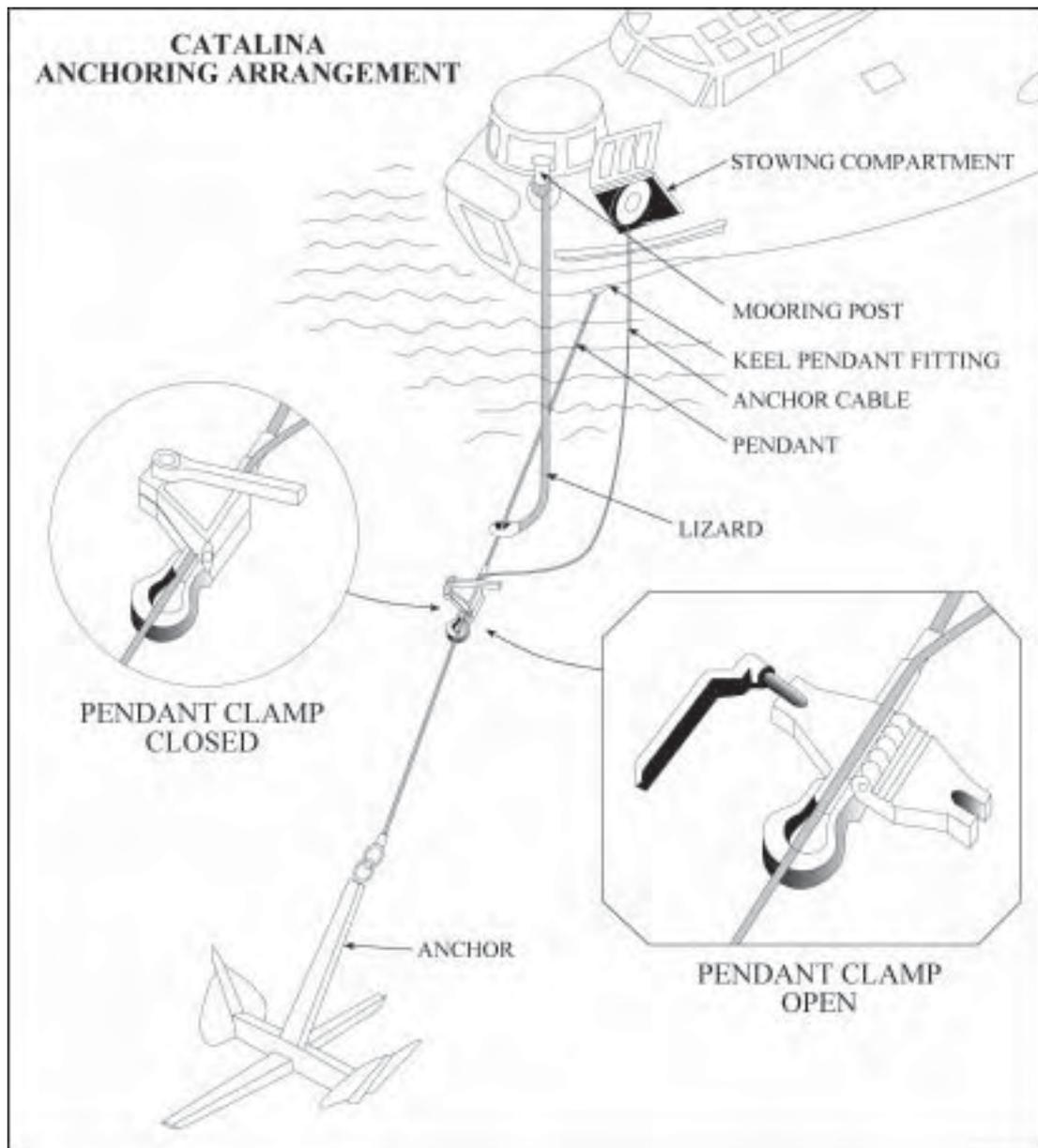


Figure 32. Catalina mooring arrangement (Scarborough 1995:10).

and not anchored as in Figure 32. The mooring post, however, was always removed before flight. The existence of this post on the wreck site, therefore, indicates that this machine was moored and not flying at the time of its loss.

It is not known which method the Darwin Catalinas were moored by. The anchors that have been recovered by divers were said to have been found inside the hulls, indicating that all of the Catalinas were lost while moored to a buoy and not anchored (see Photo 8 and Photo 9). Objects such as mooring buoys may have survived on the Catalina wreck sites, but these, including the buoy anchors, are yet to be discovered.



Photo 74. A crew man stands in the forward gun turret awaiting the captain's orders to let go the mooring line on the snubbing post. Note that the gun turret is turned to starboard, to facilitate accesses to the mooring rope (Scarborough 1995:43).



Photo 75. Qantas Catalina 'Altair Star' about to cast off. Note the lizard line attached to the mooring or snubbing post. The crew man to the right is holding the pendant line. The folding anchor is stowed in the anchor locker, at the man's feet (Leebold 1995:41).

The archaeological results show that the Catalina 3 wreck site is that of a Flying Boat that was moored at the time of its loss and was not in flight, as was previously believed. Furthermore, this Catalina did not burn. The historical evidence indicates that only one Catalina Flying Boat (excluding A24-1) was not lost to fire, but to a depth charge explosion and that was A24-206. As a result, excavation beneath the port wing may find unexploded depth charges, as it was said by Alic Emslie that one wing had already been loaded when the accident occurred. The archaeological evidence indicates that the explosion occurred under the starboard wing. Why the depth charges under the port wing did not explode when they sank with the aircraft is unknown.

6.2.3 Catalina 4 wrecking sequence

The wing on the Catalina 4 wreck site has also separated at the fuel tanks as a result of fire. Unlike the wings on the Catalina 2 and Catalina 5 wreck sites that occur on one side of the fuselage, the port wing on Catalina 4 is in its correct location. The starboard wing is also on the correct side of the fuselage, but has moved straight ahead and settled near the bow. Why didn't these wings become inverted on their descent to the bottom? An answer lies in the historical account of loss for one of the USN Catalinas.

Unlike the two PB4Y-4 Catalinas in PatWing-10, Catalina #41 was recorded not to have sunk due to strafing. It caught fire, but the fire was not as intense as the other two burning Catalinas (Fig. 33). As a result, #41 remained afloat. This attracted the attention of dive bombers that dropped a bomb on it to make it sink. The bomb landed on the port wing, finally causing the Flying Boat to sink. The starboard wing, by this stage, had suffered from the fire and had detached from the fuselage. It did not, however, become inverted because the starboard engine had fallen from its mount prior to or, during the descent to the bottom.

6.2.4 Catalina 5 wrecking sequence

Catalina #41 of the USN PatWing-10 was the only Catalina recorded to have been bombed. The other two wreck sites, according to the accounts of the air raid, sank quickly. The

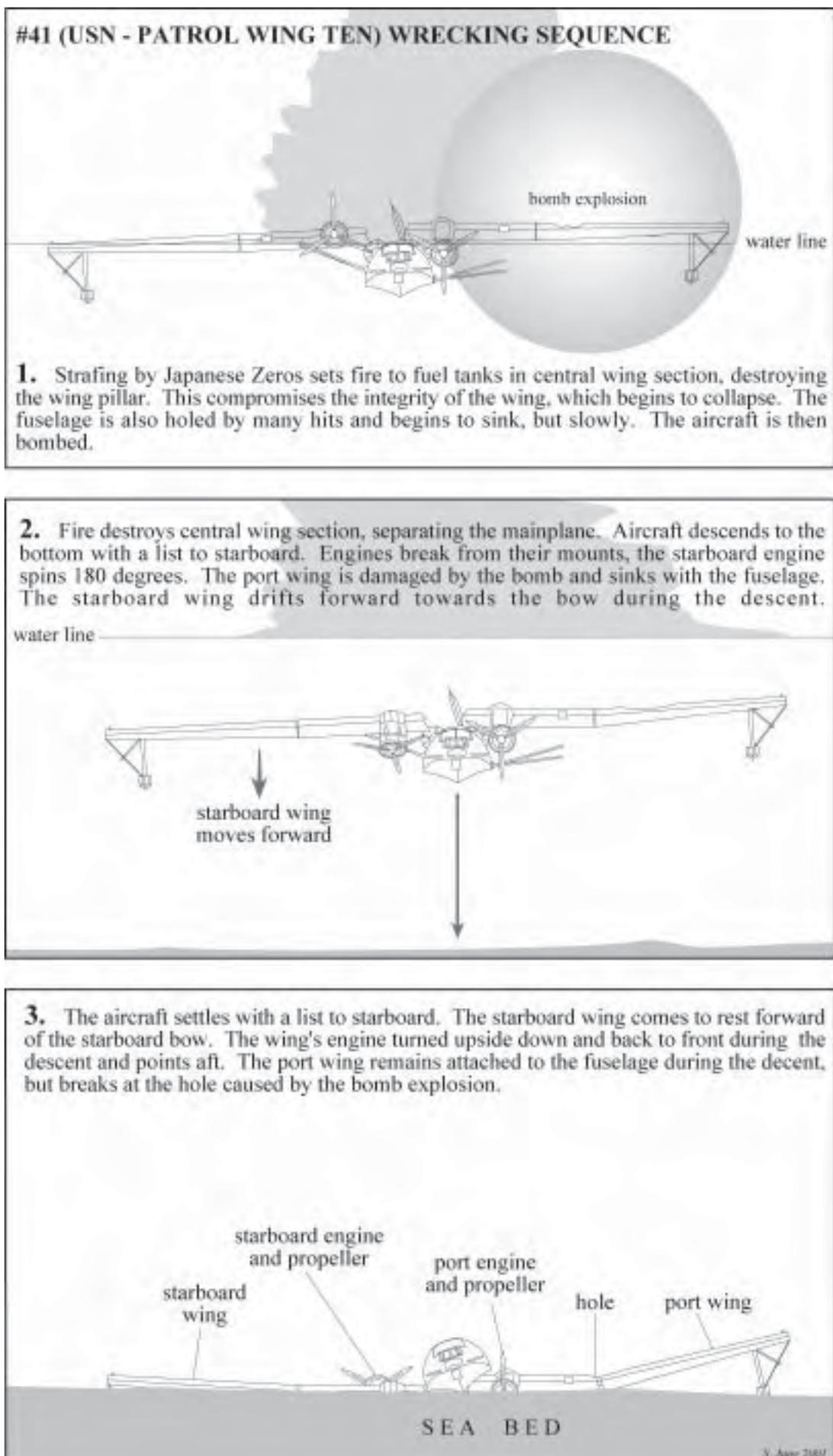


Figure 33. Wrecking sequence of Catalina 4.

archaeological evidence indicates that the fires that engulfed these two Flying Boats were intense. Catalina 5 is a PBY-4. The intensity of the fire that caused its loss is evident in the layout of the wings. With the central wing section (containing the fuel tanks) inevitably being consumed by fire, the port wing separated. The port wing then became inverted during descent. The fuselage was dragged to the bottom by the now unbalanced starboard wing, hence the hull's list to starboard (Fig. 34).

6.3 Heritage significance

In 1978 the Northern Territory government announced that it would be establishing a Heritage Advisory Committee (HAC). One of the committee's tasks was to establish criteria for the heritage register (Carment 1992:71). A criteria was developed and this has been criticised elsewhere:

Given the declaration of places and the mitigation work imposed upon developers it is clear that the Heritage Advisory Council [Committee] has developed working criteria for significance evaluation. However the Council is not a public body, and its deliberations, including assessment criteria, have not been revealed (Hiscock 1994:59).

While the HAC's deliberations are still not revealed, an assessment criteria has been released for use by archaeologists, historians and others who wish to nominate places for listing on the heritage register. The criteria is followed here to assess the heritage value of the Catalina wreck sites in East Arm.

The results of this study show that the Darwin Harbour Catalinas, under Part 4 of the *Northern Territory Heritage Conservation Act 1991* (NTG 1991), are heritage places that have 'special significance in the Territory' (Heritage Advisory Committee n.d.). The Catalina wreck sites are heritage places, as opposed to heritage objects, for several reasons:

- 1) the place where each wreck site is located is historically significant to events that occurred in the Northern Territory and without that context, what each wreck site signifies is lost i.e., *in situ*. they are archaeologically significant;

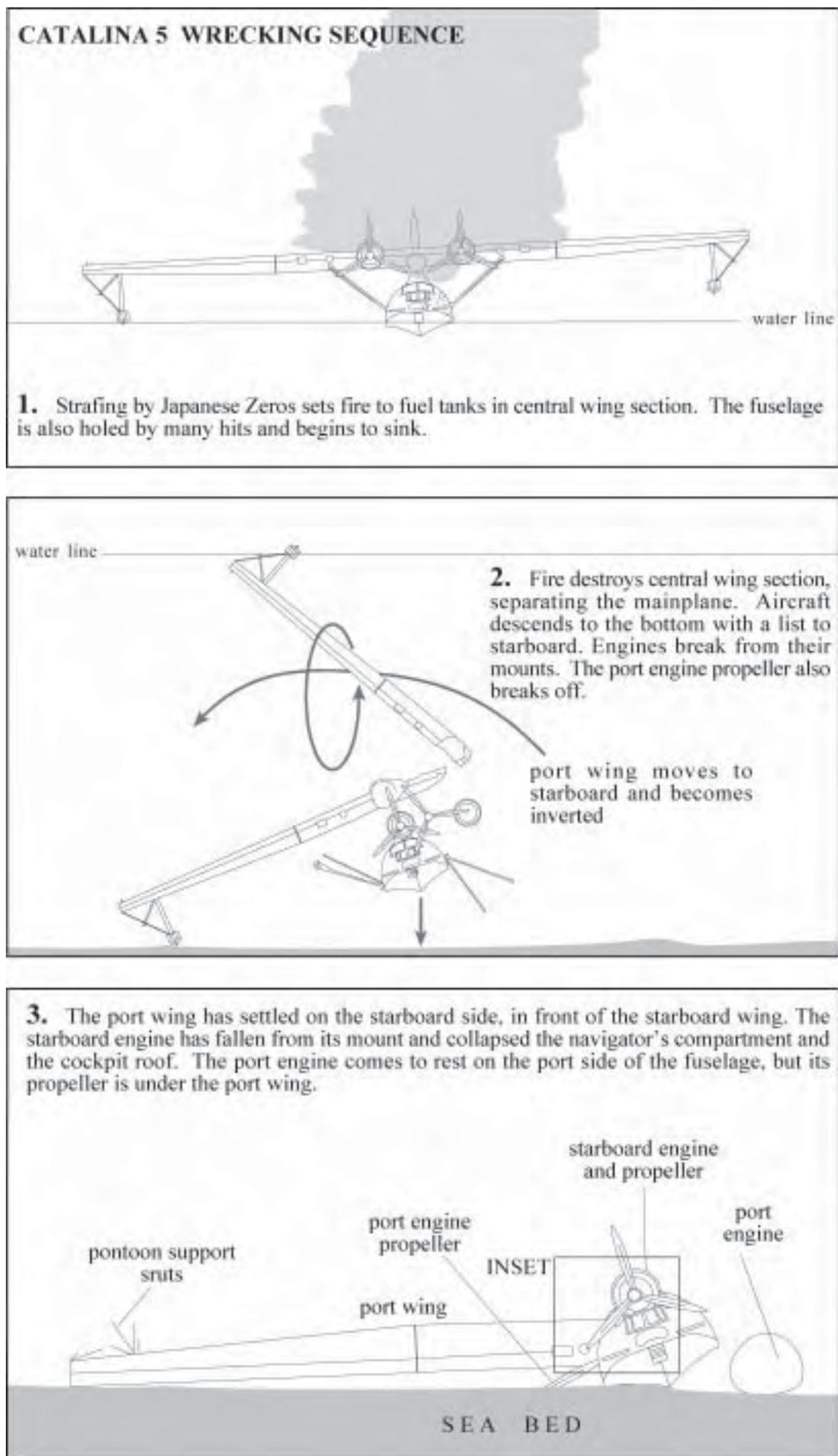


Figure 34. Wrecking sequence of Catalina 5 (see Fig. 27 for inset).

2) the wreck sites are fragile. It is the preferred option to leave them undisturbed than to raise them, since the conservation resources are not available in the Northern Territory and for the simple fact that no salvage attempt of aircraft raised from the marine environment has been successful. This makes the place where the wreck sites are located important to their preservation;

3) in the terrestrial environment, heritage places are rarely regarded as important habitats for flora and fauna. In the marine environment, however, the wreck sites represent important artificial reef systems. Some of the oldest Catalina wreck sites have now been under water for fifty-nine years allowing the establishment of a well developed habitat for the coral and fish species.

With an understanding of the concept of the Catalina wreck sites being heritage places as opposed to them simply being heritage objects, their heritage significance can then be understood in terms of the assessment criteria (HAC n.d.).

6.3.1 Criterion (d): ‘in demonstrating the principal characteristics of the range of landscapes, environments or ecosystems, the attributes of which identify them as being characteristic of their class;’

An important feature of an underwater wreck site is the significance of the place to the marine species that live there. A diversity of fish species and corals growths was found on all of the submerged wreck sites. The wreck sites are important artificial reef systems and characteristic of their class in terms of an artificial marine habitat. The significance of underwater wreck sites, as a result, should also be measured by assessing their importance as marine habitats, as well as regarding them as historically and archaeologically significant.

6.3.2 Criterion (h): ‘by virtue of its association with events, developments or cultural phases in human occupation and evolution;’

The Catalina wreck sites represent the material evidence of the use of Darwin Harbour for Flying Boat operations during WW2. These Catalinas played a significant part in the north Australian air war and the Pacific War. Several wreck sites are associated with an event that has national and international significance – the first air raid on Australia, which has an important bearing on the identity of the Northern Territory as Australia’s front-line during WW2.

6.3.3 Criterion (j): ‘by providing information contributing to a broader understanding of the history of human occupation;’

The Darwin Harbour Catalina wreck sites have not been identified. Study of the Catalina wreck sites, however, adds significantly to our understanding of the events that occurred in East Arm during WW2. The archaeological evidence at the Catalina 3 wreck site, in particular, also changes our understanding of how many Catalinas were actually lost in Darwin Harbour.

6.3.4 Criterion (k): ‘in demonstrating a way of life, custom, land use, function or design no longer practised, in danger of being lost or of exceptional interest;’

Flying Boats, once a common sight in Australian skies and harbours, are rare today. There are no Catalinas operating in Australia. There are approximately fifty examples operating worldwide (LeBaron 2000c). As a result, Flying Boat wreck sites represent an outdated mode of travel and warfare. The identification of an early model PB4Y-1 Catalina is of particular interest, as operational examples of this type of pre-war Catalina are rare.

Evidence of Flying Boat operations, on the shore at the RAAF Flying Boat base, will be destroyed with the construction of a new wharf that will cover over the remains of RAAF Flying Boat Base and also the Z Special Unit operations base. As a result, the underwater wreck sites will soon represent the only tangible evidence for the use of East Arm in military operations and in general, the use of Flying Boats in Darwin Harbour.

6.3.5 Criterion (m): ‘in demonstrating the principal characteristics of the range of human activities which take or have taken place in the Territory, including ways of life, customs, processes, land uses, functions, design or techniques;’

The Catalina wreck sites represent the material evidence of a time when Darwin Harbour was used for Flying Boat operations by two different nationalities. Both the USN and the RAAF were in East Arm, but at different times and under different circumstances. The USN, for instance, operated their Catalinas via a seaplane tender, whilst the RAAF established a nearby land base and used more advanced Catalina types than the pre-war USN examples.

6.3.6 Criterion (n): ‘by virtue of aesthetic characteristics or through technical, creative, design or artistic excellence, innovation or achievement held in high esteem or otherwise valued by a community;’

The Catalina wreck sites are popular dive sites, with dive tours available at local dive shops. The USN Catalinas, however, are still owned by them and they regard their sunken ship and aircraft wrecks as important places of national significance. The aircraft design is also evident at the wreck sites, showing the technical qualities of a large Flying Boat. The RAAF are still the owners of their wrecked aircraft as well (see Appendix 6).

6.3.7 Criterion (p): ‘in being highly valued by a community for religious, spiritual, symbolic, cultural, educational or social associations;’

The wreck sites of the USN Catalinas are highly regarded as significant places of American naval history. Similarly, the RAAF Catalinas are important to the RAAF's history, to the personnel who operated these machines and also to the descendants of those people who served their duty in Catalinas.

6.3.8 Criterion (q): ‘through its close association with individuals whose activities have been significant in the history of the Territory;’

The USN Catalinas belonged to PatWing-10 who used Darwin Harbour as a base for operations up until the first air raid. The story of the people of PatWing-10 in Darwin is a significant chapter in the air war in north Australia. The deaths of Richard Lewis Graham and Walter Alexander Strang on A24-206 are also significant to the history of the Northern Territory, as they were the only two people to lose their lives while serving on Catalinas in Darwin Harbour. These people, as a result, have a tragic, yet significant part in the history of the Territory.

Clearly, the Darwin Harbour Catalinas have heritage significance not only to Northern Territorians, but also to USN who lost two PBY-4s veterans of the Philippines and a 28-5MNE from Surabaya, in the early stages of WW2. The USN affords its lost aircraft the same legislative protection as shipwreck sites. Accordingly, a systematic search for aircraft wrecks has commenced with the establishment of a wreck database for approximately 12,000 extant terrestrial and submerged Navy aircraft wrecks, with nearly 3,000 combat losses in the Pacific alone (Whipple 1995:10; Neyland and Grant 2000:1).

The USN maintains an interest in its cultural resources, wherever in the world they may be, in order to preserve its nation’s heritage in naval aviation (Neyland and Grant 2000:6). This approach could be criticised by the inconsistency in which regard for aircraft wrecks are held by other services in the military. For instance, the US Air Force ‘...neither maintains title to, nor has property interest in, these aircraft’ (Air Force Material Command quoted in Hoffman 1998:38). The only reasons for an aircraft wreck to be inspected were firstly, to make it safe for divers, by removing live ordinance and secondly, to recover human remains (Neyland and Grant 2000:2).

Cultural resource managers became aware of the heritage and archaeological significance of aircraft wrecks and began a joint management program between the Navy Department's Naval Historical Centre, the Department of Defence Legacy Resource Management, the National Park Service's National Maritime Initiative, and the National Conference of State Historic

Preservation Officers. The plan aimed at complying with the National Historic Preservation Act ‘by creating a framework that allows systematic identification, evaluation, and nomination of significant historic and archaeological aircraft to the National Register’ (Whipple 1995:10). Other studies have also focused on identification of the resource and establishing a nomination program (Diebold 1993:2). From these examples, it is evident that aviation archaeological sites are undergoing a re-evaluation as more are found.

6.4 Archaeological significance

O. C. S. Crawford is quoted as saying that obsolete aircraft are strictly archaeological (Capelotti 1996:18). But what this means is unclear in terms of determining criteria for what is and what is not archaeologically significant. The *National Register Bulletin* (Milbrooke, Andrus, Cook and Whipple 1998) for the registration of Historic Places in the United States classifies aircraft as structures: ‘a structure remains relatively intact, while a wreck “site” lacks the structural integrity of an aircraft, although the site may contain the structural elements of the aircraft’ (Milbrooke, Andrus, Cook and Whipple 1998:20). Aircraft wrecks in register qualify as significant heritage places under a number of criteria, but the archaeological significance is yet to be evaluated here in terms of the condition of each wreck site. For example, aircraft qualify under Criterion D if ‘they can provide important information about aircraft design, or construction’ (Milbrooke, Andrus, Cook and Whipple 1998:31). This can only be done if the condition of the wreck site permits.

Wrecked aircraft, however, have only recently been studied as archaeological sites. Richard Gould’s study of the aircraft wrecks from the Battle of Britain demonstrated ‘the need to examine at least as carefully the behavioural processes that also affect the physical character and deposition of wrecks’ (Gould 1983:140). He is referring in this instance, to the recycling behaviour of the English towards crashed German aircraft and how that behaviour can alter interpretations of aircraft crash sites (Gould 1983:139-140). Gould is the first to use aircraft wrecks in a broad based study of contextual sites and their relationship to larger historical and anthropological themes (Capelotti 1996:19). Studies of aircraft wreck sites, however, are still predominantly

focused on individual aircraft, without regard for the broader implications of their existence (Robertson 1977; Darby 1979; Robertson 1989; Candler 1994; Plumber 2000). Aircraft wrecks, therefore, can be logically considered to be archaeological, but criteria for determining their archaeological significance are yet to be developed fully.

The ambiguity of the terminology and intention of how archaeological sites are regarded allows a criticism of the *Northern Territory Heritage Conservation Act 1991* (NTG 1991):

Three terms which are central to the discipline of archaeology, and which have been defined or accepted meaning to archaeologists, are used in the Heritage Conservation Act (1991) with other meaning. This reflects an apparent lack of specialist advice having been sought or accepted by the legislators as the Act was being drafted, and indicates their disinterest in, or possibly even antipathy towards, archaeology as a scientific discipline (Sullivan and Carment 1992:11)

The three terms, in the Act, central to the discipline of archaeology are ‘archaeological’, ‘site’ and ‘occupation’ (Sullivan and Carment 1992:11). While the Act struggles with these definitions, the archaeological significance of submerged cultural material (including aircraft wrecks) is ignored and continues to be an enigma. As a result, how can the archaeological significance of the Catalina wreck sites be assessed using the data that have resulted from this research?

McCarthy (1997) is the first to develop archaeological significance criteria to determine the scientific research potential of Flying Boats based on condition and the circumstances of the aircraft’s loss. The catalyst was a request by the Catalina Association of Western Australia to the Western Australian Maritime Museum on the feasibility of raising and conserving one of the QANTAS Catalinas that was scuttled off Rottneest Island after WW2. Archaeological significance criteria are divided into several categories, across three groups. These are adapted from McCarthy (1997) and summarised in Table 8.

The Darwin Harbour Catalinas would fit into Group A, but the wreck sites would be spread out between the categories. All of the Darwin Catalinas were sunk in operational condition and all have experienced some form of salvage. The salvage, up until the disturbance of Catalina 2 by the RANR and a local Darwin dive shop, however, has focused on loose artefacts, rather than

Table 8. *Archaeological significance criteria for aircraft*

	Group A wrecks	Group B wrecks	Group C wrecks
	Aircraft that have sunk in fully operational and active circumstance	Aircraft that have been abandoned/scuttled	Aircraft that have been stripped as per shipwreck hulk
Category 1	Remains of aircraft that have sunk in a fully operational and active circumstance (shot down etc) and which now lie completely intact	Aircraft that have sunk in fully operational serviceability, as result of scuttling by the crew to avoid capture. Some removal of objects may have occurred prior to scuttling, such as the removal of machine guns and bomb sights	Aircraft whose structural detail and fittings were not considered as suitable for salvage, which still remain <i>in situ</i> . on the site
Category 2	Former fully operational aircraft susceptible to heavy corrosion and wind/wave action	Scuttled or abandoned aircraft, which do not contain the accoutrements of action. Deliberately abandoned in a flying condition	Aircraft whose structural detail and fittings were not considered as suitable for salvage, which still remain on site, but have been disturbed by wind/ wave action
Category 3	These aircraft sites would possibly be those once forming Categories 1&2, but which have been subjected to human interference by professional or recreational salvage. Categorised according to the extent of the interference and the degree of salvage	These aircraft sites would possibly be those once forming Categories 1&2, but which have been subjected to human interference by professional or recreational salvage. Categorised according to the extent of the interference and the degree of salvage	Aircraft whose structural detail and fittings were not considered as suitable for salvage, which still remain on site, but have been disturbed by wind/ wave action and salvaged. Categorised according to the extent of the interference and the degree of salvage

entire structural sections. The one remaining unlocated Catalina wreck site, however, has the potential of a Group A, Category 1 wreck site to still contain personal artefacts of its crew and accoutrements necessary for military action.

One wreck site, A24-1, however, fits into Group B and Category 2. It was abandoned in a fully operational condition, but not fitted for the accoutrements of war i.e., it was stripped of weapons so as to carry returning POWs. Evidently, the archaeological significance of aircraft wreck sites must be determined on an individual basis, as each wreck site is uniquely different.

Archaeological significance, as a result, is directly associated with the condition of the wreck site and its integrity. The Burra Charter describes the integrity of an archaeological site in terms of its fabric. Fabric is described as 'all the physical material of the place' (Marquis-Kyle and Walker 1992:21). The charter defines the scientific value of the fabric found at a place as

:

The scientific or research value of a place will depend upon the importance of the data involved, on its rarity, quality or representativeness, and on the degree to which the place may contribute further substantial information (Marquis-Kyle and Walker 1992:73)

The concept of rarity of the machine found at a wreck site is briefly discussed, to demonstrate what that this means in terms of the Darwin Catalinas. This concept is lacking in the understanding of Flying Boat wreck sites, since little is known about the extent of the resource elsewhere in Australia. The results of the field survey have found one PB4. This is arguably a rare Flying Boat type. Only thirty-four were made and most of these were lost in the early stages of the Pacific War. There is one other, and this machine is found on Australia's Murray River, but it has been extensively been modified as a houseboat (Photo 76). This was one of two PB4s from PatWing-10 that escaped from the Philippines in 1942. Both were turned over to the RAAF for training aircrew and survived the war. Jim Vale bought this machine; the fate of the other is unknown (LeBaron 1999b). The fabric at the Catalina 5 wreck site, therefore, is much more integral to the original morphology of a PB4 Catalina than any PatWing-10 veterans that have survived.

6.5 Further considerations

Historical and archaeological significance of a wreck site may be argued for by professional historians and archaeologists, or anyone else interested in the preservation of the Territory's cultural identity, but the decision for the protection of, in this instance, the Catalina wreck sites ultimately lies with the government ministers:



Photo 76. *A PBV-4 (BUAERNO: 1217), called 'Paddlecat', modified as a house boat on the Murray River (Lebaron 1999b).*

The ability of Cabinet or the Chief Minister to grant a permit for site destruction without necessarily requiring or following expert advice, and the ability of landowners or lessees to object to the registration of places of assessed significance on their land could indicate that the government may see the Act as a way of ridding itself of an embarrassing collection of heritage phenomena which are still perceived as standing in the way of development (Sullivan and Carment 1992:17).

Historical and/or archaeological significance is often not a consideration in whether or not a place is protected, if the protection of that place compromises the economic growth of the region. As a result, the appropriate minister often ignores the advice of the HAC (Sullivan and Carment 1992:17). The future protection of these sites now depends on the outcome of a nomination process. This is the first step in having them listed as heritage places under the *Northern Territory Heritage Conservation Act 1991* (NTG 1991).

6.6 Conclusions

This chapter has pointed out the results of this thesis and what they indicate in terms of identifying the Catalina wreck sites in East Arm. These have enabled a reconstruction of the events that caused the loss of the Flying Boats.

Developing an understanding of the history and archaeology of the Catalina wreck sites has also resulted in the compilation of a body of data that can be used to assess the significance of the wreck sites, which in turn is used to argue for their protection under the *Northern Territory Heritage Conservation Act* (NTG 1991). Despite the Catalina wreck sites meeting most of the heritage significance criteria set by the HAC, archaeological significance has been assessed on the basis of their information potential that corresponds to the circumstances of their loss, their condition, their integrity and their rarity. Some of these archaeological criteria are not addressed in the heritage assessment criteria, indicating that understanding archaeological significance is limited only by the types of questions being asked. For example, would an intact aircraft wreck (of which there are still flying examples) be more significant than one which was rare, but had broken-up?

Archaeological and heritage significance is also related to the concept of place, where objects have a specific relationship to a geographic location. This is evident by the Catalina wreck sites, where their location is significant. Information about one wreck site affects how others are interpreted. The distribution of wreck sites in East Arm has been shown to reflect behavioural patterns, which explains how the wreck sites came to be where they are. This in turn is useful in determining where one unlocated wreck site might be. For example, if the USN aircraft were all moored towards the southern shoreline in East Arm, searching the northern shore line for PatWing-10s third aircraft loss would be pointless, as they were said to have been moored in the same area.

CHAPTER 7: CONCLUSIONS

7.1 Introduction

This chapter presents the conclusions that can be determined from this combined archaeological and archival investigation of the Catalina wreck sites in East Arm. The identity of five of the six located wreck sites has been positively determined in this thesis, but the limitation of the approach made the identification of the one wreck site problematic.

Aircraft wreck sites are undergoing a re-evaluation and it is evident that the research focus of maritime archaeologists has been on identification of the resource (Whipple 1995:10; Rodgers, Coble and Van Tilburg 1998). The aim of this thesis was to verify the identify of five located Catalina Flying Boat wreck sites in Darwin Harbour's East Arm by historical and archaeological research. It is, however, first necessary to understand the details and patterns of the past, before making theories about it (Bass 1981:101; South 1981). This is achieved in this thesis, whereby the details of the past in both the historical and archaeological record have been analysed. It is only after having done this, that archaeologists and historians can determine the events that occurred in East Arm during WW2. This thesis has provided additional information on the events surrounding the loss of Catalina Flying Boats in Darwin Harbour, information that has been forgotten in archives and in the structures found at the wreck sites.

7.2 An identity for the Darwin Harbour Catalinas wreck sites

The wreck site known as Catalina 2 is a PB5Y-5A (M) model flying boat. There was only one of this type lost in Darwin Harbour and that was a RAAF Catalina known as A24-69 (Bureau of Aeronautics Number 34056), which caught fire by accident on 14 December 1945. The wreck site that is known as Catalina 2 should hereafter be referred to as A24-69.

The wreck site known as Catalina 3 is a PB2B-1 model Flying Boat. There was only one of this type lost in Darwin Harbour and that was a RAAF Catalina known as A24-206 (Bureau of

Aeronautics Number 44217; ex-Royal Air Force JX611, which sank as a result of an accidental depth charge explosion on 20 June 1945. The wreck site that is known as Catalina 3 should hereafter be referred to as A24-206.

The wreck site known as Catalina 4 is a 28-5MNE model Flying Boat. There was only one of this type lost in Darwin Harbour and that was a United States Navy aircraft known as simply: #41; ex-Y41- Netherlands East Indies, *Marine Luchtvaart Dienst*. This aircraft was sunk during the first Japanese air raid on 19 February 1942. The wreck site that is known as Catalina 4 should hereafter be referred to as #41.

The wreck site known as Catalina 5 is a PBY-4 model flying boat. There were two of this type lost in Darwin Harbour on 19 February 1942 and those were USN aircraft known as simply: #4 (Bureau of Aeronautics Number: 1214; ex-102-P-27, ex-102-P-12) and #8 (Bureau of Aeronautics Number: 1233; ex-101-P-8). It is not known which of these two aircraft is found at the Catalina 5 wreck site, but suffice to state, for the moment, that the wreck is of a USN aircraft and not RAAF. As a formal name change, it is suggested that this site be referred to as Unknown PBY-4.

On the basis of this information, it is evident that the missing Catalina is that of a PBY-4 type, one of two PBY-4s lost on 19 February 1942. Identification of the located PBY-4, however, is not possible using diagnostic attributes of the wreck site, as a result of there being two Catalinas of the same type reported to have been lost. How can individual aircraft be identified from amongst a group of wrecks in the same area?

Excavation and the collection of artefacts found on the seabed are ways of determining an identity for the Unknown PBY-4. For example, artefacts that were marked with the Flying Boat's identity revealed the identity of a Dutch Dornier Flying Boat of the *MLD* found in Broome's Roebuck Bay. In this case, Stan Gadjia (1982) identified the *MLD* Dornier X-1 on the basis of 'X-1' being engraved on the tools recovered from the wreck site. Similarly, excavation and recovery of artefacts from the Unknown PBY-4 wreck site in Darwin may

reveal as yet unknown identifying characteristics related to behaviour of that particular crew, or to the routines of a particular nationality. For instance, did the USN Catalinas engrave their tools the aircraft's serial number? Given the number of designation changes in PatWing-10, it would seem unlikely, but this needs to be tested. The discovery of the contractor's plate from A24-69 is another example of the usefulness of artefacts as wreck site identifiers. This prompts the question of what is inside the sediment filled hull of the Unknown PB4Y-4, or buried in the seabed around the remaining structure? Excavation, as part of this thesis, was not a consideration as there are no conservation facilities in the Northern Territory.

7.3 Future work

There is an excavation potential at the Unknown PB4Y-4 wreck site, but this needs a feasibility study to assess the capacity of the personnel and the resources to conserve the recovered artefacts. A conservation strategy for the protection of recovered artefacts or entire aircraft must be developed along with the dive plan and archaeological considerations.

The Rottneest Island Catalina wrecks case study is useful in determining what is necessary for the preservation of a recovered Catalina after fifty plus years immersed in seawater. John White, the curator of military technology at the Australian War Memorial, states in the report that: 'there is yet to be a successful restoration of an aircraft taken from a salt water environment' (quoted in McCarthy 1997:13). Photo 77 illustrates the potential of airframe preservation in a marine environment. However, the caption to this photo (the only information available) indicates that the salvage was not conducive to the aircraft's preservation. Furthermore, the discovery of a USAAF Curtiss P-40L Kittyhawk off the coast of Capo Portiere near Latina, Italy, in 1998 indicates that the likely preservation of an aircraft in a marine environment is also attributable to the anaerobic conditions of the wreck site itself. The Kittyhawk was found in four metres of water, a short distance from land and buried in sand. A storm in 1997 uncovered the wreck site, which proved to be in a remarkable state of preservation (Giannitrapani, McDonald and Colla 2000). Successful restoration, therefore, depends on the condition of the aircraft and on the availability of resources to conserve it once it has been removed from the sea.



Photo 75. 'An A6M5 Zeke recovered from Simpson Harbor, Rabaul, in 1971...The Zeke was shipped to the USA but neglect of anti-corrosion precautions have since taken their toll to the point where disintegration is now well advanced and the aircraft today is little more than a rather expensive curiosity' (Darby 1979:23).

This still leaves cultural resource managers a challenge with what to do with the Catalina wreck sites. Two wreck sites are in the way of the new port development and it is suggested here that the developers change their plans. This has been done previously when the foot of the wharf was moved further north to avoid hard ground. There has been no discussion as to why the plan could not be modified further to avoid historical and archaeologically significant wreck sites. Consequently, wreck site destruction must be viewed as the last option, not the first.

In situ. conservation is the preferred option over preservation of recovered material. In this way archaeological material is left in its original context. Future management concepts should adopt the philosophy of 'do as much as necessary, as little as possible' (Marquis-Kyle and Walker 1992:13). The basic *in situ.* conservation of the Darwin Catalinas could involve the establishment of a mooring system for visitors, alleviating the problem of small boat anchors picking and pulling apart fragile airframes and the thin aluminium skin on surviving structures (Fig. 35). However, the best method to help preserve the Darwin Catalina wreck sites is education. Humans present the greatest threat to the Darwin Catalina wreck sites. For instance,

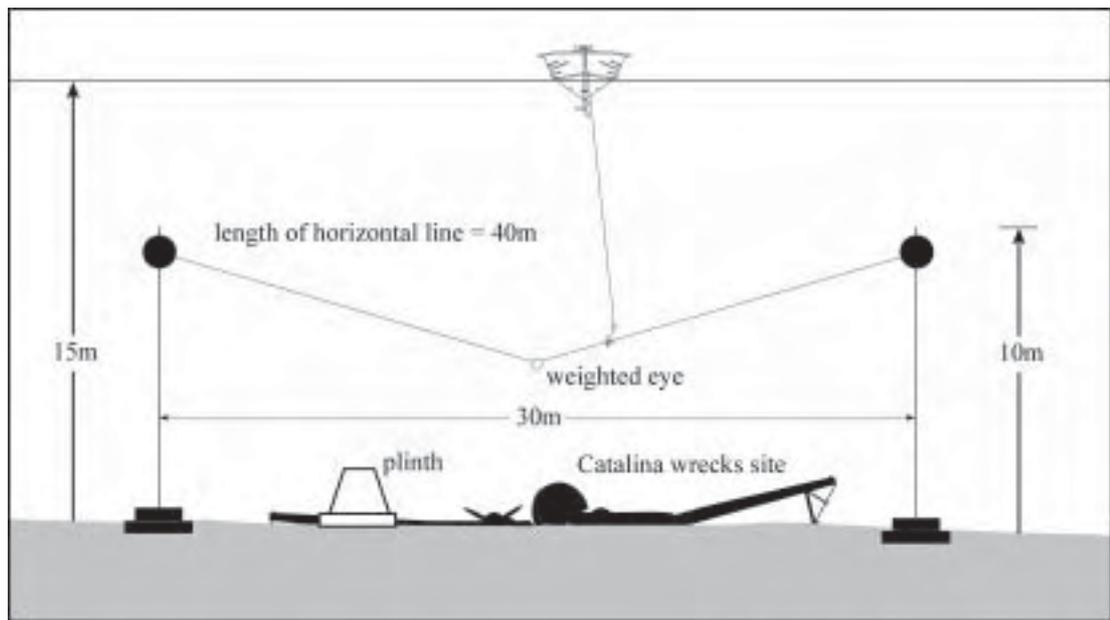


Figure 35. Concept mooring system, based on the system developed for the SS Lady Darling (After Nutley 1998:117).

there is currently no interpretative material available for visitors to East Arm about the Catalina wreck sites. Wreck site information plinths (and a memorial on land) will give divers an understanding of the otherwise amorphous wreckage and help prevent their visit from compromising the fabric of the wreck sites (Fig. 36).

The Catalina wreck sites could then be included in heritage trails or other such projects to foster the value of the resource. The Northern Territory Department of Lands, Planning and Environment (DLPE) are the responsible government agency for archaeological and heritage sites in the Northern Territory. Yet they provide virtually no information to the public regarding ship and aircraft wrecks in Darwin Harbour, or information about those types of wrecks anywhere else in the Northern Territory. Heritage trail signs established by the DLPE reflect this. For example, the heritage marker for the Flying Boat Base on Quarantine Island does well to mention the activities that were conducted on the Island during WW2, but no mention is made of the sunken Flying Boats or of the famous A24-1 exposed at low tide (Fig. 37). This was because there was little information on the wreck sites to inform the public about.

There needs to be greater recognition of the RAAF Catalina squadrons and the USN that operated from East Arm. The only plaque recognising their work and sacrifice is located several kilometres



Figure 36. Concept wreck site plinth (After Dean 1988:11).

away on the Darwin esplanade. The Cairns Catalina memorial is an example of the type of structure that should be constructed on Quarantine Island (Photo 78). A heritage sign board situated next to an industrial bin adjacent to the old Flying Boat ramp, is not enough recognition of the important role the Catalina wrecks played in the Allied war effort during WW2. The wreck sites, as a result, currently all suffer an ignominious end.

7.3.1 Flying Boat wreck sites in Australian waters

In Darwin Harbour, the research potential of Flying Boats may not necessarily be restricted to Catalinas. A Dornier Do-24K Flying Boat was lost in 1943, but whether or not it has been completely salvaged is yet to be determined (Peter Dermoudy research files, MAGNT). Photo



Figure 37. Heritage signage at East Arm. Note the lack of information on the Catalina wreck sites, and the USN use of East Arm (Conservation Commission of the NT 1992:43).

79 is said to be of the Dornier (see also photo 80), but its labelling has been made ambiguous by it having been referred to also as the USS *Peary* (Smith 1991; Smith 2000). The photo was actually taken from Mindil Beach looking out towards East Point. The headland to the right of the photo is Bullocky Point. Photo interpretation, therefore, indicates that it is neither of the Dornier (A49-5) or the USS *Peary*, both of which were lost off the Darwin esplanade. Further research is needed to determine what was captured in the image as Fannie Bay has no known wreck sites. Another possible Flying Boat wreck in Darwin Harbour is that of the Qantas Short Empire Flying Boat 'Cornithian'. Archival information indicates salvage crews did not raise this enormous Flying Boat and that its wreck may still be found in the harbour, but unfortunately in the vicinity of the new port development (Series: MP238/1/0, National Archives of Australia).

There are potentially another fifty-one Catalina wreck sites in Australian waters, let alone the other Flying Boats models that were lost such as Dorniers and Empire Flying Boats (Appendix



Photo 78. The Cairns Catalina war memorial (Photo: Gailits 2000, <http://www.egroups.com/message/pbypictures/128>).

7; see also photo: 81, 82, 83 and 84). Figure 38 and 39 illustrate the condition of some of the Broome aircraft wrecks. Considering the amount of post depositional damage done to these wreck sites, it appears that the Darwin Catalinas are in much better condition.

7.4 Implications for maritime archaeology

...within the framework of underwater archaeology, submerged aircraft wrecks potentially form a class of archaeological site in themselves (McCarthy 1997:11).



Photo 79. 'No. 41 Squadron's Dornier A49-5, DQ-H is test flown by S/Ldr. Geoff Marshall 12/6/43' (Freeman 1995:112).



Photo 80. 'Dornier flying boat in flames' (Smith 1991). Note: later edition captions this photograph as: 'American destroyer sinking after bombing by Japs - off Pelican Point' (Smith 2000:125).



Photo 81. 'Potshot, Exmouth Gulf, Western Australia. 1943-04-29. A United States Navy diver descending into the water at the spot where a Catalina aircraft crashed on 28th April. Of the crew of seven, four reached the shore. Three bodies were still in the plane' (Australian War Memorial, Neg. No. 051700).



Photo 82. 'Unknown US Navy Catalina on Enderby Island, off Dampier W.A. (Finch Bellringes via Peter Dermoudy Collection, MAGNT n.d.).



Photo 83. 'Short Brothers Empire flying-boat A18-10, previously QANTAS Centaurus destroyed at Broome on March 3rd, 1942' (Photo: K. Caldwell, via Rorrison 1992:275).



Photo 84. 'Qantas Short Empire flying Boat "Corinna" used to evacuate personnel from Java. It was destroyed in Roebuck Bay by "Zero" fighters' (AWM, via Tyler 1986:106).

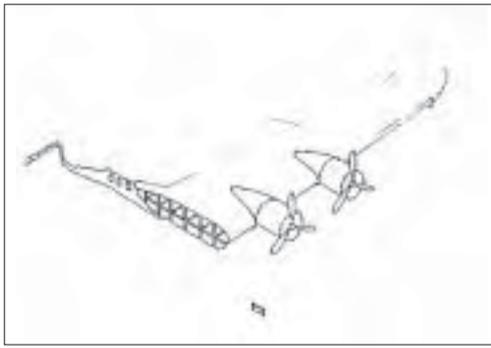


Figure 38. *Short Empire Flying Boat wreck site plan, Broome 1999 (Courtesy Geoff Parker).*

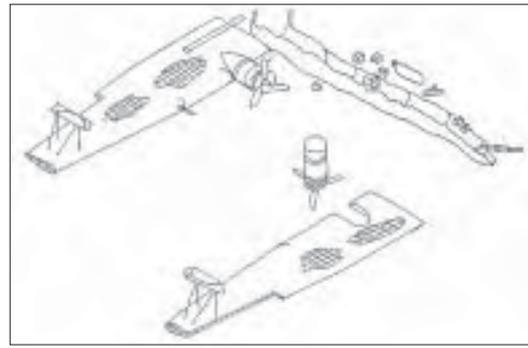


Figure 39. *Catalina wreck site plan, Broome 1999 (Courtesy Geoff Parker).*

This study has shown that much more needs to be done to the development of the theory of maritime archaeology and the types of wreck sites that maritime archaeologists study. Flying Boats form a distinct subgroup of aircraft wrecks that are indicative of a unique type of maritime activity that is becoming a rare sight worldwide. This is exemplified by the nature of the Northern Territory's last Catalina, which left in 1986 after being converted into a land plane and, hence, could no longer use the water (Photo 85).

Archaeological investigation has shown that the Darwin Catalina wreck sites, despite their fragile nature and the impacts that have acted upon them since their deposition, are remarkably well preserved. This makes them archaeologically significant, as well as rare. The potential number of Catalina Flying Boat wreck sites around Australia would suggest that there is much to be learnt regarding Australia's Flying Boat history. Until this thesis, only one side of the story had been told. It has been up to archaeology to tell the final story as to the fate of these famous aircraft.

As a result of this thesis, archaeologists now know more about this type of resource, which in turn allows historians of WW2 to reconsider the events that occurred in East Arm. This defines what work still needs to be done in terms of surveying and to determine the positive identification of the located wreck site, Unknown PB4-4. Apart from the archaeological research that is still required, there is much work to be done informing both the public and government agencies about the historical significance of underwater cultural resources that are important to the identity of the Northern Territory. These giant Flying Boats were once a common sight in Darwin



Photo 85. The Northern Territory's last Catalina at Tennant Creek. 'David Bowen, pilot with Bill Mitchell Senior Engineer and John Edwards on wing' (Tennant & District Times 1986).

Harbour and an integral part of Allied operations during WW2. The wreck site of A24-1 is especially significant for its associations with pioneering flights and the crossing of the Pacific by air. The Flying Boat, by a chance circumstance, ended up abandoned in Darwin Harbour while on a mercy flight in peacetime. But what should be done with these places now?

Never before in the history of Darwin Harbour has such a large-scale project as the East Arm Port Development occurred. This development threatens at least two wreck sites, A24-69 and A24-206. What will be their ultimate fate? Their proposed destruction is a signal to cultural resource managers to take care of the remaining wreck sites as a resource for the future, so as not to forget the role the RAAF and the USN had in Darwin Harbour during WW2. The way to do this is to change people's attitudes by making them aware of the significance of these places

and the obligations they should follow when visiting them. This will be the ultimate challenge for maritime archaeologists who in the past have argued for these things for other types of maritime sites, as well as for Dutch shipwrecks. The treasure in Darwin Harbour is the information wreck sites contain about the past in their environmental context, which is what visitors to these wreck sites have been missing all along:

Such sites can enrich our understanding of ourselves and our culture - a far greater reward, I believe, than what the salvage of them whole or in pieces might provide to a few individuals monetarily or materially (Capelotti 1998).

REFERENCE LIST

- Aviation Archaeological Investigation and Research (AAIR). 1998. 'What is aviation archaeology'. (<http://www.sonic.net/azfuller/whatis.htm>). Accessed 14 October.
- Acer/Vaughan. 1994. *Draft environmental impact Statement. Darwin port expansion - East Arm*. Northern Territory Department of Transport & Works, Darwin.
- Aircraft History Card. Bureau of Aeronautics Number 1214. Naval Historical Centre, Washington Navy Yard, Washington D.C.
- _____ Bureau of Aeronautics Number 1233. Naval Historical Centre, Washington Navy Yard, Washington D.C.
- _____ Bureau of Aeronautics Number 2306. Naval Historical Centre, Washington Navy Yard, Washington D.C.
- Aviation Historical Society of the Northern Territory (AHSNT). 1991. *Darwin's Air War 1942-1945: an illustrated history*. The Aviation Historical Society of the Northern Territory, Inc. and Colemans Printing Pty. Ltd., Darwin.
- Babits, L. and Van Tilburg, H. (eds) 1998. *Maritime archaeology: a reader of substantive and theoretical contributions*. Plenum Press, New York.
- Baker, J., Anuskiewicz, R. and Garrison, G. 1998. 'Mapping and Site Characterization in Zero Visibility: The C.S.S. Georgia'. In Babits, L. and Van Tilburg, H. (eds) *Maritime archaeology: a reader of substantive and theoretical contributions*. Plenum Press, New York:493-506.
- Bass, G. 1983. 'A plea for historical particularism in nautical archaeology'. In Gould, R. (ed.) *Shipwreck archaeology*. The School of American Research, University of New Mexico Press, Albuquerque:91-104.
- Bradley, J., Dice, J. and Griess, T. 1984. *The Second World War: Asia and the Pacific*. Department of History, United States Military Academy, West Point, New York. Avery Publishing Group Inc., Wayne, New Jersey.
- Candler, C. 1994 'WW II wreck hits dry land'. *Northern Territory News*. 27 August:2.
- Capelotti, P. 1996. A conceptual model for aerospace archaeology: a case study from the Wellman site, Virgohamna, Danskoya, Svalbard. Unpublished Ph. D. thesis, Rutgers University, New Jersey.
- _____ 1998. 'Buried Treasure'. *Air and Space*. Smithsonian. (<http://www.Airspacemag.com/ASM/Mag/Index/1996/AS/butr.html>). Accessed 15 December 15.
- Carment, D. 1992. 'Heritage legislation in the Territory'. In Sullivan, M. and Carment, D. *Cultural Heritage conservation in the Northern Territory*. Darwin: North Australian Research Unit. The Australian National University. Discussion paper No. 10:70-77.
- Conservation Commission of the Northern Territory. 1992. *Signs of History: a photographic collection of the World War II Historic sites signs in the Northern Territory*. Conservation Commission of the Northern Territory, Darwin.
- Contact. 1985. 'The Flying Boat Era'. *Contact: magazine of the Royal Australian Air Force Association*. Victoria. Vol. 40, No. 1:5-7

- Creed, R. 1985. *PBY: The Catalina flying boat*. Airline Publishing Ltd., Shrewsbury, England.
- Crocker, M. 1987. *Black cats and dumbos: WWII's fighting PBYs*. TAB Books, Inc., Blue Ridge Summit.
- Dagnese, C. (cdagnese@hotmail.com) 2000. Re: 'Self sealing tanks'. E-mail sent to PBY@egroups.com. 8 June.
- Darby, C. 1979. *Pacific Aircraft Wrecks and where to find them*. Kookaburra Technical Publications Pty. Ltd., Melbourne.
- Davis, L. (n.d.) Locating the enemy at sea: The History of Fleet Air Wing 10. September 1939 to 1 June 1945. Unpublished. Copy held at the Naval Historical Centre, Washington.
- Dean, M. 1988. *Guidelines on acceptable standards in underwater archaeology*. Scottish Institute of Maritime Studies, University of St Andrews.
- Delgado, J. (ed.) 1998. *Encyclopaedia of underwater and maritime archaeology*. British Museum Press, London.
- Department of Primary Industries and Fisheries (DPIF). 1992. *Darwin's Artificial Reefs*. Fisheries Division, Recreational Fishing Section (RFS), Darwin.
- Diebold, P. 1993. 'Aircraft as cultural resources'. *CRM*. (10):2-7.
- Dorny, L. (<http://www.catalina.demon.nl/pby/a24-1.htm>) 1999a. 'PBY Catalina Pages: A24-1'. Accessed 9 December.
- Dorny, L. (npodorny@foxinternet.net) 1999b. Re: 'Patrol Wing Ten - #41'. E-mail to Silvano Jung (s_jung@banks.ntu.edu.au) 18 June.
- Dorny, L. (npodorny@foxinternet.net) 2000a. Re: 'Photos of PatWing-10 in Darwin'. E-mail sent to PBY@egroups.com. 31 March.
- Dorny, L. (npodorny@foxinternet.net) 2000b. Re: 'Conflicting aircraft numbers'. E-mail sent to PBY@egroups.com. 14 April.
- Douglas, R. (rmdover2u@earthlink.net) 1999. Re: 'PBY-3 and PBY-4 Identities'. E-mail sent to PBY@egroups.com. 29 August.
- Eames, J. 1999. *The Searchers and their endless quest for lost aircrew in the Southwest Pacific*. University of Queensland Press, St Lucia, Queensland.
- Edmonds, W. 1951. *They fought with what they had: the story of the Army Air Forces in the Southwest Pacific, 1941-1942*. Little, Brown and Company, Boston.
- Environment Protection Unit (EPU). 1994. *Darwin port expansion - East Arm*. Department of Lands, Planning & Environment (formerly the Conservation Commission of the Northern Territory), Darwin.
- Flight. 1939. 'Pictorial Specification: A Photographic Study of a Notable American Flying Boat'. *Flight*. Vol. 10:A - E.
- Florian, M. 1987a. 'The underwater environment'. In Pearson, C. (ed.) *Conservation of Marine Archaeological Objects*. Butterworth & Co., London:1-19.

- _____ 1987b. 'Deterioration of organic materials other than wood'. In Pearson, C. (ed.) *Conservation of Marine Archaeological Objects*. Butterworth & Co., London:21-98.
- Freeman, B. 1995. *Lake Boga at war*. Catalina Publications, Swan Hill.
- Gadja, S. 1980. 'Air - raid on Broome'. *After the Battle*. Vol. 7 (28):44-48.
- _____ 1983. 'To identify a wartime wreck'. *Book of Flying*. Yaff Publishing Group.
- Gaunt, C. and Cleworth, R. (eds) 2000. *Cats at war: the story of RAAF Catalinas in the Asia-Pacific Theatre of War*. Published by J. R. Cleworth, 7 Wandella Avenue, Roseville 2069, Australia.
- Giannitrapani, M., McDonald, D. and Colla, A. 2000. 'Sole Survivor'. *Classic Wings Downunder*. Issue 27:14-17.
- Gill, G. 1957. *Royal Australian Navy 1939-1942*. Australian War Memorial, Canberra.
- Gould, R. 1983. 'The archaeology of war: Wrecks of the Spanish Armada of 1588 and the Battle of Britain, 1940'. In Gould, R. (ed.) *Shipwreck anthropology*. The School of American Research, University of New Mexico Press, Albuquerque:105-142.
- Graham, W. (wbg@bigpond.com) 1999a. Re: 'VP5 PBY3(?)'. E-mail sent to PBY@egroups.com. 8 September.
- Graham, W. (wbg@bigpond.com) 1999b. Re: 'U.S. Navy PBY-4 wrecks'. E-mail sent to PBY@egroups.com. 27 August.
- Green, J. 1996. 'Management of maritime archaeology under Australian legislation'. In Smith, L. and A. Clarke (eds). *Tempus: Issues in management archaeology*. Vol. 5:85-98.
- Griffiths, O. 1942. *Darwin Drama*. Bloxham, Sydney.
- Heritage Advisory Committee (HAC). (n.d.) Northern Territory of Australia Heritage Conservation Act 1991 Heritage Assessment Criteria. Not published. Heritage Advisory Council, Darwin.
- Hanks, P. (ed.) 1979. *Collins dictionary of the English language*. Collins Publishers Pty. Ltd., Sydney.
- Hanley, R. 1988. 'Invertebrate Fauna of Marine Habitats in Darwin Harbour'. In Larson, H., Michie, M. and Hanley, R. (eds) *Darwin Harbour*. Australian National University North Australia Research Unit, Mangrove Monograph No. 4:135-152.
- Hall, T. and Hall, E. 1979. *The observer's book of civil aircraft of Australia and New Zealand*. Methuen of Australia, Sydney.
- Hargrave, W. 1942. Survival report of Ens. W. W. Hargrave, USNR, 5 February - 22 May 1942. Naval Historical Centre, Washington D.C.
- Henderson, G. 1988. 'The archaeological value of iron vessels and steamships'. In McCarthy, M. (ed.) *Iron ships and steam shipwrecks. Papers from the first Australian Seminar on the management of iron vessels and steam shipwrecks*. W.A. Museum, Perth:1-12.
- Hendrie, A. 1988. *Flying Cats: The Catalina aircraft in World War II*. Naval Institute Press, Annapolis.

- Hiscock, P. 1994. 'Coming to terms with the Northern Territory Heritage Conservation Act 1991'. *Australian Archaeology*. No. 38:55-60.
- Hoffman, C. 1998. 'Whose planes are they, anyway?'. *Air&Space*. October/November:37-43.
- Honan, R. 1989. *That's That*. Lutheran Publishing House, Adelaide.
- Joll, T. 1982. 'When World War II came to the Swan'. *Western Mail*. February/March:20.
- Jung, S. 1996a. Northern Territory shipwreck database (NTSD). Unpublished report to the Commonwealth Department of Communications and the Arts, Canberra.
- _____ Jung, S. 1996b. 'Archaeological investigations of the Catalina wreck sites in East Arm, Darwin Harbour'. *Bulletin of the Australian Institute for Maritime Archaeology*. Vol. 20 (2):23-40.
- Katz, L. (papakatz@mail.arkansas.net) 1999. Re: 'U.S. Navy PBY-4 wrecks'. E-mail sent to PBY@egroups.com. 26 August.
- Kinzey, B. 2000. *PBY Catalina in detail and scale*. Detail & Scale, Inc., Carrollton, Texas.
- Knott, R. 1979. *The American Flying Boat: an illustrated history*. The United States Naval Institute, Maryland.
- _____ 1981. *Black Cat Raiders of WW II*. Zebra Publishing Corporation. New York.
- Leach, J. 1999. *RAAF Flying Boats at War*. Australian Military History Publications, Loftus N.S.W.
- LeBaron, A. (allan_lebaron@hotmail.com) 1999a. Re: '22-P-41 BUAERNO'. E-mail sent to PBY@egroups.com. 17 June.
- LeBaron, A. (allan_lebaron@hotmail.com) 1999b. Re: 'PBY-4 as paddlewheel houseboat'. E-mail sent to PBY@egroups.com. 21 June.
- LeBaron, A. (allan_lebaron@hotmail.com) 2000a. Re: 'Self sealing fuel tanks'. E-mail sent to PBY@egroups.com. 7 June.
- LeBaron, A. (allan_lebaron@hotmail.com) 2000b. Re: 'photos of Patwing Ten in Darwin'. E-mail sent to PBY@egroups.com. 24 March.
- LeBaron, A. (allan_lebaron@hotmail.com) 2000c. Re: Catalina's flying today. E-mail sent to PBY@egroups.com. 28 April.
- Leebold, A. 1995. *Silent victory: breaking the Japanese air-blockade between Australia and Europe*. Banner Books, Belconnen, A.C.T.
- Lemonnier, P. 1989. 'Bark capes, arrowheads and Concorde: on social representations of technology'. In Hodder, I. (ed.) *The meanings of Things*. Unwin Hyman, London.
- Lewis, T. 1991. 'Darwin Marine Wrecks - Important but Ignored'. *Northern Perspective*. Vol. 14 (2). Northern Territory University, Darwin:1-11.
- _____ 1992. *Wrecks in Darwin Waters*. Turton & Armstrong Pty. Ltd., Wahroonga, NSW.

- _____ 1995. 'Darwin's Catalinas'. In Crowe, S. (ed.) *Scuba Diver*. Yaffa Publishing Group, Surrey Hills, New South Wales:24-26.
- Marquis-Kyle, P. and Walker, M. 1992. *The Illustrated Burra Charter: making good decisions about the care of important places*. Australian Heritage Commission, Australian ICOMOS Inc., Prestige Litho, Brisbane.
- McCarthy, M. 1996. SS Xantho: Towards a new perspective. An integrated approach to the maritime archaeology and conservation of an iron steamship wreck. Unpublished Ph. D. thesis, James Cook University of North Queensland.
- _____ 1997. The Black Cats - Report into the feasibility of locating, raising and conserving one of the four Catalina Flying Boats scattered off Rottneest Island in the years 1945-46. Unpublished report, Department of Maritime Archaeology, WA Maritime Museum, No. 125.
- _____ 1998. 'The submarine as a class of archaeological site'. *The Bulletin of the Australian Institute for Maritime Archaeology*. Vol. 22:61-70.
- McCarthy, S. 1992. *World War II shipwrecks and the first Japanese air raid on Darwin 19 February 1942*. Technical Report Series No. 1. Northern Territory Museum of Arts & Sciences, Darwin.
- McDonell, R. 1995. *Australian Salvors of World War 2*. Polly Woodside Publishers, Melbourne.
- McLachlan, I. 1989. *Final Flights: Dramatic wartime incidents revealed by aviation archaeology*. Patrick Stephens Ltd., Somerset.
- _____ and Zorn, R. 1992. *Eighth Air Force Bomber Stories*. Patrick Stephens Ltd., Somerset.
- _____ 1994. *Night of the Intruders*. Patrick Stephens Ltd., Somerset.
- McLaren, I. 1958. *Australian Aviation: a bibliographical survey*. Published by the author. Originally published in: *The Victorian Historical Magazine*. Copy held in author's collection.
- McMillan, A. 1994a. Transcript of interview with Jim Rodgers by Andrew McMillan 1994. Unpublished oral history. Copy held at the Museum & Art Gallery of the Northern Territory, Darwin.
- _____ 1994b. Transcript of interview with Alic Emslie by Andrew McMillan. Unpublished oral history. Copy held at the Museum & Art Gallery of the Northern Territory, Darwin.
- Messimer, D. 1985. *In the Hands of Fate - The story of Patrol Wing Ten. 8 December 1941 - 11 May 1942*. Naval Institute Press. Annapolis, Maryland.
- Milbrooke, A., Andrus, P., Cook, J. and Whipple, D. 1998. *National Register Bulletin: guidelines for evaluating historic aviation properties*. U.S. Department of the Interior, National Parks Service, National Register of Historic Places.
- Minty, A. 1994. *Black Cats*. RAAF Museum, Point Cook, Victoria.
- Moorer, T. 1986. 'APBY Meets with Destiny'. In Mason, J. (ed.) *The Pacific War remembered: an oral history collection*. Naval Institute Press, Annapolis, Maryland.
- Muckelroy, K. 1978. *Maritime Archaeology*. Cambridge University Press, London.

Murgatroyd, W., Jung, S. and Oliver, K. 2001. EIS anthropological component: GTL Resources methanol plant, Darwin. Report 1, Pipeline Route – GTL Resources Plant to East Arm Port. Unpublished report for URS/Dames & Moore, Level 1 Arkaba House, Darwin NT 0801.

National Archives of Australia. Series: A705/1. Item: 9/30/203. Title: DTS [Directorate Technical Services] - Catalina aircraft [PB5Y-5A] - landing gear - removal. National Archives of Australia, Canberra, A.C.T.

_____ Series: A705/1. Item: 32/17/263. Title: Accident to: - Catalina A24-1. Date: 30.8.45. Locality: - East Arm. Darwin. National Archives of Australia, Canberra, A.C.T.

_____ Series: A705/1. Item: 32/17/270. Title: Accident to: - Catalina A24-69. Date: 14.12.45. Locality: - East Arm. National Archives of Australia, Canberra, A.C.T.

_____ Series: A705/7. Item: 171/6/218. Title: Darwin NT - Flying Boat base and marine section at East Arm. National Archives of Australia, Canberra, A.C.T.

_____ Series: A1608/1. Item: K17/1/2 Part 1. Title: War - 1939 PB5Y Flying Boats. Part One. National Archives of Australia, Canberra, A.C.T.

_____ Series: A1608/1. Item: K17/1/2 Part 2. Title: War - 1939 PB5Y Flying Boats. Part Two. National Archives of Australia, Canberra, ACT.

_____ Series: AWM64. Title: Operations Record Book No 43 Squadron 1/5/1943 to 31/10/1945. National Archives of Australia, Canberra, A.C.T.

_____ Series: A9186/16. Item: 405. Title: RAAF unit History sheets (Form A50) Flying Boat Maintenance Unit (FBMU) 1 and 2 Jun 42 - Oct 45. National Archives of Australia, Canberra, A.C.T.

_____ Series: A9845/1. Item: Box 11. RAAF - Aircraft crash reports [flying accidents] - Sunderland, Catalina, CA4 Fighter, Moth Minoi. National Archives of Australia, Canberra, A.C.T.

_____ Series: A10297/1. Item: Block 141. Title: Aircraft status cards - Catalina A24-1 to A24-99. National Archives of Australia, Canberra, A.C.T.

_____ Series: A10297/1. Item: Block 143. Title: Aircraft status cards - Catalina A24-200 to A24-206. National Archives of Australia, Canberra, A.C.T.

_____ Series: MP238/1/0. Item number: 8/115/205. Item title: Movement of Empire Flying Boat, G-AEUF "Corinthian". Melbourne Archives Centre, Victoria.

Nevitt, D. 1996. 'IJN Maikaze: Tabular Record of Movement'. (http://www.skypoint.net/~jbp/maikaz_t.htm). Accessed 15 June.

Neyland, R. and Grant, D. 2000. 'Navy Aircraft as artifacts'. (<http://www.history.navy.mil/branches/org12-7f.htm>). Accessed 8 May.

Northern Territory Government. 1991. *Northern Territory Heritage Conservation Act 1991*. Government Printer of the Northern Territory, Darwin.

Northern Territory News. 1992. 'Battle pilot finds his old plane wreck'. *Northern Territory News*. 12 May:1.

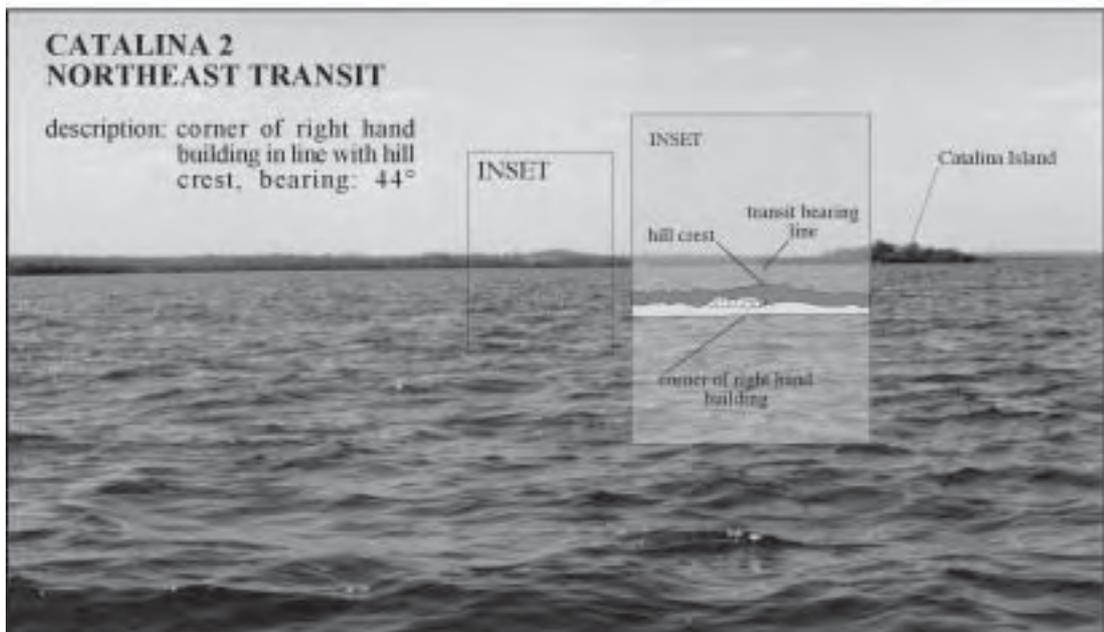
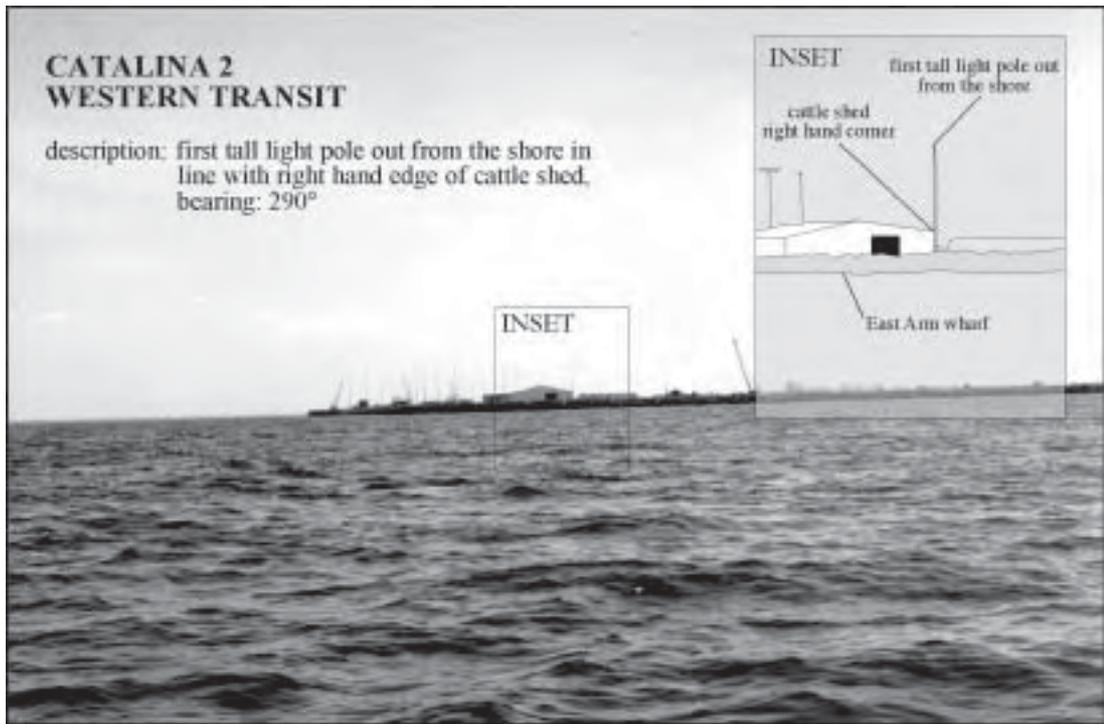
- Nutley, D. 1998. 'Ten years of shipwreck access and management practices in new South Wales'. *Bulletin of the Australian Institute for Maritime Archaeology*. Vol. 22:115-118.
- O'Beirne, F. 1945. Supplementary report on details concerning Japanese air attack on Darwin on February 19, 1942. Unpublished. Copy held at the Naval Historical Centre, Washington DC.
- PatWing Ten War Diary, February 1942. Microserial 41176. Naval Historical Centre, Washington.
- Pearcy, A. 1996. *Lend-Lease aircraft in World War II*. Airlife Publishing Ltd., England.
- Plumber, S. 2000. 'WWII fighter found on Bathurst Island'. *Northern Territory News*. 26 May:7.
- Powell, A. 1992. *The Shadow's Edge: Australia's northern war*. Melbourne University Press, Melbourne.
- _____ 1996. *War by Stealth: Australians and the Allied Intelligence Bureau 1942-1945*. Melbourne University Press, Melbourne.
- Prime, M. 1985. *WA's Pearl Harbour: the Japanese raid on Broome*. Royal Australian Air Force Association, Bullcreek, Western Australia.
- _____ 1998. *Broome's one day war: the story of the Japanese raid on Broome on 3rd March 1942*. Broome Historical Society, Broome.
- RAAF Historical and Archives. 1945. 'Aircraft Accident Data. Catalina A24-205'. RAAF Historical and Archives, Canberra, ACT.
- Prossor, D. 2001. 'WW2 Beaufort wreck and crew discovered'. *Australian Aviation*. May:77.
- Raleigh, J. 1943. *Pacific Blackout*. Dodd and Mead, New York.
- Riddell, J. 1992. *Recounting the operations of RAAF Catalinas*. Murwillumbah Print Spot, Murwillumbah, N.S.W.
- Riley, J. 1988a. 'Isometric recording of high profile sites'. In McCarthy, M. (ed.) *Iron ships and steam shipwrecks. Papers from the first Australian Seminar on the management of iron vessels and steam shipwrecks*. W.A. Museum, Perth:68-69.
- _____ 1988b. 'The waterline theory of iron ship disintegration'. In McCarthy, M. (ed.) *Iron ships and steam shipwrecks. Papers from the first Australian Seminar on the management of iron vessels and steam shipwrecks*. W.A. Museum, Perth:191-197.
- _____ 1996. 'Low cost "Zs"'. *Bulletin of the Australian Institute for Maritime Archaeology*. Vol. 20 (2):54.
- Robertson, B. 1977. *Aviation archaeology: a collector's guide to aeronautical relics*. Patric Stephens, Ltd., Cambridge.
- _____ 1989. *Final Flights*. Patric Stephens, Ltd., Cambridge.
- Rodgers, B., Coble, W. & Van Tilburg, H. 1998. 'The lost flying boat of Kaneohe Bay: archaeology of the first U.S. Casualties of Pearl Harbor'. *Historical Archaeology*. Vol. 32 (4):8-18.

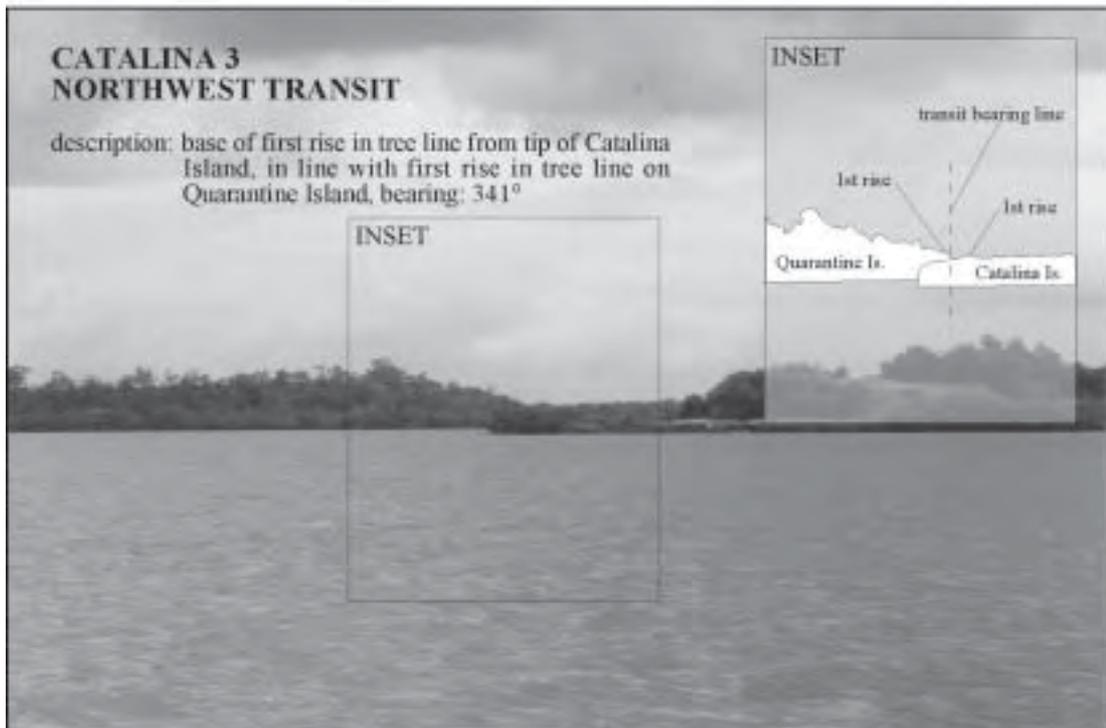
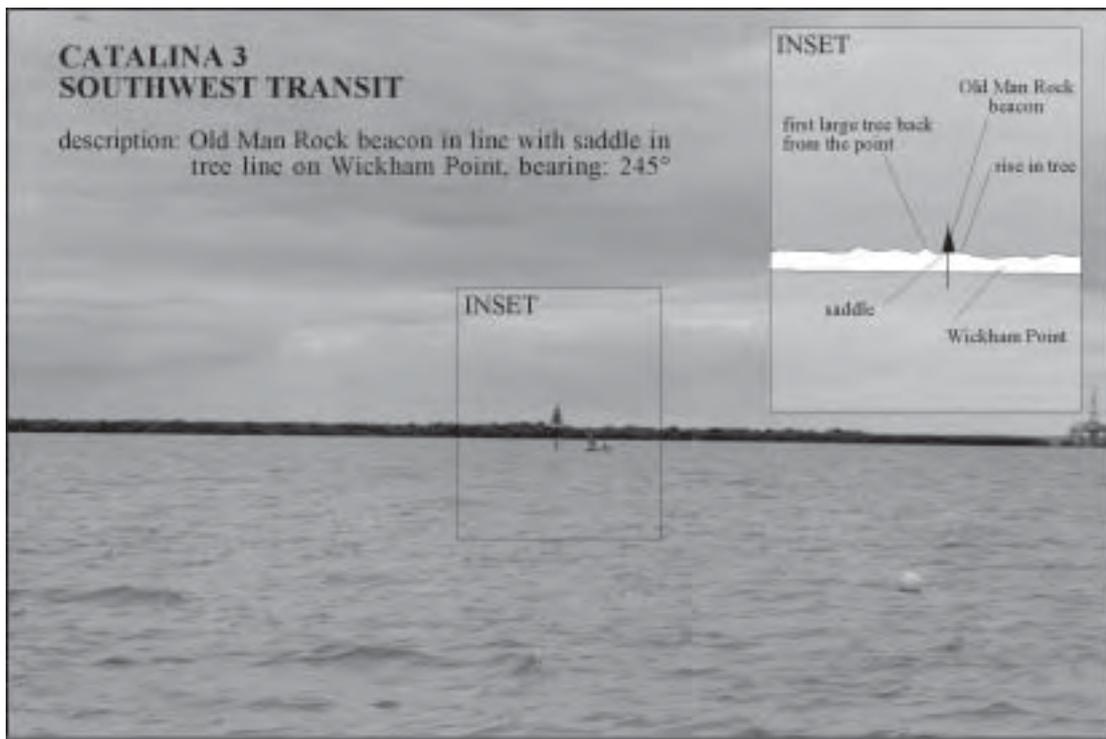
- Rorrison, J. 1992. *Nor the years contemn: air war on the Australian front 1941-1942*. Palomar Publications. James Ferguson Pty. Ltd., Hamilton Central Queensland.
- Sawruk, J. (jsawruk@juno.com) 1999a. Re: 'U.S. Navy PBV-4 wrecks'. E-mail sent to PBV@egroups.com. 27 August.
- Sawruk, J. (jsawruk@juno.com) 1999b. Re: '22-P-41 BUAERNO'. E-mail sent to PBV@egroups.com. 16 June.
- Scarborough, W. 1983. *PBV Catalina in Action*. Squadron/Signal Publications, Inc., Carrollton, Texas.
- _____ 1995. *Walk Around: PBV Catalina*. Squadron/Signal Publications, Inc., Carrollton, Texas.
- Semeniuk, V. 1985. 'Mangrove environments of Port Darwin, Northern Territory: the physical framework and habitats'. *Journal of the Royal Society Western Australia*. Vol. 67:81-97.
- Smith, A. 1991. *Convoys up the track: a history of 121st Australian General Transport Company (AIF) 1941-1946*. Published by the author in association with A.C. Smith Pty. Ltd., Griffin Press Ltd., Netley.
- _____ 2000. (2nd ed.) *Convoys up the track: a history of 121st Australian General Transport Company (AIF) 1941-1946*. Published by the author in association with A.C. Smith Pty. Ltd., Griffin Press Ltd., Netley.
- Smith, D. and Davis, P. 1980. *Kookaburra: the most compelling story in Australia's aviation history*. Lansdowne Press, Sydney.
- Smith, T. 1998. Project AE2: investigation of the H.M.A. [sic] AE2 submarine wreck site. Turkey, October 1998. Unpublished. NSW Heritage Office, Sydney, New South Wales.
- _____ 1999. 'Submarines by the sea full: The Pacific's unique archaeological resource'. *Bulletin of the Australian Institute for Maritime Archaeology*. Vol. 23:79-85.
- South, S. 1981. 'Research strategies in Historical Archaeology: the scientific paradigm'. In Gould, R. and Schiffer, M. (eds) *Modern Material Culture: the archaeology of us*. Academic Press, New York:1-12.
- Sullivan, M. and Carment, D. 1992. *Cultural heritage conservation in the Northern Territory*. Darwin: North Australian Research Unit. The Australian National University. Discussion paper No. 10:1-27.
- Spennemann, D. 2000. 'Essays on the Marshallese Past: Aviation Archaeology in the Marshall Islands'. (<http://life.csu.edu.au/marshall/thml/essays/es-ww2-6.html>). Accessed 23 February.
- Tennant & District Times. 1986. 'Old Catalina flies out'. *Tennant & District Times*. Friday, 26 September.
- The Sunday Mail. 1992. 'Search on for fighter'. *The Sunday Mail*. 3 May 1992:37.
- Trotzig, G. 1986. 'The cultural dimension of development - an archaeological approach'. In Cleere, H. (ed.) *Archaeological heritage management in the modern world*. Unwin Hyman, London.

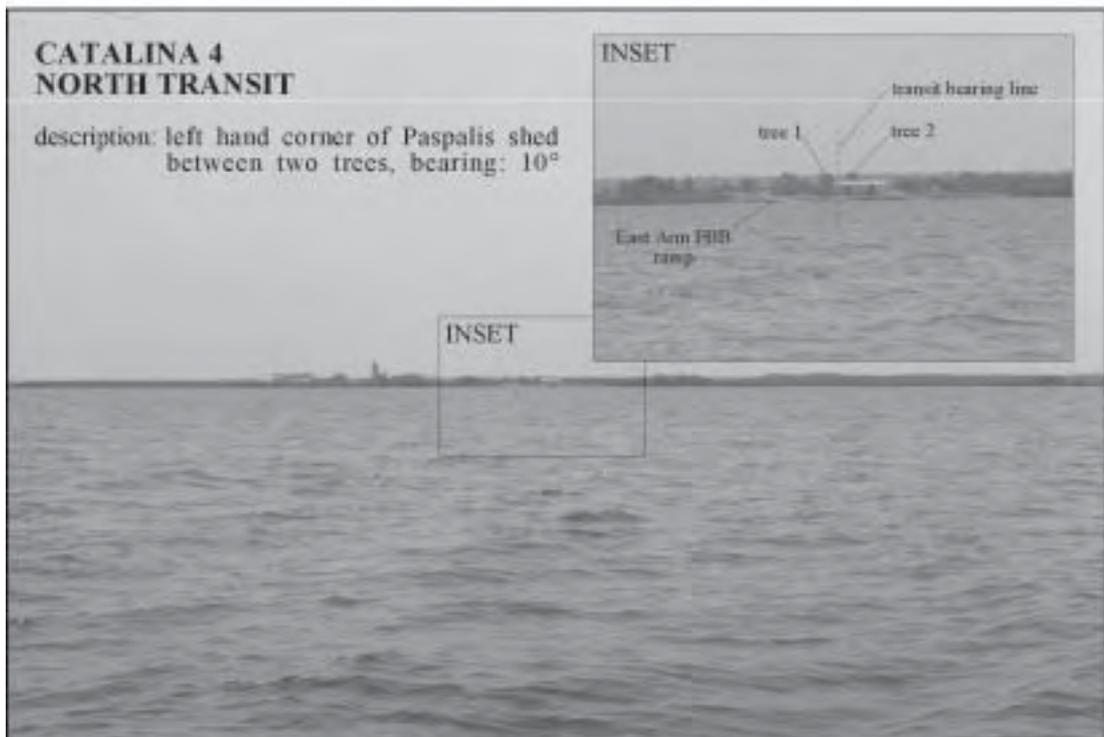
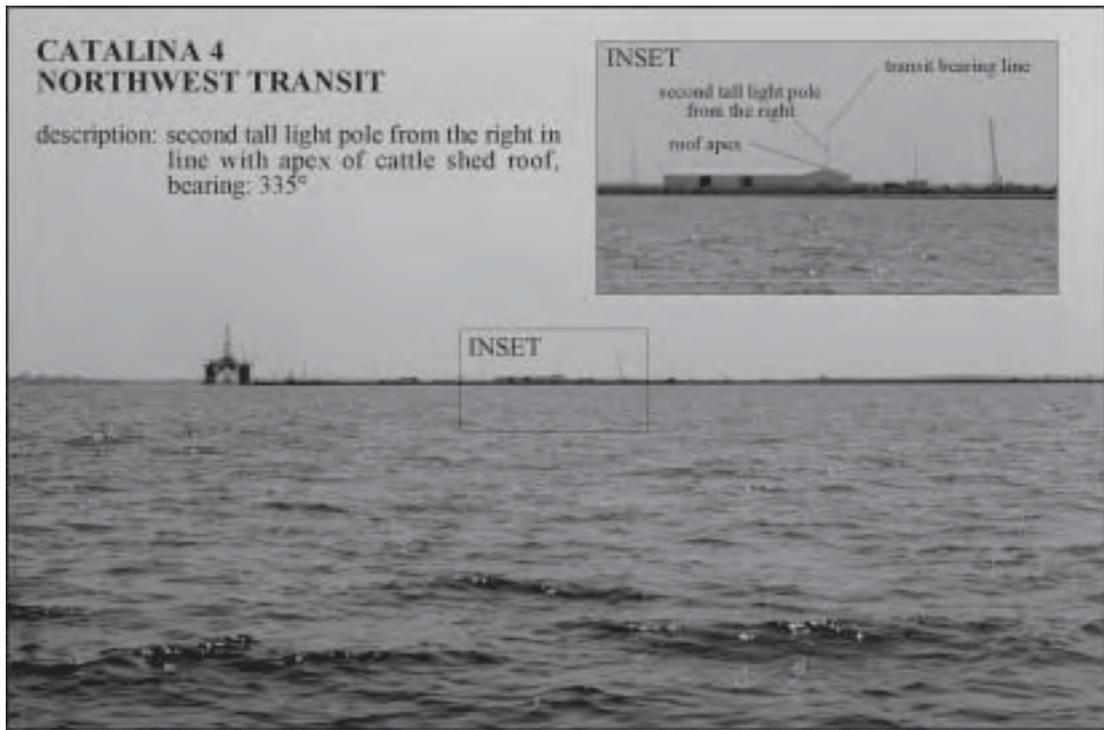
- Vernon, D. 1994. 'Sinking of the Japanese troop ship "Nichiryu Maru"'. In Minty, A. *Black Cat*. Point Cook RAAF Museum, Point Cook:31-35.
- Vetaffairs. 2000. 'Military funeral for WWII airmen'. *Vetaffairs: a newspaper for the veteran community*. Vol. 16, No. 4. December:5.
- Vincent, D. 1981. *Catalina Chronicle*. Published by the author through LPH, Adelaide.
- Wagner, R. 1968. (2nd ed.) *American combat planes*. Doubleday & Company, Inc., Garden City, New York.
- _____ 1972. *The story of the PBY Catalina*. Flight Classics, San Diego.
- _____ 1976. *Reuben Fleet and the story of Consolidated Aircraft*. Aero Publishers, Inc., Fallbrook, California.
- War Department. 1944. *Handbook on Japanese Military Forces*. War Department, United States Government Printing Office, Washington.
- West, A. 1989. 'A fighter's rescue from a watery grave'. *Australian Geographic*. April/June:17-18.
- Whipple, D. 1995. 'Aircraft as cultural resources: the Navy approach'. *CRM*. (2):10-12.
- Wilson, S. 1991. *Catalina, Neptune and Orion in Australian service*. Aerospace Publications Pty. Ltd., Weston Creek, ACT.
- Wittenberg, E. (ewitten507@aol.com) 1999. Re: 'Liberty Bell Space Capsule'. E-mail sent to: MARHIST-L@post.queensu.ca. 21 June.

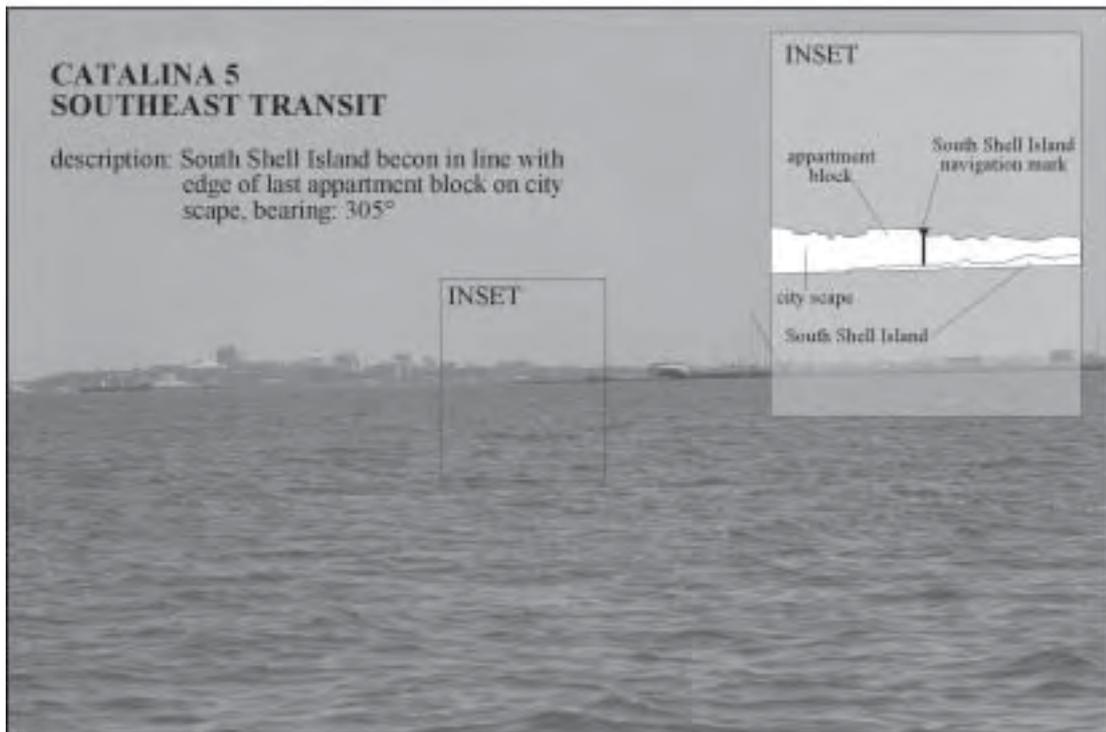
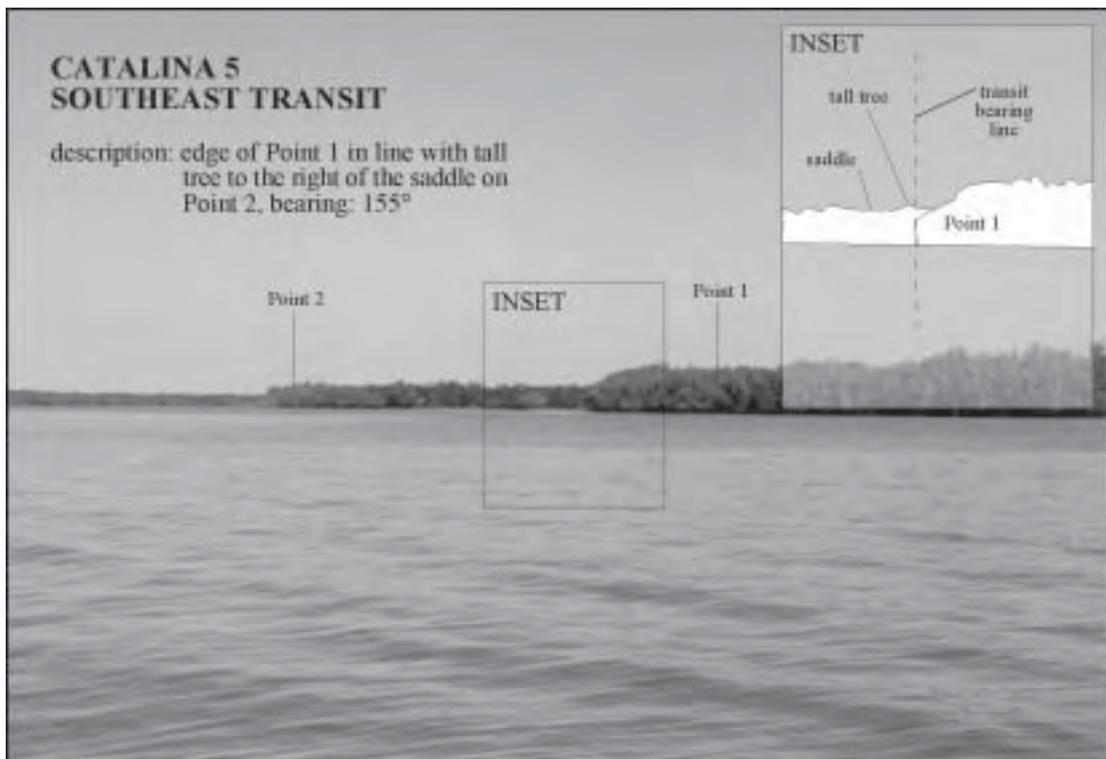
APPENDIX 1:

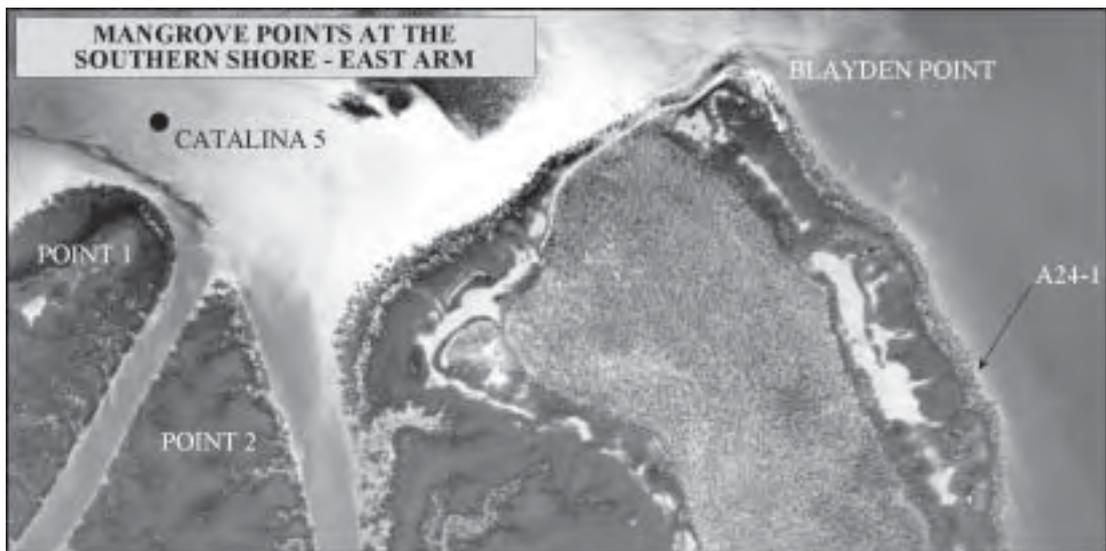
Photographic transit marks for the Darwin Harbour Catalina Flying Boat wreck sites











Maps NT. Department of Lands, Planning and Environment, 1997. Aerial photograph: NTC1352, 30/8/97, Run 6, Darwin Rural, Skymap 1:20000. Northern Territory Government, Darwin.

APPENDIX 2:

Specifications for the types of Catalina lost in Darwin Harbour

Model	PBY-4	PBY-5 (Model 28-5MNE)	PBY-5	PBY-5A (M)	PB2B-1
Aircraft lost	US Navy #4 and #8	US Navy #41	RAAF A24-1	RAAF A24-69	RAAF A24-205 and A24-206
Wing span (ft)	104 31.72 m	104 31.72 m	104 31.72 m	104 31.72 m	104
Length (ft-in)	65-2	63-10	63-10	63-10	63-10
Height (ft-in)	18-6 5.64 m	18-11	18-11	20-2	20-2
Wing area (sq ft)	1 400	1 400	1 400	1 400	1 400
Weight (lbs) empty /gross/max	16 837 / 24 813 / 32 011	17 400 / 26 200 / 33 389	17 400 / 26 200 / 33 389	20 910 / 33 975 / 35 300	33 133
Fuel capacity (gal)	1 750	1 260 - 1 750	1 260 - 1 750	603 - 1 478	?
Power plant (x2)	R-1830-72	R-1830-82	R-1830-82	R-1830-92	R-1830-92
Engine make	Twin Row Wasps	Twin Row Wasps	Twin Row Wasps	Twin Row Wasps	Twin Row Wasps
Propellers	Pratt and Whitney	Pratt and Whitney	Pratt and Whitney	Pratt and Whitney	Pratt and Whitney
Manufacturer	Hamilton Standard constant speed and feathering	Hamilton Standard constant speed and feathering	Hamilton Standard constant speed and feathering	Hamilton Standard constant speed and feathering	Hamilton Standard constant speed and feathering
Place built	Consolidated	Consolidated	Consolidated	Consolidated	Boeing
State/Province	San Diego	San Diego	San Diego	San Diego	Vancouver
Country	California	California	California	California	British Columbia
Horse power	USA	USA	USA	USA	Canada
Maximum speed (Mph/Alt)	1 050 T/O / 900 @ 12 000	1 200 T/O / 1 050 @ 5 700	1 200 T/O / 1 050 @ 5 700	1 200	?
Cruising speed (mph)	197/12 000, 176 @ s.l.	200/5 700, 189 @ s.l.	200/5 700, 189 @ s.l.	179/7 000	187/7 000
Landing speed (mph)	115	110	110	117	117
Ceiling (ft)	71	72	72	78	?
Absolute Ceiling (ft)	24 100	21 600	21 600	14 700	15 800
Range (mi)	2 070 normal	1 945 normal	1 945 normal	2 545 normal	?
	1 285/2 000 lbs bombs	1 245/2 000 lbs bombs	1 245/2 000 lbs bombs	1 820/2 000 lbs bombs	2 690 normal
	4 430 max	1 895 max	1 895 max	? max	?
Climb Ft/Min	870/1	990/1	990/1	518/1	?
T/O Time calm sea	25	25	25	30	?
Crew	8	9	9	9	9
Armament	OFFENSIVE four 500 lb (227 kg) or 1 000 lb (454 kg) bombs or four 325 lb (147 kg) depth charges or two torpedoes on underwing hard points DEFENSIVE two 0.30 in Browning machine guns, one in bow turret with 1 000 rounds, one in tunnel position with 500 rounds, One 0.50 in Browning machine gun in each waist position (x2) with 800 rounds per gun	OFFENSIVE four 500 lb (227 kg) or 1 000 lb (454 kg) bombs or four 325 lb (147 kg) depth charges or two torpedoes on underwing hard points DEFENSIVE two 0.30 in Browning machine guns, one in bow turret with 1 000 rounds, one in tunnel position with 500 rounds, One 0.50 in Browning machine gun in each waist position (x2) with 800 rounds per gun.	OFFENSIVE four 500 lb (227 kg) or 1 000 lb (454 kg) bombs or four 325 lb (147 kg) depth charges or two torpedoes on underwing hard points DEFENSIVE three 0.30 in Browning machine guns, two in bow turret with 1 000 rounds, one in tunnel position with 500 rounds, One 0.50 in Browning machine gun in each waist position (x2) with 800 rounds per gun. Note: WWT Lewis machine guns were fitted on A24-1 (Riddle 1992: Photo page 5).	OFFENSIVE four 500 lb (227 kg) or 1 000 lb (454 kg) bombs or four 325 lb (147 kg) depth charges or two torpedoes on underwing hard points DEFENSIVE three 0.30 in Browning machine guns, two in bow turret with 1 000 rounds, one in tunnel position with 500 rounds, One 0.50 in Browning machine gun in each waist position (x2) with 800 rounds per gun	OFFENSIVE four 500 lb (227 kg) or 1 000 lb (454 kg) bombs or four 325 lb (147 kg) depth charges or two torpedoes on underwing hard points DEFENSIVE three 0.30 in Browning machine guns, two in bow turret with 1 000 rounds, one in tunnel position with 500 rounds, One 0.50 in Browning machine gun in each waist position (x2) with 800 rounds per gun

APPENDIX 3:

**NOTES ON NAVIGATION PROCEDURE FLIGHT
OF CONSOLIDATED CATALINA AH534
SAN DIEGO TO SYDNEY
JANUARY 1941**

(Series: A1196/6, Item: 37/501/42. Title: 'Reports on delivery flights to Australia'.
National Archives of Australia, Canberra, A.C.T.)

San Diego to Honolulu. The aircraft departed San Diego at 2349 G.M.T. on a heading 231° true for a point in Lat. $23^{\circ} 30' N$. Long $130^{\circ} 00' West$ and thence direct to Honolulu. This southerly diversion from the direct line was taken to avoid adverse weather conditions reported by Pan American Airways' meteorological section.

The flight was made on dead reckoning until 0252 G.M.T., when a position line from Sirius, nearly abeam, combined with the dead reckoned distance run, showed the aircraft to be 28 miles south off the course. Course was then altered to make up the leeway and further series of sights of Jupiter, Sirius and Polaris showed the aircraft to be making good the course for the point mentioned above.

Radio bearings were received half hourly from Station KNDB, San Francisco. As was expected from recorded experience there was considerable discrepancy in these bearings. There was, however, a greater tendency to accuracy with distance out from the land, the bearings being considerably more accurate 1000 miles from the station than when close in to the coast of California.

At 0725 G.M.T. the aircraft was estimated to be at the point in Lat. $23^{\circ} 30' N$. Long. $130^{\circ} 00' West$, and course was accordingly altered to 265° true for Honolulu. Sights of Polaris and Jupiter were taken soon after alteration of course as a check against the previously estimated position.

Further star sights were taken at convenient intervals to check progress on the course for Honolulu. For this purpose any star which was conveniently ahead or astern was combined with latitudes from Polaris to give this information.

Throughout the night, flight was maintained at 5000 feet above strato cumulus cloud, the top of which averaged 3000 feet. No drift sights were taken owing to the absence of sufficiently large areas of cloud-free space below and the length of time necessary to rig the tail drift sight provided. Owing to the perfect conditions for astronomical navigation, a better indication could be obtained from a series of star sights.

When half way to Honolulu radio bearings were being received from both San Francisco and Honolulu were consistently in the region of 150 miles north of the estimated position. Some deflection of these bearings was expected owing to the situation of the Honolulu station relative to the aircraft's position. As the line of positions from star sights consistently showed the aircraft to be holding the course, the radio bearings from Honolulu were recorded but not used at this stage.

Regular progress was maintained throughout the night till 1400 G.M.T. when, owing to some uncertainty as to the amount of fuel remaining in the tanks it was considered advisable to alter course for Upolu Point, the north point of the Island of Hawaii, to bring the aircraft within reach of Hilo base on that island, some 200 miles closer than Honolulu.

Perfect flight conditions continued and progress was regular for Upolu Point. Shortly after dawn, however, and when still 500 miles from Honolulu, the Consolidated Aircraft Corporation's pilot in charge of the aircraft to Honolulu informed me that he proposed to fly the aircraft on the radio homing device, homing on Hilo station. He did not inform me as to his reasons for adopting this procedure. I believe, however, that the difference between the radio bearings received from Honolulu and the positions shown by astronomical navigation led him to adopt this course. So far as was possible in the circumstances, I continued to estimate and to report the position of the aircraft throughout considerable variations of course which followed. Eventually, however, because the aircraft was not, in my opinion, headed for the Hawaiian Islands at all, and because there appeared to be insufficient fuel for any considerable diversion, I strongly suggested to the Captain that a course be set and steered on the compass for the north

point of the island of Hawaii. This procedure was adopted, and the aircraft was brought back on to her course. A line from the sun was taken as a check on distance run and frequent bearings of the aircraft were taken from and reported by the Honolulu station. The accumulated evidence was combined with dead reckoning to bring the aircraft direct for Honolulu as soon as it was shown that progress justified a direct course being set for the original objective. At 1930 G.M.T. the island of Maui was sighted on the port bow, and also the 13,000 ft peak of Mauna Kea on Hawaii, bearing south, estimated 70 miles. The remainder of the flight was made by contact, the aircraft passing between Maui and Molokai, along the south shore of that island, and in to Honolulu.

Honolulu to Canton Island. Departure was made from Pearl Harbour at 1710 G.M.T. direct for Canton Island, on a course of 209° True for the island. Height was maintained between 700 and 1500 feet for the first 5 hours, and the course steered was based on accumulated evidence of radio bearings from Honolulu, drift sights when possible, and forecasts from Pan American Airways meteorological section.

At 1950 a line from the sun parallel to the course was obtained and was in agreement with radio bearings of 211° received from Honolulu.

Deviation of the compass was determined by Sun bearings with the Gurley Pelorus. Deviation recorded as 2° West at San Diego was shown to be 7° West.

At 2130 a line from the Sun combined with dead reckoned distance run showed the position to be Lat. $14^{\circ} 28' N$. Long. $162^{\circ} 23'' W$., 17 miles west of the course. At this point there was a sudden swing in the radio bearings, which had remained practically constant over a distance of 600 miles, from 211° , in a period of 25 minutes, to 216° . Later bearings remained at 216° , but as the sun had gone too far ahead to give any reliable indication of distance off course no further check on course at this or any subsequent period of the flight could be obtained from the Sun. Further procedure adopted was therefore based upon a combination of dead reckoning and radio bearings.

At 0005 G.M.T. the distance run was determined from the Sun, at that time bearing dead ahead.

At 0042 G.M.T. a bearing of 19° was received from Canton Island.

Another Sun line was taken at 0126 G.M.T., and a further check on distance run obtained.

Radio bearings from Canton Island remained consistently west of the course, swinging in to some extent, though course was not altered, as distance was made towards the objective. Apart from two short diversions for weather course was held until within 250 miles of Canton Island when a consistent [sic] swing of the bearings showed that the aircraft would pass west of the island. Course was then altered until the bearings remained constant. Canton Island light was sighted at 0650 G.M.T. and the aircraft was over the island at 0715.

Radio bearings from both Honolulu and Canton Island on this section of the flight were sufficiently reliable up to 1000 miles to give a fair indication of direction, accuracy increasing to fine limits as distance decreased. Without radio assistance accurate approach to Canton Island could not be relied upon, since the island is so low and small that it would be possible to run by it a mile off in rain without sighting it. The recorded experience of Pan American Airways and the experience of this flight has shown very good results from the Canton Island station. Throughout this and all other sections of the flight maximum possible assistance was received from the Radio Operator in the aircraft in providing information for navigation purposes.

It should be recorded that sufficiently accurate approach to Canton Island could be relied upon by astronomical methods only in the most favourable circumstances of available astronomical

bodies and visibility at the island. It follows that flight for this island should be made only with absolutely reliable and adequate radio facilities, both in the aircraft and at the ground station.

Canton Island to Noumea. This flight was made through the night, with departure from Canton Island at 0500 G.M.T. Deviation recorded at San Diego as 2° West was shown to be 0° . Bearings from Canton Island showed the aircraft to be making 2° of leeway to starboard. As these bearings were consistent over a period of 3 hours, and were likely to be reliable, allowance was made accordingly. At suitable intervals throughout the night stars were taken and resulting lines, and positions, used as a basis for holding the aircraft to the course for Noumea.

According to the information desired at the time a single star was taken ahead or astern for distance run, and abeam for course, and when desirable two or more stars were taken for a position.

As on the flight from San Diego to Honolulu, except for the natural periodic movement of this aircraft, conditions were perfect for astronomical navigation. Stars chiefly used were Sirius and Canopus ahead, Arcturus astern and a Centauri abeam.

Radio bearings were received from Noumea when 800 miles out. As would be expected at this distance and in the situation of the station surrounded by high land, there was some differences in the bearings recorded, but in the absence of star visibility and smooth air conditions, the accuracy on these bearings would have been sufficient for approach to Noumea without any serious diversion from the course.

The East coast of New Caledonia, at a point bearing north east of Noumea, was sighted through a gap in the cloud at 1905 G.M.T. and descent was made for contact flight round the south point of the island owing to overcast conditions and bad visibility.

Noumea to Sydney. This flight was made by day, the aircraft departing from Noumea at 1925 G.M.T. on a course of 230° True for Sydney. The wind was fresh from the south east, and an allowance of 9° was made to port to allow for leeway.

The aircraft was climbed to 8000 feet, holding that height above the layer of strato cumulus cloud, the top of which was at 6000 feet.

There were insufficient gaps in the cloud to obtain satisfactory drift sights, so in the absence of further information course was held with 9° for drift. It was later possible to obtain further drift sights in somewhat unfavourable conditions which showed a reversal of drift of 2° to port, indicating a reversal of wind immediately above the cloud layer. It was estimated that course being made good was some 5° less than the direct course for Sydney. It was decided to hold this course to obtain if possible a check on Middleton Reef and also to observe the waters enclosed by it as a matter of interest.

At 2300 G.M.T. a line was taken from the Sun for a check on distance run, and this, combined with dead reckoning, placed the aircraft in Lat. $27^{\circ} 55' S.$, Long. $160^{\circ} 30' East$. Owing to dispersal of cloud the visibility below was good, and Middleton Reef was sighted at 2340 G.M.T. It was abeam at 2355 G.M.T., distant 15 miles south east. Course was then altered direct for Sydney. Radio bearings were now received from Sydney, and these remained constant at 60° . As a matter of interest it may be recorded that in every case these bearings placed the aircraft slightly south of its actual position, but to an extent which would not have caused serious diversion had the weather conditions been such that no other check had been available.

Bearings were obtained from Lord Howe Island station at 0056 G.M.T. which coincided with the dead reckoned distance run from Middleton Reef.

At 0240 G.M.T. a line was taken from the Sun, abeam, showing the aircraft to be 5 miles south of the course. At 0248 G.M.T. a bearing was given from Lord Howe Island station which was accurate within 2° , the distance being 260 miles. Drift remained to port though the lower wind was east. At 0320 G.M.T. the New South Wales coast was sighted, temporarily, and identified as Sugarloaf Point, bearing 280° , distant approximately 40 miles. Sixty miles out, owing to deep cloud and bad visibility, descent was made to 800 feet for the approach to Sydney, and course was altered 7° to port to allow for the Easterly at the low level.

At 0415 G.M.T. Port Jackson was sighted, and landing made at Rose Bay at 0425 G.M.T.

Radio Aid to Navigation. The utmost assistance was provided throughout the flight by radio bearings and by weather information received by radio in the aircraft. The importance of reliable radio equipment, and of the high standard of radio operation which was available to the navigator in this aircraft, cannot be too greatly stressed. The basis of navigation on this delivery flight was a combination of dead reckoning, radio direction finding and astronomical methods, placing such reliance upon each method which circumstances at the time indicated was desirable. It is considered essential that a sound basis of all three be available to the navigator on the trans-Pacific flights.

Compasses.

Pilots...though not situated in the best position in the aircraft, this compass proved to be very satisfactory indeed.

Navigators...Considerable changes in deviation occurred in this compass throughout the flight, and no reliance was place upon it. Apparently its inconsistency was due to its position in the aircraft.

Sextant. the Sextant used was Hughes Mark VIII instrument supplied by the makers in 1933. Though the Bubble of this Sextant is considerably less stable than that in later types, notably the Bosch and Lohm, it is considered superior in simplicity to some later types, the advantages of which are largely theoretical.

Tail drift sight. Little use was made of the Tail Drift Sight, generally on account of the complications associated with actually obtaining a drift sight with this instrument. to do so, in the position to which it has to be fitted and unshipped and stowed every time a drift sight is taken, is a major operation, only feasible when there is practically unlimited time and clear space below to obtain a sight. A Drift Sight of the Gatty or Pioneer type mounted at the navigator's table would provide easy and quick access to drift information, which is desirable. The Tale Drift sight might also be retained for use when time and ease of access are unimportant.

Gurley Pelorus. This or similar instrument is necessary for aircraft on the Trans-Pacific delivery flights, so that the deviation of the compass may be known, and so that when a course is set on the compass it may be known that the aircraft is in fact headed on that course. This is particularly essential on flights made in daylight when little astronomical information is available.

Observation through plexiglass. In tests made before departure at San Diego there was detectable difference in the altitude of bodies observed with the blister open or closed.

Mounting of Chronometers. It is strongly recommended that some thought be given to the anti-vibration mounting of chronometers. At present there is no provision in the aircraft for this. Serious errors in time can occur in a comparatively short period if chronometers are subject to vibration. Sextant cases should also be anti-shock mounted.

The general lay-out of the navigator's station is good.

(Sgd.) P.G. Taylor.

APPENDIX 4:

Diving record

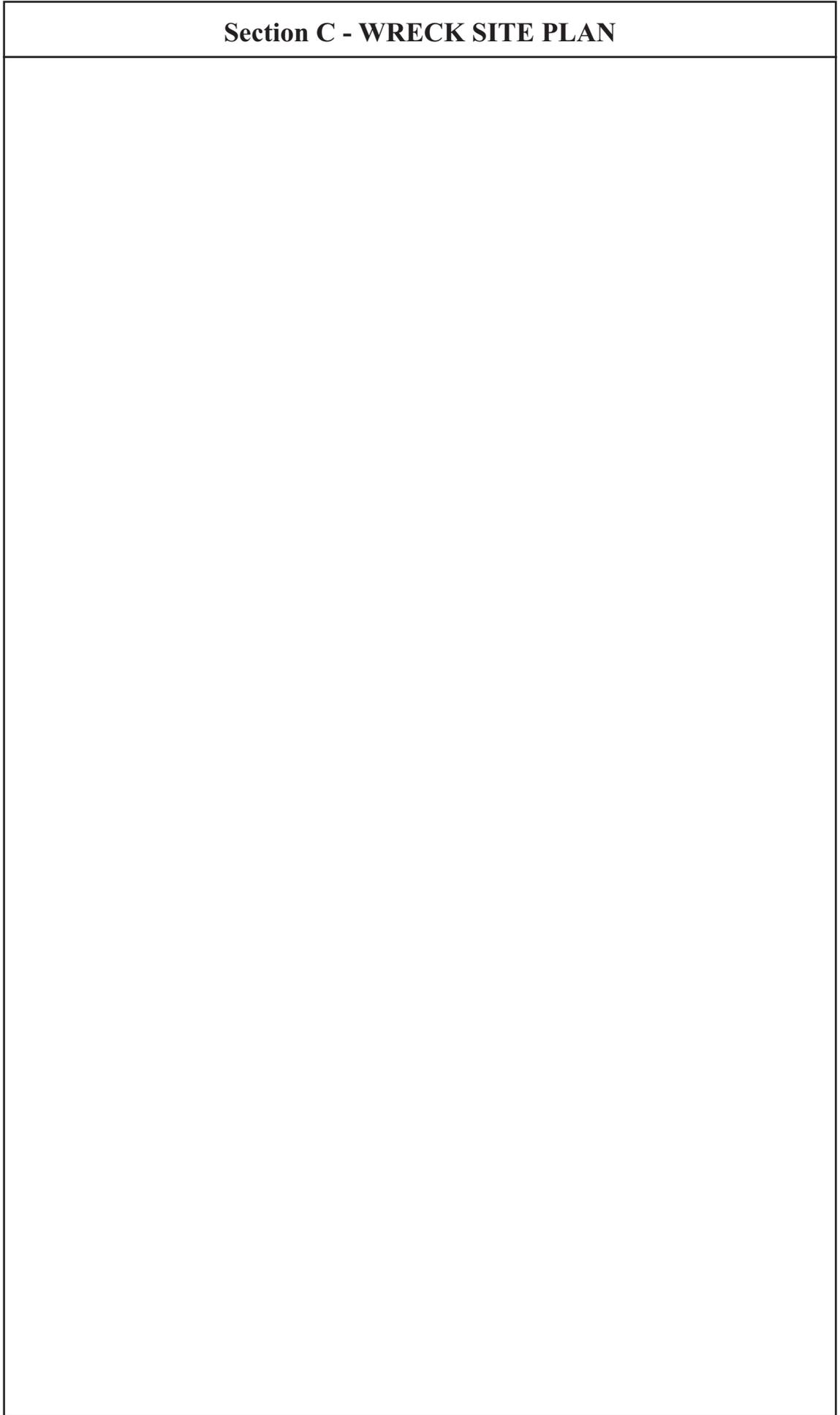
Site Name	ADN*	Date	Diver's Name	Dive No.	Bottom Time
Catalina 2	1	03-Apr-1998	Jung	1	48
Catalina 2	2	03-Apr-1998	Smith	1	48
Catalina 3	3	25-Apr-1999	Jung	1	55
Catalina 3	4	25-Apr-1999	Smith	1	55
Catalina 3	5	25-Apr-1999	Steinberg	1	55
Catalina 3	6	25-Apr-1999	Jung	2	55
Catalina 3	7	25-Apr-1999	Smith	2	55
Catalina 3	8	25-Apr-1999	Steinberg	2	55
Catalina 3	9	10-May-1999	Jung	1	45
Catalina 3	10	10-May-1999	Steinberg	1	45
Catalina 3	11	10-May-1999	Jung	2	45
Catalina 3	12	10-May-1999	Steinberg	2	45
Catalina 3	13	10-May-1999	Jung	3	43
Catalina 3	14	10-May-1999	Clark	1	43
Catalina 3	15	08-Jun-1999	Jung	1	45
Catalina 3	16	08-Jun-1999	McKenna	1	45
Catalina 3	17	08-Jun-1999	Jung	2	35
Catalina 3	18	08-Jun-1999	McKenna	2	35
Catalina 5	19	25-Jul-1999	Jung	1	45
Catalina 5	20	25-Jul-1999	Jung, C	1	45
Catalina 5	21	25-Jul-1999	Steinberg	1	45
Catalina 5	22	21-Aug-1999	Jung	1	40
Catalina 5	23	21-Aug-1999	Steinberg	1	39
Catalina 5	24	21-Aug-1999	Smith	1	39
Catalina 5	25	21-Aug-1999	Jung	2	44
Catalina 5	26	21-Aug-1999	Steinberg	2	44
Catalina 5	27	09-Jun-2000	Jung	1	20
Catalina 5	28	09-Jun-2000	Richards	1	40
Catalina 5	29	09-Jun-2000	Steinberg	1	40
Catalina 4	30	11-Jun-2000	Jung	1	33
Catalina 4	31	11-Jun-2000	Steinberg	1	33
Catalina 4	32	11-Jun-2000	Jung	2	32
Catalina 4	33	11-Jun-2000	Richards	1	32
Catalina 4	34	11-Jun-2000	Daly	1	32
Catalina 2	35	11-Aug-2000	Jung	1	55
Catalina 2	36	11-Aug-2000	Steinberg	1	55
TOTAL MINUTES:	1565	TOTAL HOURS:	26.133		

*accumulated dive number

APPENDIX 5:

Submerged Historic Aircraft Wreck Inspection Form

Section C - WRECK SITE PLAN



APPENDIX 6:

Correspondence relating to ownership issues of the Darwin Catalina wreck sites



DEPARTMENT OF THE NAVY

NAVAL HISTORICAL CENTER
 WASHINGTON NAVY YARD
 301 M STREET SE
 WASHINGTON DC 20374-8002

3091

IN REPLY REFER TO:

5000
 Ser UA/00644
 July 8, 1998

Silvano Jung
 Anthropology
 School of South East Asian and Australian Studies
 Northern Territory University
 Darwin NT 0909
 Australia

Dear Mr. Jung,

Thank you for your efforts to protect submerged U.S. Navy aircraft in Darwin Harbor. Our records indicate that two of the three Catalinas that you provided in your letter were stricken long after the Darwin Harbor raid and we were unable to positively identify the aircraft previously used by the Dutch (see enclosed aircraft history cards and PalWing 10 War Diary). However, we can confirm that submerged US Navy Catalinas in Darwin Harbor are the property of the US Government. Sunken Navy aircraft and shipwrecks remain United States property assigned to the Department of the Navy until formal and specific action is taken to dispose of them, loan them, or transfer ownership, regardless of loss location or passage of time (see enclosed policy fact sheet). I have also included several articles about a PBV that was recently documented in Kaneohe Bay, Hawai'i for your information.

Please visit our web site at www.history.navy.mil for access to our Policy Fact Statement and let us know if you can recommend any sites there that we can link to.

Again, we applaud your efforts to preserve the submerged cultural resources of Darwin Harbor and hope that the enclosed information is of some use to you. If I can be of further assistance please do not hesitate to contact me via e-mail at mecland@nhc.navy.mil or at (202) 433-9784 via phone, or (202) 685-0131 via fax.

Sincerely,

ROBERT S. NEYLAND
 Underwater Archaeologist



Office of the
Minister for Defence

309A

Parliament House
Canberra ACT 2600
Telephone: (06) 2777800
Facsimile: (06) 2734118

Mr Silvano Jung
Anthropology
School of South East Asian and Australian Studies
Faculty of Arts
Northern Territory University
DARWIN NT 0909

23 JUL 1998

Dear Mr Jung

I refer to your letter of 18 June 1998 to the Minister for Defence seeking advice on the ownership of the wrecks of World War II military aircraft in Darwin Harbour. The Hon Ian McLachlan AO MP has asked me to respond on his behalf.

Australian military aircraft remain the property of the Australian Government, as do Japanese military aircraft which were ceded to Australia under the Treaty of Peace with Japan.

Military aircraft of the United States of America (USA) and the United Kingdom (UK) remain the property of the relevant government. Government-to-Government administrative arrangements currently existing between Australia, the USA and the UK allow the Royal Australian Air Force to act on behalf of those Governments, in relation to military aircraft found within Australia or her contiguous seas.

The Air Force welcomes your efforts to bring the sites of the known aircraft wrecks in Darwin Harbour under the protection of Northern Territory heritage conservation legislation.

Similarly, the Air Force has no objections to members of the public searching for military aircraft wreckage. However, this approval is conditional, being subject to possible State heritage regulations, Native Title considerations or other State or Federal legislation which may be in force, and does not vest in any person, authority to enter either private or public lands.

Should any previously unknown sites of military aircraft be found, details of the find should immediately be advised to Air Force Headquarters. The contact officer is:

Wing Commander Mike Sargent
SOCOORD-AF
R1-6-B053
Department of Defence
CANBERRA ACT 2600

Telephone: (02) 6265 3939
Facsimile: (02) 6565 1806

-2-

3093

Individuals are prohibited under Commonwealth law from interfering with or removing any material from aircraft sites. The aircraft may contain human remains, and it is appropriate that these remains should be treated with respect and not disturbed before appropriate authorities are notified. In addition, unexploded or unstable ordnance, weapons, munition or other hazardous materials may exist at the site, and may present dangers to untrained personnel and scavengers.

Additionally, the news media should not be approached before action has been taken by authorities to identify those who may have perished in the aircraft, and attempts have been made to notify their relatives.

Finally, any decision in regard to the granting of permission for the salvage/recovery of aircraft remains the responsibility of the Government concerned.

Yours sincerely



PETER JENNINGS
Senior Adviser

APPENDIX 7:

A chronology of submerged Catalina wreck sites in Australian waters

NO.	OWNER	SERIAL No.	PREVIOUS SERIAL No.	MODEL	Bu. No.	C/N	DELIVERY DATE	DATE of LOSS	LAT.	LONG.	ACCOUNT OF LOSS	REFERENCE/S
1	USN	#18	ex-22-P-9 ex-22-P-4	PBY-5	2306	70496	?	19/02/42	?	?	Shot down W. of Bathurst Island, Northern Territory.	Knott 1981:59; Messimer 1985:246; James 1997; Wagner 1997; Aircraft History Card: 2306, Naval Historical Centre.
2	USN	#4	ex- 101-P-27	PBY-4	1214	C58101	17/10/38	19/02/42	12 30.64?	130 54.17?	Destroyed by enemy action, Darwin Harbour.	Knott 1981:59; Messimer 1985:246; James 1997; Wagner 1997; Aircraft History Card: 1214.
3	USN	#8	ex- 101-P-8	PBY-4	123 or 1238	C58101	10/01/39 or 30/01/39	19/02/42	12 30.64?	130 54.17?	Destroyed by enemy action, Darwin Harbour.	Knott 1981:59; Messimer 1985:246; James 1997; Wagner 1997; Aircraft History Card: 1238.
4	USN	#41	ex- Y-41	28-5MNE	N/A	?	N/A	19/02/42	12 30.63	130 53.89	Destroyed by enemy action, Darwin Harbour.	James 1997; Wagner 1997.
5	USN	#6	ex- 101-P-26	PBY-4	1227	?	N/A	03/03/42	?	?	Destroyed by enemy action, Broome Harbour.	Prime 1985?:11; Gadja 1980:48.
6	USN	#7	ex- 102-P-26 ex- 101-P-13	PBY-4	1237	?	N/A	03/03/42	?	?	Destroyed by enemy action, Broome Harbour.	Prime 1985?:11; Gadja 1980:48.
7	RAF	FV-N (W8433)	?	28-5MNE	N/A	?	N/A	03/03/42	?	?	Destroyed by enemy action, Broome Harbour. From 205 Squadron.	Prime 1985?:11; Gadja 1980:48.
8	RAF	FV-W	ex- Y-54	28-5MNE	N/A	?	N/A	03/03/42	?	?	Destroyed by enemy action, Broome Harbour. From 205 Squadron.	Prime 1985?:11; Gadja 1980:48.
9	RNNAS	Y-59	?	PBY-5	N/A	?	N/A	03/03/42	?	?	Destroyed by enemy action, Broome Harbour.	Prime 1985?:11; Gadja 1980:48.
10	RNNAS	Y-60	?	PBY-5	N/A	?	N/A	03/03/42	?	?	Destroyed by enemy action, Broome Harbour.	Prime 1985?:11; Gadja 1980:48.
11	RNNAS	Y-67	?	PBY-5	N/A	?	N/A	03/03/42	?	?	Destroyed by enemy action, Broome Harbour.	Prime 1985?:11; Gadja 1980:48.
12	RNNAS	Y-70	?	PBY-5	N/A	?	N/A	03/03/42	?	?	Destroyed by enemy action, Broome Harbour.	Prime 1985?:11; Gadja 1980:48.
13	USN	No. 6	?	?	?	?	N/A	26/11/42	?	?	No. 6 FAW. 10. (Krogh) crashed alongside USS. "Preston" and sank. (1k)	Peet, 1993: 6.
14	USN	No. 15	?	?	?	?	N/A	17/12/42	?	?	No. 15 FAW. 10 (?) sank between 25 10'S and 108 45'E and Fremantle while being towed by USS. "Heron". Force landed 13/12/1942 during sector 1 patrol.	Peet, 1993: 6.
15	USN	No. 6	?	?	?	?	N/A	23/01/43	31 20	115 30	No. 6, FAW. 10. Forced landed near Wreck Island	Peet, 1993: 6.
16	RAAF	A24-25	ex-RCAF 9708	PBY-5	?	?	04/42	28/02/43	?	?	Crashed into the sea north of Green Island. 'Skipped by Wing Commander J. Daniell failed to return from an anti-submarine patrol.	http://home.st.net.au/~dumm/28feb43.htm; Wilson, 1991: 63; Vincent 1981:30.
17	USN	No. 4	?	?	?	?	N/A	28/03/43	?	?	No. 4. FTR from sector 1 patrol (N.W. coast) extensive FAW. 10 searches carried out until -/1943. (Whole crew missing)	Peet, 1993: 6.
18	RAAF	A24-41	N/A	PBY-5	?	08203	02/43	07/04/43	?	?	Caught fire and lost Gulf of Carpentaria.	Vincent 1981:34,108; Wilson 1991: 63.
19	USN	No. 14	?	?	?	?	N/A	28/04/43	?	?	No. 14. FAW. 10. (?) Force landed 8 miles north of Exmouth Base. (3K)	Peet 1993: 6.
20	RAAF	A24-45	ex-USN 08269	PBY-5	08269	?	03/43	20/07/43	?	?	Fate unknown, no witnesses	Series: A9845/1. Item: Box 11, National Archives
21	RAAF	A24-24	ex-RCAF 9733	PBY-5	?	?	03/42	18/08/43	?	?	Crashed into sea off Bowen. Search by A24-56 located oil	Wilson, 1991: 63. http://home.st.net.au/~dumm/frongld.htm. Series No. AWM64, National Archives/Australia

22	RAAF	A24-50	ex- USN 08264	PBY-5	?	?	04/43	02/09/43	?	?	slick and considerable quantity of wreckage, consisting mostly parachute harness, life-saving gear and a large quantity of paper. No sign of bodies. Groote Eylandt area. Lost on ops from Sorong. Possibly crashed on Nuhu Tjut Island or north west of Fakfak	Wilson 1991: 63. http://home.star.brisnet.org.au/~dumm/1943nt.htm
23	RAAF	A24-52	ex- USN 08335	PBY-5	?	?	04/43	07/09/43	19,14	146.51	Crashed on landing. Townsville. Crashed into Cleveland Bay at Townsville and sank on 7 September 1943. Thirteen of the nineteen RAAF passengers and crew were killed and were subsequently buried at the Townsville War Cemetery	Wilson, 1991: 63. http://home.star.brisnet.org.au/~dumm/prangs1.htm http://home.star.brisnet.org.au/~dumm/7sep43.htm
24	RAAF	?	?	?	?	?	?	00/10/43	?	?	Lost along N.W. coast of Australia. FAW. 10 search failed to find any trace	Peet 1993: 6.
25	USN	?	?	?	?	?	N/A	04/11/43	?	?	Catalina No. ? V.P. 34 (FAW. 10). Sank at Heron Haven (Mobile Base along the N.W. coast.) No further information	Peet 1993: 6.
26	USN	No. 44	?	?	8339	?	N/A	04/04/44	30 50	113 21	FAW. 10 Sank west of Lancelin.	Peet 1993: 7
27	RAAF	A24-49	ex- USN 08285	PBY-5	?	?	04/43	28/04/44	?	?	Hom Island area. Lost on ops	Wilson, 1991: 63. http://home.st.net.au/~dumm/ronqld.htm http://home.st.net.au/~dumm/1944nt.htm Series: A9845/1. Item: Box 11. National Archives Peet, 1993: 7
28	RAAF	A24-76	ex- USN 48299	PBY-5A	?	?	01/44	19/12/44	?	?	43 Squadron. Crashed on take off from Broome.	Peet 1993: 7
29	RAF	JX 334	?	?	?	?	?	00/06/45	?	?	from Manokwari. Groote Eylandt area? *Carrying passengers and heavy equipment crashed on landing and caught fire. Only five of the complement of 14 survived. The wreck, lying in 4-6 metres of water, has been widely dispersed over 300-400 metres due to the effect of heavy storms and swell. *240 Sqd (RAF) transporting personnel from Madras, crashed and sank whilst landing in rough sea (9 killed).	Matthews (nd.); McCarthy, 1997; Peet, 1993.
30	RAAF	A24-206	ex-RAF JX611	PB2B-1	?	44217	02/45	20/06/45	12 29.79	130 54.52	Destroyed after explosion of depth charges East Arm, Darwin.	Vincent 1981:116; Pearey, 1996:115.
31	RAAF	A24-1	ex-RAF AH534 ex-VH-AFA	PBY-5	N/A	27	02/41	30/08/45	12 31.10	130 56.75	Lost on take off from East Arm.	Vincent 1981:107; Wilson 1991:22; Hendrie, 1988:208.
32	RAAF	A24-69	ex- USN 34056	PBY-5A(M)	34056	61123	12/43	14/12/45	12 29.75	130 53.81	Caught fire while moored East Arm.	Vincent 1981:111
33	Qantas	G-AGIE *Antares Star*	RAF JX577	PBY-5	?	?	?	17/01/46	?	?	Scuttled off Rottnest Island W.A.	Wilson 1991:58-59; McCarthy 1997.
34	Qantas	G-AGID *Rigel Star*	RAF JX575	PBY-5	?	?	?	29/01/46	?	?	Scuttled off Rottnest Island W.A.	Wilson 1991:58-59; McCarthy 1997.
35	Qantas	G-AGFL *Vega Star*	RAF FP221	PBY-5	?	?	?	13/02/46	?	?	Scuttled off Rottnest Island W.A.	Wilson 1991:58-59; McCarthy 1997.
36	Qantas	G-AGFM	RAF FP244	PBY-5	?	?	?	27/02/46	?	?	Scuttled off Rottnest Island W.A.	Wilson 1991:58-59; McCarthy 1997.

37	Qantas	'Altare Star' G-AGKS	?	PBY-5	?	?	?	?	00/03/46	?	?	Scuttled off Sydney.	Wilson 1991:58-59.
38	RAAF	'Spica Star' A24-113	ex- USN 46622	PBY-5A	?	?	?	?	04/06/46	?	?	Cat sunk at Champagny Island, 150 miles N of Derby. Holed and sank Champagny Islands.	Freeman 1995:268; Vincent 1981:119.
39	Qantas	VH-EAX	?	?	?	?	?	?	23/06/49	?	?	A24-372. Issued on loan to Qantas as VH-EAX and later taken over by them. Wrecked at Lord Howe Island.	WAMM 1985-1996, Vol. 1.
40	RAAF	?	?	?	?	?	?	?	?	?	?	Located on the beach near West Arm.	WAMM 1985-1996, Vol. 1.
41	USN	?	?	?	?	?	?	?	?	?	?	Sunk during cyclone at Exmouth, W.A. Were moored just S of Kallis's prawn processing factory.	WAMM 1985-1996, Vol. 1.
42	USN	?	?	?	?	?	?	?	?	?	?	Wreckage still believed to be there.	WAMM 1985-1996, Vol. 1.
43	USN	n/a	?	?	?	?	?	?	?	?	?	Sunk during cyclone at Exmouth, W.A. Were moored just S of Kallis's prawn processing factory.	WAMM 1985-1996, Vol. 1.
44	USN	n/a	?	?	?	?	?	?	?	?	?	Wreckage still believed to be there.	WAMM 1985-1996, Vol. 1.
45	n/a	n/a	?	?	?	?	?	?	?	?	?	Cat force landed off beach at Seabird, 60 miles N Perth.	WAMM 1985-1996, Vol. 1.
46	?	?	?	?	?	?	?	?	?	?	?	Wrecked on rocks the same night.	WAMM 1985-1996, Vol. 1.
47	?	?	?	?	?	?	?	?	?	?	?	Wreckage still there.	WAMM 1985-1996, Vol. 1.
48	USN	?	?	?	?	?	?	?	?	?	?	Cat on beach on Enderby Is. W of Dampier. Still there.	WAMM 1985-1996, Vol. 1.
49	?	?	?	?	?	?	?	?	?	?	?	Cat sunk at Cygnet Bay, 60 miles NW of Derby. Seen sometimes on very low tide.	WAMM 1985-1996, Vol. 1.
50	?	?	?	?	?	?	?	?	?	?	?	Palm Island	http://home.star.brisnet.org.au/~dunn/prangs1.htm
									146.44	146.44	?	Calliope Channel, Palm Island	http://home.star.brisnet.org.au/~dunn/prangs1.htm
									18.45	18.45	?	On a date unknown, the wreckage of a USN Catalina was found in the sea off White Rock Light House on Palm Island	http://home.star.brisnet.org.au/~dunn/palm01.htm
									?	?	?	Curacao Island Reef	Gibbs, M. 2000
									?	?	?	Albino Rock Reef	Gibbs, M. 2000