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Long range shipwreck timber storage

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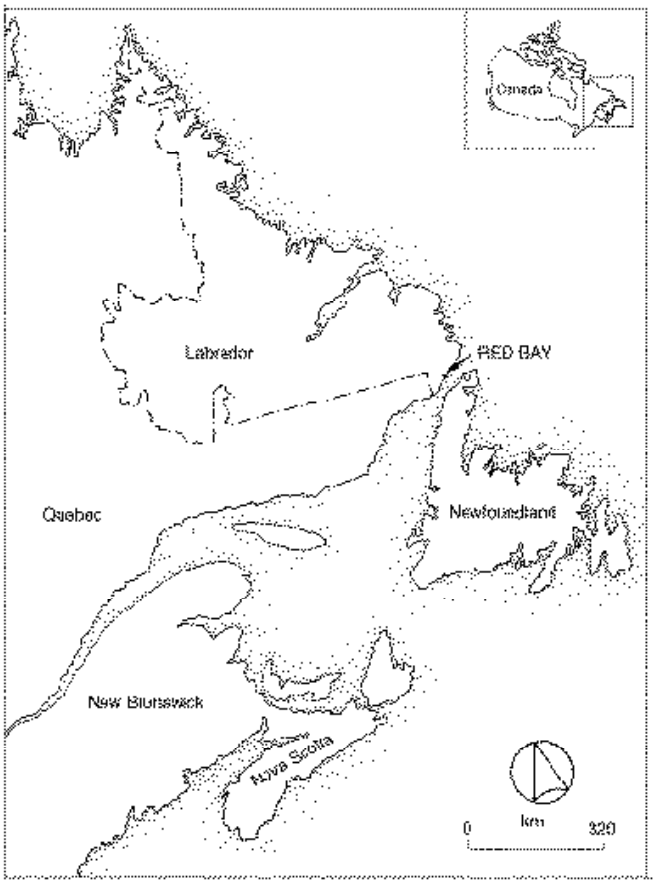

Figure 1. Location map.

Introduction

Marine archaeology and heritage conservation have long been concerned with the preservation of shipwreck timbers. This preservation becomes more of an issue once a shipwreck has been disturbed and more particularly once a vessel has been excavated. Essentially the question which arises is: what do we do with the largest artefact, the boat or ship, once excavation is completed?

Many vessels have been raised intact and conserved through the past three decades including the *Vasa*, the Kyrenia vessel, and the *Mary Rose* to name only a few. Parks Canada has also raised vessels intact in the 1960s (Amer, 1986), in addition to partial hull raising in the 1970s. In one particular instance, large sections of hull (some exceeding twelve tons), were severed, raised, conserved and now form the basis of an interpretation centre (Waddell & Zacharchuk, 1984). Most people in the marine archaeology field are familiar with the often asked 'why don't you bring her up?' Although a valid question, the fact remains that the raising of vessels is often a far easier undertaking than what comes after. Extensive interim storage, conservation and interpretive requirements and costs severely limit this possibility as a post excavation option.

The most obvious possibility is to leave the timbers on the bottom and to seal them as anaerobically as possible. Such procedure is in fact utilised widely today by many groups and organisations throughout the world. Attempts to rebury or collect silt on sites varies from simple sandbagging to the innovative use of artificial vegetation on a wreck site undertaken by the Victoria Archaeological Survey on the *William Salthouse* (Strachan, 1988; Elliget & Breidahl, 1991).

Although reburial or recovering of timbers has become a widespread practice, there has not always been a corollary effort to monitor or test the effectiveness of such procedures. This paper outlines a case study of one shipwreck that was excavated, disassembled and raised for recording and then systematically reburied. During the reburial, steps were taken to insure that timbers could periodically be recovered for testing and the reburial environment could also be analysed. The shipwreck was reburied in 1985 and monitoring was done in 1986, 1988 and 1992.

Background

For eight years (1978–1985), Parks Canada was involved in the excavation of Spanish Basque whaling vessels in Red Bay, Labrador (Fig. 1). During that time two galleons were test excavated while a third vessel was completely excavated (Stevens & Waddell, 1987). The test excavation trenches on the two partially excavated vessels were reburied conventionally with sandbags and approximately 30 tons of loose sand. Similarly it was standard procedure for interim (between field seasons), reburial to be done with sandbags and a thin layer of loose sand. Although this aided in temporarily protecting the timbers it was evidently not a suitable long range storage procedure. Summer water temperatures averaged less than three degrees Celsius. Despite the cold water it was evident that small marine borers were active on some of the exposed timbers. The level of borer activity was certainly not as pronounced as that commonly seen with teredo worms and other borers in warmer waters. Nonetheless, it was obvious that exposed organic material would eventually be consumed. In addition to biodegradation, exposed timbers also are subject to mechanical forces such as tides, current, sand abrasion, bio-abrasion, bio-reduction etc. Because of all these factors an effective, testable, cost efficient reburial methodology was sought.

The Conservation Branch of the Canadian Parks Service was asked to develop guide-lines for the work particularly as it related to long range testing of reburial

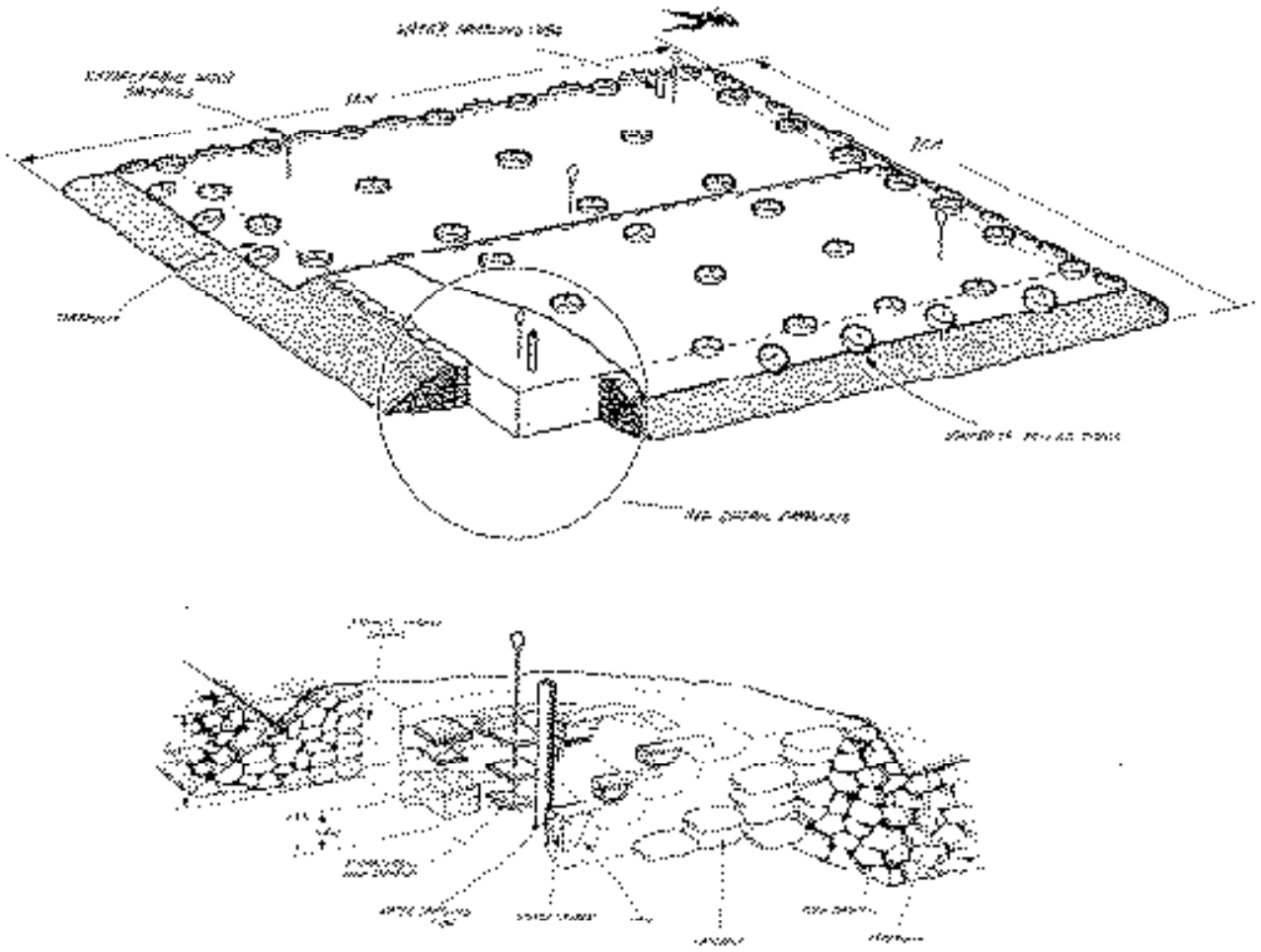

Figure 2. Sketch plan of storage area.

effectiveness. After literature searches, several consultation meetings and some experimentation, a reburial plan was formulated (Murdock & Stewart, 1985). The essence of the plan was to create a sealed and anaerobic environment for the timbers that would permit long range testing of effectiveness. The reburial would attempt to duplicate the pre-excavation environment of the timbers in terms of light, temperature and gas exposure.

Reburial

Over the course of six excavations years, the main wreck site at Red Bay was completely disassembled (Waddell, 1986). Over 3000 individual timbers and numerous timber fragments were raised to the surface, recorded and placed in temporary underwater reburial pits. An estimate of the timber volume and the largest individual timbers were used to determine that a reburial mound 14 metres by 16 metres would be required. The mound depth varied with bottom topography and ranged from about 1.2 metres to 1.5 metres. This dimension permitted the stacking of timbers in three distinct layers with 20 centimetres of sand above each layer. The profile of the reburial area was kept as low as possible to minimise iceberg contact. The sea-bed depression created by wreck excavation was the obvious area to install the mound in that it offered a reasonable water depth of 10 metres, a lower overall profile than the surrounding area and a region of known sterility.

To contain the timbers and sand a sandbag wall was constructed using some 1200 plastic salt bags containing approximately 36 metric tonnes of sand. The mound walls, built in stages, were supported by timbers and sand on the inside and by rock fill on the outside. Emphasis was on readily available inexpensive materials. The sand was recovered locally, the plastic sandbags were those originally containing salt and used to salt fish at the local fish plant while the rock fill was ship's ballast stone which had been previously excavated, raised for study and then stored on the sea-bed. The outside rock support was built on a taper which simplified construction but more importantly provided a tapered stable wall that would greatly aid in deflecting and minimising disturbance by scouring icebergs that could severely damage any vertical walls.

The area of the wreck sloped slightly downward from south-west to north-east. The deeper portion of the pit, the northern side, was used for larger timbers that sometimes passed through more than a single reburial layer. This included the 14 metre keel, the keelson and several other great and compass timbers. The first layer

Species	Sea Water	1986 Mound	1988 Mound	1992 Mound
Sulphide (mg/L S)	0.050	0.040	<0.010	***
Dissolved Oxygen (mg/L O)	(9.82*) 9.2**	(0.20*) 1.5**	1.7**	***
Alkalinity (mg/L $CaC0_3$)	100	101	127	144
pH	7.830	7.090	6.340	7.040
Nitrate (mg/L N)	<0.002	0.008	***	***
Nitrate (mg/L N)	<0.002	0.008	<0.001	<0.002
Nitrate and Nitrite (mg/L N)	***	***	<0.004	<0.004
Ammonia (mg/L N)	<0.010	1.100	0.670	1.410
Kjedldahl Nitrogen (mg/L N)	0.130	1.600	0.690	2.260
Orthophosphate (mg/L $P0_4$))	0.013	0.076	<0.010	0.140
Total Phosphorus (mg/L $P0_4$)	0.034	0.308	0.120	0.570
Silicate (mg/L Si)	0.100	0.750	0.600	0.580
Iron (mg/L Fe)	0.090	9.900	5.510	2.890

* by Winkler titration
** by dissolved Oxygen Metre (YSI Probe model 5739, Yellow Springs Instrument Co., USA
*** not determined

Table 1. Results of chemical analysis of water taken from outside and inside the burial mound (J. Stewart).

was laid within the reburial pit on the sterile, previously excavated sea-bed. Timbers were fitted or 'nested' to maximise the total wood volume in each level. As the timbers were being put in, each timber in the layer was mapped in order to facilitate later recovery should it be required. Upon completion of the individual level map, the sand dropping operation began. Sand was lowered into position over the site in a specially designed dump bucket with a capacity of two metric tonnes. This was manoeuvred into position with the diver giving signals to the surface crane operator. When the proper position was reached the diver pulled a pin and the sand was dropped into the mound. Gaps between timbers were filled since the sand 'flowed' easily with hand and leg pushing. Over the entire first layer of timbers, a 20 cm thick layer of sand was applied. The following two timber layers were built up similarly, producing an overall mound height of approximately 1.2 to 1.5 m. Ninety-six metric tonnes of sand were put over the first timber layer, followed by 93 metric tonnes for the second layer and 126 metric tonnes in the final layer which resulted in an overall total of 315 metric tonnes. In effect, a six layer 'sandwich' consisting of alternate levels of sand and timbers was created (Fig. 2).

A tarpaulin was required over the entire mound in order to eliminate erosion of the sand and also to minimise any gas transfer. The covering used was a commercially available synthetic elastomer rubber which had a reinforcing weave. This Hypalon tarpaulin was 36 mm in thickness and was made in two pieces in order to simplify handling underwater. The two sections were laced together underwater to form an overall dimension of 16 by 18 metres. This permitted an overlap or border of one metre around the mound. To hold the cover down, 60 concrete filled tyres, totalling nine metric tonnes, were dispersed over its surface (Fig. 2).

Reburial of the timbers at Red Bay is one of the largest undertakings of its kind which is specifically directed at maintaining shipwreck timbers in an optimum state. To help establish the effectiveness of the procedure, wood samples from the ship were employed. Spacers or fillets were used on the ship between frames, a common practice on 16th century vessels. It was decided that these spacers, once fully recorded would make ideal effectiveness testing samples for the reburial procedure. Several of these small timbers were sliced in two. One half of each spacer was placed in the reburial mound while the second half was frozen and stored as a long range control. The spacers that were placed in the mound were strung on a rope at spacings simulating that of the reburial mound timber levels (Fig. 2). These timber samples can be pulled from the reburial mound without disturbing the surrounding timbers. To date, one set of wood samples have been pulled from the mound (in 1992). Comparison with the control samples is currently under way in the form of wood deterioration tests. Preliminary visual analysis indicates that the reburied sections look as good or better than their frozen counterparts.

The primary reburial effectiveness testing is being done through water sampling tubes which were installed in the mound. These tubes are constructed and installed so that water samples can be drawn from deep within the reburial mound without contaminating the mound itself (Fig. 2). Syringes are purged above the mound and then water samples are drawn off into them. Multiple samples are taken and contrasted with ambient sea-water. Following the 1985 reburial, testing has been

done three times, in 1986, 1988 and 1992. The analysis summary chart (Fig. 3), indicates that the samples taken are clearly anaerobic. Within one year of sealing, the oxygen level was approximately 1 mg/litre and this value has held constant during the latter field tests. Water from immediately above the mound has been consistently in the 9 to 10 mg/litre range. Quite simply, the sea-water is saturated with oxygen and the mound water is heavily depleted. Further, all of the chemical analysis results (Fig. 3) support the fact that the reburial mound is a reducing environment (Stewart, 1993).

During collection of data in 1992, one edge of the tarpaulin was uncovered to permit the recovery of some dendrochronology samples. During this procedure some fresh oak samples were installed on the site. The samples were strung on rope in a similar manner to that used to install the spacer samples. With the fresh oak samples however, the upper block has been left uncovered above the reburial mound as a control. In the future this should provide further real site evidence on wood deterioration.

A visual inspection of the overall mound integrity has been generally favourable. The tapered rock wall backfill has been contacted by ice at several points. This has left a minor impression in the rocks but there is no apparent disturbance to the sandbag walls. At least one iceberg has contacted the top of the mound directly but has hit the most prominent part, the concrete tyres. Evidently the load weight was distributed as the tyre has been depressed slightly into the tarpaulin and upper layer of sand of the mound. There are perhaps a dozen small tears (10 to 20 cm) in the tarpaulin that have come from projectile type ice contact. This contact must be light as there is no evident gouging or shifting of the upper sand layer. There is little question that the 'turtle-like' mound shape has been helpful in protecting the buried timbers.

It is archaeology's collective responsibility to insure that cultural resources are maintained despite some unavoidable impact in surveying, studying and excavating underwater sites. The challenge is to do this responsibly, cost efficiently and in a manner that can be assessed in terms of effectiveness. This case study should aid in providing some data for those charged or concerned with long-range preservation of cultural resources on underwater sites. Ideally the procedures will be monitored, changed and improved upon by others over time.

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National Shipwrecks Project

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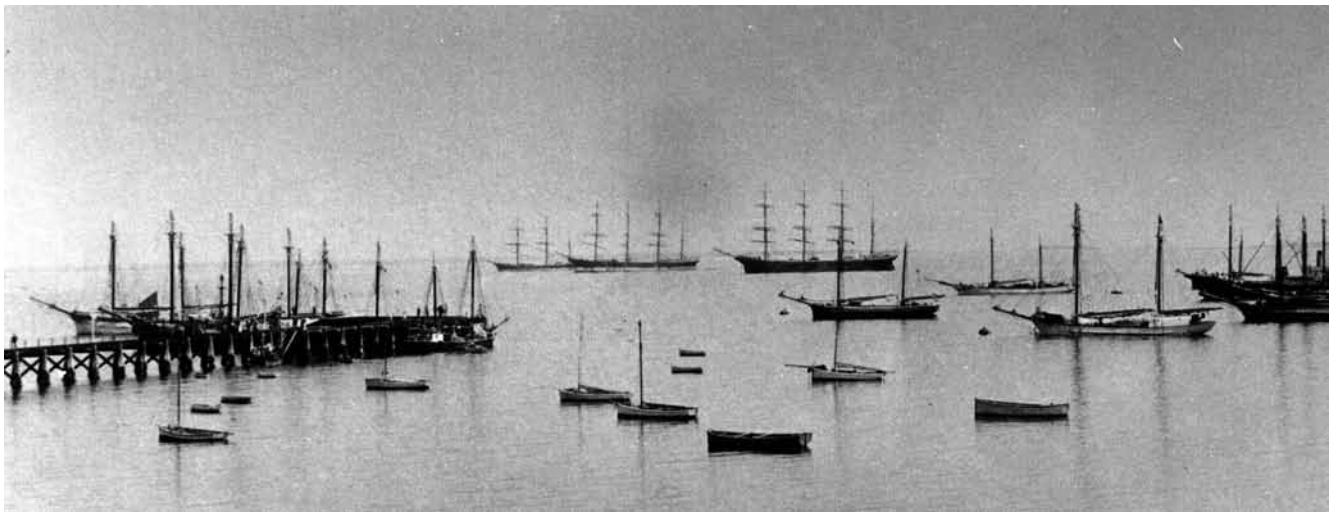

Figure 1. A scene off Port Victoria, Spencer Gulf, South Australia, *c.* 1920 showing the range of ships and boats important in the history of this region. Mortlock Library of South Australia.

Introduction

The following paper provided background material for a workshop conducted at the 12th AIMA conference at Geelong in 1993. During the workshop other participants elaborated on some aspects of the project. They were: Peter Bell, discussed the relevance of historical themes in sorting out research aims and gave an example of how historical themes have been applied to terrestrial heritage sites; Terry Arnott, provided an example of a maritime historical theme (Navy ships in Victoria) and gave some details about a wreck site interpretation project; Alan Roberts, gave the Commonwealth's view of the project.

This paper follows on from an earlier paper given at the 11th AIMA conference in Sydney in 1992 (Jeffery 1993: 1–6) and is also a result of some discussion and correspondence from maritime archaeological colleagues from around Australia.

Aims of the Project

The aims of the project are to provide the community with a better understanding of the value of shipwrecks and the role these ships played in Australia's history.

Background

Shipwrecks are predominantly an invisible heritage resource to many Australians and their significance in Australia's history is not well understood. Recent efforts in the *Australian Historic Shipwrecks Program* have been to define objectives and activities in carrying out the work and in managing sites. They have not provided a direction for research and interpretation (outcomes).

The *Australian Historic Shipwrecks Program* is implemented through State and the Territory public agencies which vary between a dedicated maritime archaeological museum; two general museums; four cultural resource management (CRM) agencies coordinated through a Commonwealth CRM agency. This variety of agencies means there are different levels of research and a number of different outcomes.

The role of this project is to see if some research based on the aims of this project can be coordinated amongst the States and the Territories, implemented over the next few years, and interpreted by 1 January 2001 (Centenary of Federation) and beyond.

How to implement aims

1. develop a national plan of research for Australia's shipwrecks;

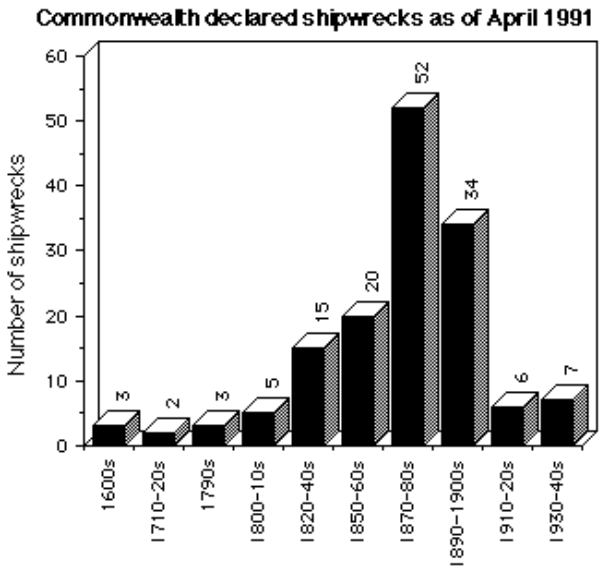

Figure 2. Histogram of declared shipwrecks by date.

Table 1. List of composite-built shipwrecks in Australian waters (disregarding 'River Murray' composite vessels).

2. develop a national plan of interpretation for Australia's shipwrecks;
3. involve a range of people (professionals, general community) in the project;
4. initiate project.

National Research Plan

The strategy for the research phase of this project should have as its goal 'what aspects of Australia's history can be revealed by a study of Australia's maritime archaeological heritage'.

One of the ways in which the project should be implemented is by involving a number of different people, from the maritime archaeological practitioners to historians, community divers, anthropologists, conservators, academics, etc. all making some contribution toward several research issues. For all of these people to have a clear understanding of where the research is headed it would be a good idea if a documented framework could be referred to. A framework would also be an important tool in promoting the project with sponsors and in keeping politicians and the community informed about the direction of the research.

An appropriate first step therefore should be to compile a framework which would include the following aspects:

- an historical overview of Australia's maritime history;
- a summary of the main historical themes;
- a list of significant maritime events and developments;
- regional themes;
- bibliography;
- analysis of current maritime archaeological research;
- research issues/questions related to themes;
- recommendations.

It is thought that this framework could be compiled by a consultant over a six month period during which time the consultant could interview those involved in the program, historians and other appropriate people. All of this data would then be documented and a report produced as a result. A similar document was produced by Marsden (1980), titled *Historical Guidelines, South Australian State Historic Preservation Plan.* It has been used in South Australia as a guide in the selection and preservation of heritage items so that they reflect the significant historical themes. The work was also conducted to suggest areas of further research or action needed to preserve or discover important historical material or relics.

A brief example of the usefulness of this work can be seen by applying some similar analysis carried out by Marsden, to Australia's Historic Shipwrecks. The enclosed graph is a result of plotting the time periods in which the shipwrecks occurred, against the number of declared historic shipwrecks (as at April 1991). It highlights the predominance of vessels wrecked during the 'boom years' of the 1870s to the 1880s. It was also found that the majority of these vessels were British square rigged sailing vessels. One theory for this predominance is that these vessels are the most popular for scuba divers in their explorations—salvage?— and then reporting to government agencies. Are they then a good reflection of the maritime archaeological heritage of Australia? Are they then the dominant vessels that should be the subject of the research that will contribute to an understanding of Australia's history?

The production of this type of objective framework would provide a direction for the coordinated national research into Australia's shipwrecks. It could also be a very useful document in identifying what themes, and therefore sites, should be protected and managed under the Historic Shipwrecks Legislation.

Consideration needs to be given to the integration of all types of the maritime archaeological resource in this project and not just shipwrecks. Like shipwrecks they are part of the maritime heritage landscape of Australia and the establishment of harbour facilities, lighthouses, etc. can tell something about the ships and trades that were the reason for their development. Similarly, the project should be involved with relating the archaeological remains to the people and societies associated with these particular ships, trades or whatever. They are after all, the only reason that archaeological remains exist.

There has been some discussion with maritime historians about the need and use of a framework and in particular the development of historical themes that could guide research. There was no general consensus on whether they were wholly satisfactory or not but some comments from four of the five historians contacted remarked:

Australian history in general should provide the framework for themes; how maritime history contributes to this; and how maritime archaeology can contribute to this.

- should not set a too rigid framework of themes;
- should allow for sub-themes that evolve from research;
- consider social issues more than economic issues; the impact on peoples lives, e.g.:
- race relations;
- law and order;
- women;
- support systems;
- defence;
- the shipping industry of Australia;
- pre-European craft;
- pre-1800 craft;
- 1800–1850 shipping;

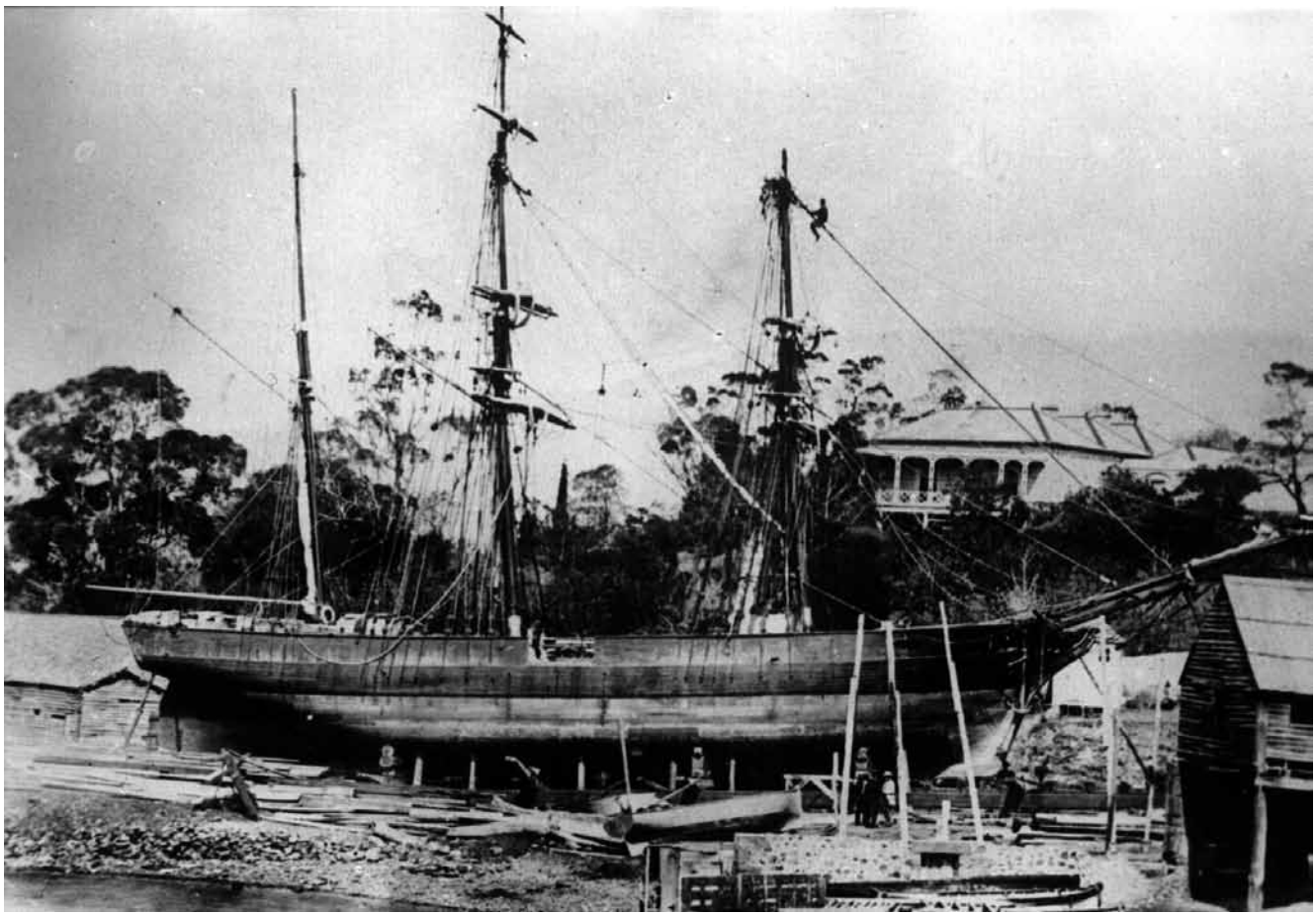

Figure 3. Locally built ships and boats and the shipbuilding industry are a significant aspect of our maritime heritage. Mortlock Library of South Australia.

- coastal steamers;
- the importation of large timber hull sailing ships;
- settlements resulting from shipping and shipbuilding activities;
- industries and trades developed through shipping;
- shipbuilding (and its extent) in the different regions of Australia;
- inland river shipping;
- particular shipwrecks—*Pandora–Gothenburg;*

The next phase in developing a National Research Plan would be knowing what the resource base is and analysing it according to the developed framework.

A National Shipwreck Database is being coordinated by the Australian Institute for Maritime Archaeology (AIMA) and is well underway and in its present form has some limited use. For example, the Table 1 on composite vessels (as per Lloyd's Rules) wrecked in Australia provides some basis in determining which of these sites may be the most useful in obtaining archaeological information on this type of composite ship construction, or the development of this technique in different countries. The majority of the 'composite vessels' wrecked in Australia are the 'River Murray' type which could be integrated in this study or it could easily stand on its own as a separate study.

Of these wreck sites, the *Zanoni* and *La Bella* have been located and are declared historic shipwrecks under respective South Australian and Commonwealth Historic Shipwrecks legislation. The *La Bella* is located in a high energy environment and many artefacts have already been removed from the site. The wreck site is therefore not expected to be in a very good condition. The *Zanoni* sank in relatively deep water and was not found until 1983. The wreck site has therefore had little disturbance.

A site, possibly the *Ellerton* has been located and investigated although no iron frames were found. The wreckage is broken down and scattered about on the outer edge of a reef slope but it possibly contains sections of the ship in deep water (20 metres) that are buried in sand and well preserved (Gesner 1992).

None of the other wreck sites have been located but from an historical/archaeological view the *Farningham, Mars, Black Prince, Jabberwock and Phoebe Dunbar* could provide significant evidence on composite construction. Of these the *Mars* was wrecked in a high energy environment; the *Farningham* sunk in the middle of Bass Strait; the *Phoebe Dunbar* was burnt out on a beach and possibly salvaged. Some of these sites may be useful in a comparison of the way different countries constructed composite vessels but the historical information and physical evidence suggests the *Zanoni* is a long way in front as the site with the most integrity.

Figure 4. PS *Tarella* and a barge at Goolwa, South Australia *c.* 1910. Existing port facilities should be examined in the context of this project to provide additional information about maritime activities. Mortlock Library of South Australia.

This is a very simple example of how the National Shipwreck Database could be used in selecting sites, or a range of sites pertaining to a theme, that could become the subject of some more intensive historical or archaeological research. In terms of coordinating research on a national basis the database is one of the most important starting points. It is therefore important that the information be accurate, and up to date, which at this stage it is not. For example, this thematic search of Australia's composite built shipwrecks highlighted two anomalies, the *La Bella* has been confirmed to be an iron vessel (pers. comm. P. Harvey and T. Arnott), and the *Lady Elizabeth* (Western Australia) is known to be a composite vessel but not shown as such in the database (McCarthy 1983: 387). A concerted effort should therefore be made as a priority to complete the database and make it useful for this and other projects.

The National Research Plan should be developed as a useful and working document beyond 2001 but it is important that this date be seen as a focal point for the dissemination of some information to the community. Some of this research therefore needs to be realistic and achievable by 1 January 2001.

National Interpretation Plan

The strategy for the interpretation phase of this project should have as its goal the need to interpret the research so that it conveys to the community the project aims.

There are many interpretation methods that could be utilised to effectively reach different sections of the community. It must be remembered that it is the whole community that must be reached not one or two sections of it, such as scuba divers. This interpretation should also include outcomes that will stay with the community for some time rather than only be short lived, transient things such as a travelling display or a documentary film. While a travelling display may reach communities in those cities that can accommodate it, many of the important regional communities could miss out because they do not have an appropriate display venue. While 1 January 2001 is a significant time to aim for, the date should be used as a springboard for further work, particularly in maintaining the interest in, and an appreciation of shipwrecks and their role in maritime history.

Interpretation methods will also be dependent on the nature of the research and its results, for example what do we do with large quantities of artefacts that may be recovered? It may be more appropriate to simply publish a good quality book and not have to worry about how to interpret and display artefacts. But would this outcome reach young school children who need to be more interactive with things, and because of their fascination with shipwrecks, would be keen to learn about their significance in Australia's maritime history? Would it effectively illustrate the historic theme being pursued by that research? There will obviously be a need for some

balance between artefact interpretation and the other forms of interpretation. It is also important that any artefacts used in interpretation illustrate, and provide an understanding of, the way and why people used them. Maritime archaeology or shipwreck research still attracts an antiquarian label and it is indeed one of the strengths of shipwrecks that they do contain artefacts of such large quantity and of a high integrity, and dateable to a time, day and year. The weakness has been in analysing this material into what it can tell us about past societies and how they behaved and why?

How the interpretation and the outcomes are determined should be the subject of a careful study which should then be documented as the National Interpretation Plan. It is therefore recommended that a contract be let to someone with expertise in this field after the completion of the National Research Plan.

Involve a range of people in the project

The reason for this aim should be fairly obvious; a greater number of people with different skills being involved is going to increase and broaden the research and outcomes, and help to reach a greater number of the community.

The initiation of this project will need the involvement of the existing practitioners and managers in addition to historians, museum professionals and people with expertise in the heritage interpretation field. As the project develops the diversity of the professional skills required in the different research aspects should increase. It may be that some of these professionally skilled people can be picked up as volunteers, but it should also be an aim of the project to give people with these skills a contract and pay them. Some of the research and interpretation issues may be topics that could be taken on by students as part of their studies. With a documented framework and the identification of some research issues it should become easier to get students involved and suggest areas of research for their studies. This is an aspect that should be encouraged. Support should also be given for separate publications to be made by the people or groups carrying out certain aspects.

People from the regional communities should play a significant role in the research and interpretation aspects of the project, not only in the implementation stages but also at the planning stages of the project. Where assistance is required in field-work the involvement of community divers (and non-divers where needed) should be encouraged particularly at the regional level.

An appreciation and involvement of various people, from different organisations and regions, and at different stages in the project, need to be addressed in the research and interpretation plans.

Initiate project

The aim of the National Research Plan is the selection of a number of different themes or research issues that can be used to point toward different shipwrecks that should be the subject of some research and interpretation. It is important that the research and interpretation to be implemented by 1 January 2001, and the selection of sites for investigation, be realistic and achievable by this date.

The selection of themes, research issues and shipwreck sites may mean that it includes some sites that have already been located and studied. Any additional work required on these sites will depend upon the research issues addressed in the National Research Plan and the interpretive methods recommended in the National Interpretation Plan. For example, the Dutch shipwrecks, HMS *Pandora*, HMS *Sirius*, and *Sydney Cove* could fall into this category.

The project requires the cooperation of the Commonwealth Government and State Governments and to date the project has the general support of these agencies. But if it is to develop further then resources and funding from these agencies are going to be required. There will be the need for different levels of commitment from other organisations, such as the Australian National Maritime Museum, Australian Heritage Commission, State and regional maritime museums, universities, and sponsoring bodies. Contact with some of these institutions should be initiated during the formulation of the research and interpretation plans and further developed according to their interest after the completion of the plans.

There is some apprehension about certain aspects of the project from some of the State agencies particularly with the commitment of resources from what are already stretched resources, on some new sites or themes when there are already sites being investigated or known sites awaiting investigation. It is important that this project, while it considers these sites, does not take on a study of sites that only pertain to a narrow part of Australia's maritime history, just because they are dominant in the maritime archaeological resource and have been popular with souvenir scuba divers. This project may help to redirect research and interpretation away from some sites, although State and regional issues and sites of interest to a State agency will need to be subjected to ongoing management.

The project needs to be coordinated Nationally and the existing Australian Cultural Development Office of the Department of Communications and the Arts which control the *Australian Historic Shipwrecks Program* should administer the project. They should also be a major source of funding for the two Research and Interpretation contracts.

The project should begin with the development of a brief for the research plan and attached is a draft brief. The brief needs to be considered by the Commonwealth Government and all the State Government agencies before being advertised. The Interpretation brief needs to consider what the research plan recommends and be subject to comments from the Commonwealth and States before it can be developed, which is about 12 months away.

The Australian Institute for Maritime Archaeology should be a major forum for providing comments on the consultants' briefs and the results of the consultancies. This organisation should also provide the main driving force for the project once the directions for research and interpretation have been finalised.

Australian Historic Shipwrecks Program National Research Plan

Project Brief

1. Study Area

The whole of Australia and its external territories.

2. Background

The Commonwealth Department of Communication and the Arts administers the *Historic Shipwrecks Act 1976* and coordinates a program on historic shipwrecks with all the States and Territories. Each of the States and the Northern Territory coordinate a more regional program associated with their shipwrecks and other maritime archaeological sites and artefacts, in addition to administering their own State and Territory legislation where applicable.

Shipwrecks are predominantly an invisible heritage resource to many Australians and their significance in Australia's history is not well understood. Recent efforts in the *Australian Historic Shipwrecks Program* have been to define objectives and activities in carrying out the work and in managing sites. They have not provided a direction for research and interpretation (outcomes).

The *Australian Historic Shipwrecks Program* is implemented through State and Territory public agencies which vary between a dedicated Maritime Archaeological Museum; 2 General Museums; 4 Cultural Resource Management (CRM) agencies coordinated through a Commonwealth CRM agency. This variety of agencies means there are different levels of research and a number of different outcomes.

3. Objective

The project will investigate and recommend a number of themes or research issues for Australia's shipwrecks that can be used as a guide in implementing work that has the following goal; 'what aspects of Australia's history can be revealed by a study of Australia's maritime archaeological heritage' (maritime includes riverine). This is to be known as the National Research Plan. Some aspects of the plan should be achievable and capable of being interpreted according to an Interpretation Plan (yet to be developed) by 1 January 2001, and there should be aspects that provide a guide for longer term research.

4. Tasks

The following tasks will be carried out:

- review the significant published literature on Australia's maritime history;
- review the significant published literature on maritime archaeology (Australia and International);
- liaise with State libraries, appropriate State and National Museums on their records and artefact collections;
- investigate the potential of the National Shipwrecks Database and any other appropriate databases;
- confer with Commonwealth officials, all State and Territory maritime archaeological practitioners, managers and State Delegates under the *Historic Shipwreck Act 1976*;
- confer with historians, academics, museum curators, conservators and other researchers who work in the field of maritime history and maritime archaeology;
- confer with some representatives of the regional communities, local governments and maritime museums.

5. Outcome and Presentation

The outcome for the project will be a report to be known as the National Research Plan and which:

- summarises the current state of knowledge about Australia's maritime history;
- draws attention to any new themes, and gaps in knowledge, and what action is needed to remedy these;
- analyses current maritime archaeological research;
- proposes a framework such as historical themes and sub-themes that could be used as a guide in the long term research of Australia's shipwrecks, of which some aspects can be interpreted in the short term, i.e. by 1 January 2001;
- reports on the viability of the National Shipwrecks Database as a research tool;
- considers regional issues, time periods, maritime events and developments when compiling the framework;
- presents the information in a way that makes it useful as a research guide by many people;
- provides a list of personnel, groups and agencies consulted;
- provides a bibliography of all literature consulted during the project.

The report is to be presented as a draft report to the Australian Cultural Development Office at a time agreed in the project timetable. It will consist of an A4 format hard copy complete with any illustrations ready for reproduction, as well as a copy on floppy disks. The report is to conform to the conventions of the current *AGPS Style Manual*.

The consultant will also lodge all notes, tapes and correspondence with the Australian Cultural Development Office.

6. Timetable

The project will commence by… At the commencement of the project the consultant will prepare a timetable, to be agreed with the Australian Cultural Development Office.

The project will be completed by…including the presentation of the draft report to the Australian Cultural Development Office.

7. Liaison

The consultant will liaise with…at all stages of the project. The consultant will make personal contact with the State maritime archaeology practitioners, State Delegates under the *Historic Shipwrecks Act 1976*, historians, academics, museum curators, and representatives of some regional communities recommended by the contact officer. The Australian Cultural Development Office will provide letters of introduction and other assistance to the consultant as required.

8. Payment

Eighty percent of the consultant's fee will be paid in stages at dates to be agreed at the commencement of the project, on production of a brief report indicating satisfactory progress. The remaining twenty percent will be paid on acceptance by the Australian Cultural Development Office of the draft report. All fees will be paid to the consultant, who is responsible for paying for any other persons engaged to work on the project, and any other expenses incurred in implementing the project.

9. Contract

The project will be carried out under a contract between the Australian Cultural Development Office and the consultant according to this brief, which will be the basis for the contract. Any amendment to this brief will be done only with the written agreement of this office and the consultant.

Acknowledgements

I would to thank Dr Peter Bell, Susan Marsden, Mike Nash, David Nutley, Mark Staniforth, Alan Roberts, Peter Gesner, Peter Harvey, Terry Arnott, Dr Frank Broeze, Ron Parsons, Dr John Bach, and Dr Leonie Foster for their advice and assistance in putting this paper together.

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Community based shipwreck surveys

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Ever since Scott Sledge's 1979 survey of the northern Western Australian coast (Sledge, 1979), regional surveys of various sections of the Australian coast have identified and documented shipwreck heritage. The major purpose of most of these surveys has been to provide shipwreck management agencies with information upon which to develop management strategies.

The information from these surveys has been presented in a number of publications including, of more recent years, Mike Nash's Occasional Papers on Tasmanian wrecks (Nash, 1988, 1990), Paul Clark's survey of wrecks in the south-east of South Australia (Clark, 1990) and Sarah Kenderdine's survey of historic shipping on the South Australian section of the Murray River (Kenderdine, 1993).

The quality of these reports is very high. They are well researched, informative and functional cultural resource management (CRM) tools. However, beyond CRM agencies their relevance is often minimal. While there is certainly a degree of community liaison, their production has been almost exclusively the domain of professional maritime archaeologists. It is also likely that professional maritime archaeologists make up the bulk of their readership. The impact of these reports on the wreck diving community and the community at large is usually small. Even where volunteers have participated in the field surveys, or in aspects of research, the number of individuals is small and the final shipwreck survey report is primarily the work of one individual.

An exception where a report is more widely read may be Sarah Kenderdine's work on shipping on the South Australian section of the Murray River (Kenderdine, 1993). This report has been in strong demand. It is not yet clear whether this is due to publicity generated through the Muddy Waters Conference that was held in Echuca during the survey period or to publicity that the South Australian Department of Environment and Natural Resources arranged for the launch of the report. It may simply reflect the high level of interest that is intrinsic to communities associated with the Murray River.

The New South Wales community based Wreck Survey Project has been developed in the belief that there are many advantages in returning a degree of control of heritage management to the community where, inevitably, the original push for heritage management originated. This approach is consistent with the general trend in heritage management in New South Wales where there is a concerted push to decentralise heritage management—to identify other agencies, private organisations and individuals who may be able to contribute by adopting specific responsibilities.

This approach is also consistent with the conclusions of an evaluation of the first three-year Underwater Heritage Program in NSW. The focus of that first three-year program was the establishment of clearly articulated policies, procedures and educational strategies and the development of an appropriate infrastructure for their implementation. Nevertheless, the evaluation identified a need to increase local government and community involvement in the documentation, interpretation and protection of underwater cultural heritage. As a result, strategies for the current three-year program have included:

- an update of the Policies and Procedures Manual, produced in 1989 and which will now specifically address the role of communities and local government;
- the development of specific guidelines for distribution to Local Councils to advise on their potential role in underwater heritage management;

However the major strategy in respect to community involvement is the community based Wreck Survey Project.

It is not intended that community based wreck surveys displace the need for professional assessment of significance and recommendations for appropriate management strategies. What they can achieve is much more positive communication links between CRM agencies, community groups and individuals who have an active interest and involvement in shipwrecks from a recreational point of view. These links are also likely to assist in ensuring that published reports about shipwrecks and subsequent management proposals have wider community relevance.

Advantages of community based wreck surveys include:

- linking with existing interests of individuals;
- linking with existing commercial interests of the recreational dive industry (attracting new divers, retaining active divers, gaining publicity);
- linking with and providing a focus for wreck diver courses;
- increasing the range of people involved in shipwreck management;
- increasing the depth of awareness/understanding of shipwreck heritage;
- the project can be structured to involve divers and non-divers.

Maritime Archaeological Associations, with their experience in research and survey, can undertake research on specific wrecks themselves. In addition, they can play a valuable role in promoting the project and in assisting other dive clubs, shops etc. with advice, workshops and so on.

The New South Wales Wreck Survey Project was launched in July by Clean Up Australia Director, Ian Kiernan, at the 1993 Scuba Expo in Darling Harbour, Sydney. A kit to guide contributors has also been

produced and was distributed at Scuba Expo as well as to all subsequent enquiries.

To date some 24 individuals and dive shops/clubs have expressed interest in being involved and about 21 projects are underway. Updates on who is doing what are being sent to dive magazines to help promote both individuals and organizations. The final publication will include acknowledgment, throughout the book, of the contributors and their associated organisations. The information this publication contains will be verified by Department of Planning maritime archaeologists. Its design and presentation will be developed in consultation with the dive industry body Dive Australia.

The objective is to produce an attractive and informative document that is used by divers, general researchers and cultural resource managers. By forming positive, structural links between the community and those who are professionally responsible for shipwreck management, there is enormous potential for cooperation and information exchange.

If maritime archaeologists are seriously intending to establish projects that will make the National Historic Shipwreck Program relevant to the 21st century, we must first ensure that the program is relevant to the wider community.

What better way of ensuring relevance than to involve the community in gathering the information that will guide management decisions.

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Public access to maritime archaeology

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Maritime archaeology in Australia today is a marginalised subject. This is despite a good professional publications record, an established international reputation (largely as a result of the work done in Western Australia) and, most recently, a series of successful AIMA conferences. Part of the reason for the marginal state of maritime archaeology is the continuing attempt to persuade the world that what maritime archaeology does really is significant or important, or at least as good as the sort of things that other disciplines do. It has been suggested that this problem is symptomatic of a young discipline trying to establish itself. Unfortunately this argument is wearing thin after more than two decades of maritime archaeology in Australia and it is largely up to maritime archaeologists to attempt to do something about changing the current situation.

Some of the other reasons why maritime archaeology in this country has been marginalised are that it has been far less successful at establishing a presence within the school curriculum, the University framework, even in basic SCUBA diving training but, most importantly, with significant numbers of the general public. Recognition of the need for maritime archaeology to establish 'a broadly developed public constituency which understands the need for archaeology' is not new (see, for example, Langley & Ungar, 1984: 75 and Jeffery, 1993). However I would argue that it is probably more important now than it has been at any other time in the last two decades. In this paper I am going to concentrate on the relationship between maritime archaeology and the general public rather than with special interest groups with particular needs such as SCUBA divers. In particular I am going to concentrate on providing public access to maritime archaeology through temporary and travelling museum displays.

The theoretical shift within archaeology as a discipline to incorporate post-processual and post-structuralist ideas has led to an increased interest in the relationship between the past and the present and the way in which the past is 'presented' or 'represented' in contemporary society (see, for example, Shanks & Tilley, 1987; Hodder, 1986; Shanks, 1992 and Walsh, 1992). These, and other, authors have suggested that direct interaction with the physical remains of the past is one of the great attractions of any kind of archaeological investigation—the experience of discovering or handling an 'archaeological' object is a major attraction to members of the public. It brings people face to face with the past in an involved, active and existential way rather than the passive and non-interactive manner provided by reading, watching television or listening to lectures.

Maritime archaeologists present themselves and their work to the general public through direct interactions such as field-work and public education programs, through publishing (particularly popular books and articles), the media (television—which is arguably the most effective in terms of the number of people who actually see it) and in the form of exhibitions in museums.

Direct interaction between maritime archaeologists and the general public with regard to field-work has always been difficult simply by the nature of underwater diving operations. Even in the area of working with volunteer divers field-work activities have become increasingly constrained by the on-going saga of the Standards Association–Workcare AS2299 diving regulations. The fact that the general public rarely has the opportunity to view shipwreck sites immediately poses problems in persuading them of the importance of something that they cannot see.

However these problems should not be seen as insurmountable as the public are fascinated by archaeology of any kind and that significant numbers actually want to participate in a 'hands-on' way hence the past successes of volunteer organisations. This also goes some way to explaining why in 1992 the National Maritime Museum had relatively little trouble in persuading more than thirty volunteers, during a two-week period in mid winter, to get up before seven in the morning and spend a full day up to their elbows in mud washing bits of broken glass and ceramic. People are extremely enthusiastic about archaeology and they love nothing more than being involved in the excitement of excavation.

Unfortunately, in some respects but perhaps fortunately in others, maritime archaeologists have done less and less excavation based field-work over the past decade for a variety of reasons. However, there are other ways of involving the public in growth areas like cultural tourism which includes non-diving tours such as the *Check out the Wrecks* tours run by the Australian National Maritime Museum or in courses specifically for SCUBA divers like the Maritime Archaeological Survey Techniques Course run on several occasions since 1988 by the Queensland Museum (see Jeffery, 1990: 73–4). Finding imaginative ways of directly involving the general public in maritime archaeological work is one of the great challenges of the next decade.

Popular publications about maritime archaeology in Australia are relatively few and far between—the only ones written in the last five years which are currently available are *Pandora—an archaeological perspective* (Gesner, 1991) and the *Sirius Past and Present* (Henderson & Stanbury, 1988), while one of the few articles which can be considered 'mainstream' and intended for the general public appeared in *Australian Geographic* in March 1993 on 'The wreck of the *Sirius*' (Henderson, 1993). Certainly this is an area where there are enormous opportunities for

Individual site reports	17
Thematic and site type interpretations	13
Regional or national surveys	12
Conservation, artefact analysis & replicas	7
CRM management & legislation	5
Museum policy and operations	5
High technology (e.g. photogrammetry)	4
Others—miscellaneous	4
Specific artefact types	3
Retrospectives and future directions	2
Amateur associations	2
Aboriginal sites	2
Museum exhibitions	2
Public education	1
Theory	1
Total	81

Table 1. Survey of the AIMA *Bulletins* Vol. 12.1 (1988) to Vol. 17.1 (1993)

raising the profile of maritime archaeology in Australia.

As far as the media goes, a nationally screened television documentary like the recent ABC documentary about the *Pandora,* hosted by the Bush Tucker man Les Hiddens, gets to more people than go to all the maritime museums in Australia in a year. You can argue about what effects television has on creating or changing attitudes, but there is no denying its importance simply by virtue of the numbers of people who watch it.

Finally to museums. As Shanks and Tilley (1987: 68) have argued, the interpretation of artefacts in museums is 'probably the main institutional connection between archaeology as a profession and discipline, and wider society'. There are several ways of viewing and presenting maritime archaeology and the results of maritime archaeological work. The first is as one of a variety of sources of information and material or 'texts' which have passed down to the present from the past. In this way maritime archaeological material together with other material culture (such as museum collections), images, documents and oral history can be used to 're-present' the past. Another way is to view maritime archaeology as a practice within contemporary society and to present it as an 'activity'—what maritime archaeologists do and how they do it. I suggest that divorcing 'the historical past' or the 'archaeological reality' from the contemporary activity of maritime archaeology is impossible and that we need to come to terms with the ideological and political realities of working as maritime archaeologists (see, for example, Horne, 1984 and Walsh, 1992).

One successful example of blending maritime archaeology as a practice with a representation of historical events which does incorporate maritime archaeological material is the exhibition titled 'Yorktown's sunken fleet' which is displayed at the Yorktown Victory Centre in Virginia, USA. This display uses a combination of display techniques such as 'artists impressions' of eighteenth century British warships, drawings and labels which interpret the ships, artefacts which were excavated from the ships, modern reproductions of how the artefacts 'would have looked', reconstructions of the interiors of the ships, modern photographs of the coffer dam used in the archaeological excavation, schematic diagrams showing the archaeological remains, underwater photography showing maritime archaeologists at work and underwater drawing sheets which show part of the product of maritime archaeological work. All of these techniques have been blended to produce an exhibition which not only provides the public with an interpretation of 'the past' but also illustrates some of the techniques of maritime archaeology.

Community access is a hot topic within Australian museums at the present time and finding ways of involving the community in museums is the subject of considerable debate. As Daniel Thomas has suggested access is 'very popular in government and bureaucracy' and a subject of great interest to museum professionals in Australia at the current time (Thomas, 1993: 4). Unfortunately there are no simple answers even when discussing museum exhibitions as there are the competing needs of different groups. Questions like whether it is more important for relatively small numbers of visitors in towns and regional centres in one State to see an exhibition or whether numbers alone are the most important criteria for 'success'? Thus if an exhibition will only be seen in one particular national or State museum, does this have any meaning or value to people who will not see it and perhaps live in another location? Are travelling exhibitions an answer or do the constraints imposed by only being on display for three months in a particular State or venue make them scarcely worth putting on.

Costs are a major factor—many small and some State museums simply cannot, or will not, find the funds necessary to mount major temporary or travelling exhibitions. Finding venues which can fit in a travelling exhibition is another problem faced. Consequently there is a need to work cooperatively in order to establish a

higher priority for maritime archaeology and to generate the funding required to mount quality exhibitions.

Exhibitions cost money, frequently quite large sums of money. Even small temporary exhibitions can cost $30 000 to $60 000 depending on the needs even for quite simple graphics and exhibition hardware. Major travelling exhibitions on the other hand can cost hundreds of thousands of dollars particularly when special showcases, lighting and computer interactives are included. It is interesting to observe that maritime archaeologists are quite prepared to spend these sorts of sums of money on employing staff or on field-work and even, occasionally, on writing up and publishing the results of that field-work but they have rarely invested the same time and resources in mounting temporary and travelling exhibitions. Fortunately the same situation does not apply to the permanent exhibitions in a small number of venues like the WA Maritime Museum and the *Sirius* Museum on Norfolk Island.

To date the only attempt to stage a major nation-wide travelling exhibition of maritime archaeological material in Australia has been the less than spectacularly successful *Shipwreck*! exhibition which toured Australia in 1988; though the Australian tour of maritime archaeological material 'salvaged' from the Tudor shipwreck *Mary Rose* during 1994 to 1996 is awaited with interest. While I would suggest that the comment made by Margaret Anderson that 'the *Shipwreck*!' exhibition was severely constrained by its exhibition brief, which aimed, at least in part, to further deify the activities of Australian maritime archaeologists' (Anderson, 1990: 4) was hardly 'fair', such a view could be said to exemplify the opinions of a significant part of the Australian museum community's view of the *Shipwreck*! exhibition in particular and of maritime archaeology in general.

The title *Shipwreck*! has also been used for a somewhat more successful exhibition which tells the story of the three Spanish ships lost in 1554 on Padre Island, Texas (Arnold, 1992). This exhibition opened at the new Corpus Christi Museum of Science and Technology in Texas in 1990 and is an example which clearly demonstrates the level of fascination that the public has with shipwrecks; though perhaps at some level below that of dinosaurs. For a museum in a city with a population of 274 000 to achieve 227 000 visitors in the first twelve months was a remarkable effort. It can perhaps be seen as a model for the imaginative presentation of maritime archaeological material and as a case study when arguing for funding to support the display and interpretation of such material.

A quick survey of the AIMA bulletin for the eighty-one articles which appeared in the last eleven issues from Vol. 12 No. 1 (1988) to Vol. 17 No. 1 (1993) is particularly revealing about the subjects which maritime archaeologists are writing about (Table 1).

The subject of museum exhibition is right down there close to theory and public education as the least popular subjects for maritime archaeologists in Australia to write about. Fortunately the number of articles written about museum displays on maritime archaeology or displays which incorporate maritime archaeological material is not a direct reflection of their actual occurrence in museums. In fact there are and have been a number of such displays and exhibitions but it is just that maritime archaeologists rarely write about them.

Small displays such as the *Time and Tide* exhibition produced by the Victoria Archaeological Survey which has toured Victoria in recent years has demonstrated that travelling exhibitions are possible. It is noteworthy, however, that VAS has made no attempt to publish the construction methodology employed, the costs involved or the problems faced in the actual production of this exhibition which could act as a guide for future displays.

So what are some of the solutions to the current situation. As usual it comes down to funding and in this respect it must be said that maritime archaeology lies some distance down the political and administrative priority scale. I have made the point that we exist in a post-processual world. Consequently we should perhaps give more thought to the utterances of our politicians and to the relative position which maritime archaeology has within the administrative framework because maritime archaeology like archaeology, as Michael Shanks points out, 'serves contemporary social and political actions and ideologies' (Shanks 1992).

Let us look at contemporary Australian politics. Maritime archaeology is potentially in a very fortunate position as it can lay claim to being a part of both the 'Sciences' and the 'Arts'. At this particular point in time maritime archaeology should consider highlighting its links with the Arts because of the important part which the Arts played in the re-election of the ALP at the last election. If you do not think that there are direct links between political and administrative decision making, the provision of funding, and therefore jobs, and the progress or lack of it in the discipline of maritime archaeology, think about it in these terms—large sums of money do not guarantee success but little or no money guarantees failure.

How many maritime archaeologists have actually read the ALP cultural policy *Distinctly Australian: the future for Australia's cultural development?* More importantly maritime archaeologists need to read political pronouncements like this in terms of 'what does this mean to us'? For example, let us examine an interesting piece of political rhetoric called the 'Distributed National Collection' and the funding commitments which have been made to 'develop and implement objectives for collecting, organising, preserving and communicating material of significance in all collections'. Some $2 million is available in this area over the next four years and another $4 million is available for jointly organised temporary, travelling exhibitions of material held in small museums and other collections. It is in their own interests for maritime archaeologists to see this as an opportunity to fund temporary and travelling

exhibitions which will provide public access to the results of decades of maritime archaeological excavations and investigations.

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Revelations about river boats and 'rotten rows': a guide to wreck sites of the River Murray

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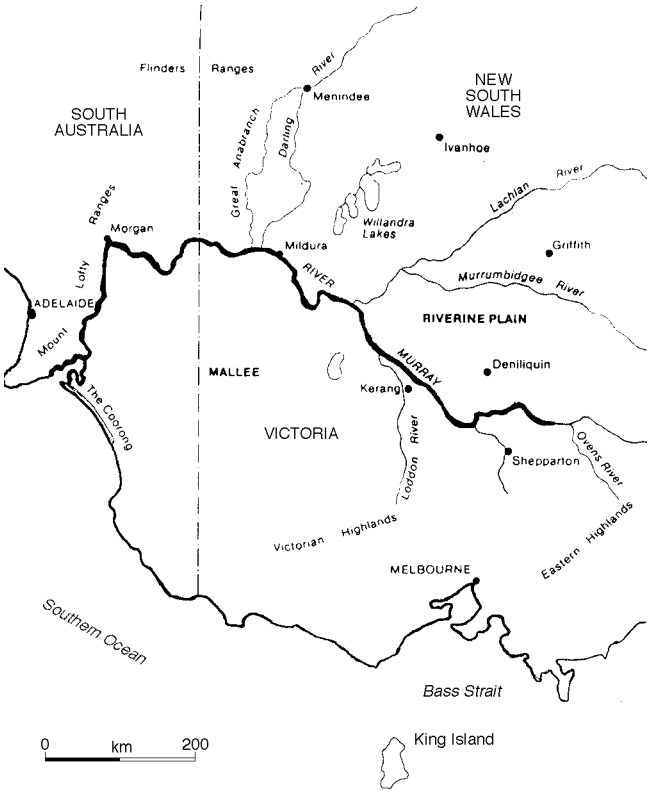

Figure 1. The extent of the combined survey region from New South Wales to South Australia.

Introduction

The purpose of this paper is to describe some aspects of the shipwreck resource that is the remains of historic shipping on the River Murray. The following assessment draws on the investigations conducted as part of two projects undertaken by heritage management departments in three States, South Australia (State Heritage Branch, Kenderdine, 1993a), Victoria (Victoria Archaeological Survey, Kenderdine, 1993d) and New South Wales (Heritage Branch, Kenderdine, 1993d).

Over the last eighteen months the two surveys have involved shipwreck and associated land site location, identification, documentation, assessment and interpretation within a framework of cultural resource management (CRM). The CRM approach was a necessary response to the increasing stress placed on sites through uncontrolled recovery, and a rapid rise in cultural tourism that sought to appreciate historic, economic and technological aspects of the historic river trade.

The 'historic shipping on the River Murray' projects have generated the first substantial maritime archaeological recording undertaken in riverine conditions in Australia. As such, each survey has involved the practice of some unique field-work techniques and demanded cooperation between three States noted for their former parochialism and rivalry during the historic shipping period.

The archaeological sites were documented within a 'cultural landscape' framework that encompasses historic shipping on the River Murray (Kenderdine 1993a, 1993c). This allowed the matrix of terrestrially located sites such as wharves, jetties, landings, slips, docks, crossings, bridges, customs houses, locks and weirs, and even grave sites to be drawn together with the wreck sites of paddle steamers, barges, punts and ferries. Given the volume of material collated on these terraqueous remains the discussion below will be restricted to a synthesis of the shipwreck resource only, together with the potential significance of these maritime archaeological sites for future research.

This synopsis includes a review of the types of vessels employed as part of the historic shipping trade; the number of these that now appear in the archaeological record; the spatial distribution of wreck sites along the river; the evolution of design in paddle steamers; and the adaptation of technology to the riverine environment and the economics of the trade. An overview of the physiological and fluvial dynamics will give insights into how the physical regime affects the submerged cultural heritage resources on the river.

The combined Murray Darling Basin catchment area covers 1/7th of the Australian continent. Its rivers' course transverses 2 500 kilometres from the Eastern Highlands in New South Wales through to the Murray Mouth in South Australia and the Southern Ocean. The extent of the combined survey region is shown in Figure 1.

Historically the river was dubbed the 'Nile of Australia' and its potential as a major transportation network was likened to that of the Mississippi. Settlers, traders and shipbuilders were soon to realise that very different environmental and economic parameters were in operation. The period 1830–1939 defines the chronological limits of what was a dynamic but short lived trade fraught with political intrigue and inter-state rivalry.

The results of these projects form a basis for maritime archaeology 'beyond 2000' by providing direction for future research into a scantily documented Australian shipbuilding industry, and as opportunities for exploring management issues in a multi-jurisdictional and multi-user environment.

Project design and methodology

The State Heritage Branch of South Australia conducted a twelve-month survey during 1992 to assess the remains of historic shipping on the River Murray. The purpose of the project was to identify and develop management strategies for terrestrial based archaeological sites and the submerged or partly submerged wrecks of vessels that lay within the State's jurisdiction. The subsequent report (Kenderdine,

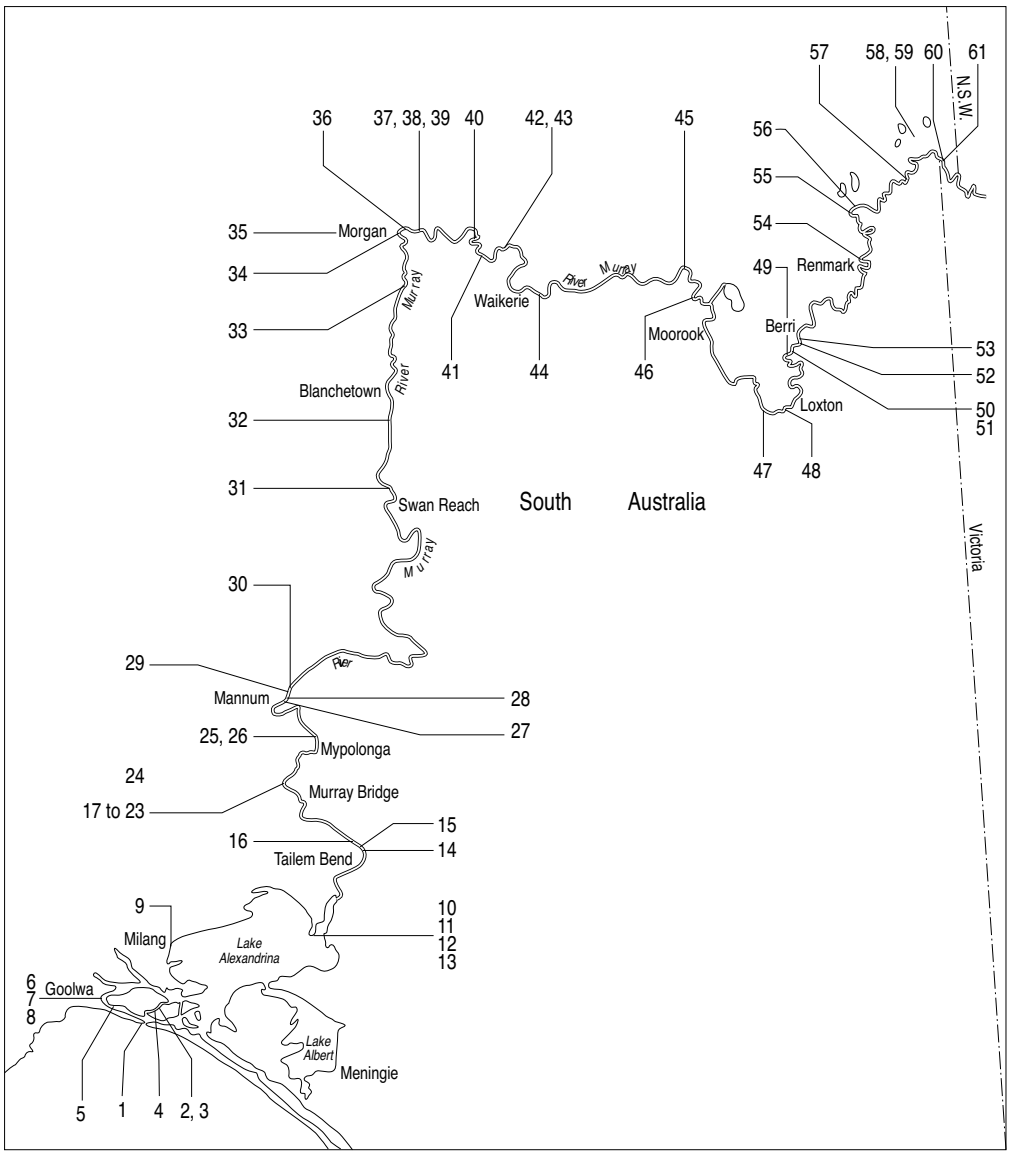

Figure 2. Wreck sites located in South Australia.

1993a) stated as one of its recommendations that a similar survey should be carried out in the New South Wales and Victorian section of the river. This initiated a six-month (May through to November 1993) historical maritime archaeological project.

Jurisdiction of the waterway in this upper section resides with New South Wales to the high water level on the Victorian bank, and the river thereby defines the State boundaries. Many of the services that supported the historic shipping trade were, however, Victorian based. The terrestrial sites that were the infrastructure to the operation of river boats lie on both banks and the dual State project sought to recognise the links between them.

The initial methodological component of each project involved the thorough research of all archival, pictorial and oral sources that would lead to the identification of and aid historical significance assessments of the archaeological sites. Field methodology differed substantially in approach due to the budget and time constraints. In South Australia an integral part of the documentation process involved extensive remote sensing and the verification of sites through diving. Conservation assessments were also carried out on a number of sites. The New South Wales–Victoria (NSW/Vic.) brief stipulated only the recording of sites that were visible at the time of the survey or those known to exist through local knowledge or historical information. In a riverine environment that undergoes substantial fluctuations in level despite the extensive lock, weir and dam system of controls it was fortunate that field-work for this project took place at a time of unseasonally low water.

The success of both projects at a field identification level was largely due to community members along the river who were able to bridge the gap between the archival sources and the actual location of sites. Many participants in field-work were either descendants of those who worked work as river captains or engineers or who were themselves involved in the latter days of operation of the trade.

The existence of many sites entirely submerged in water

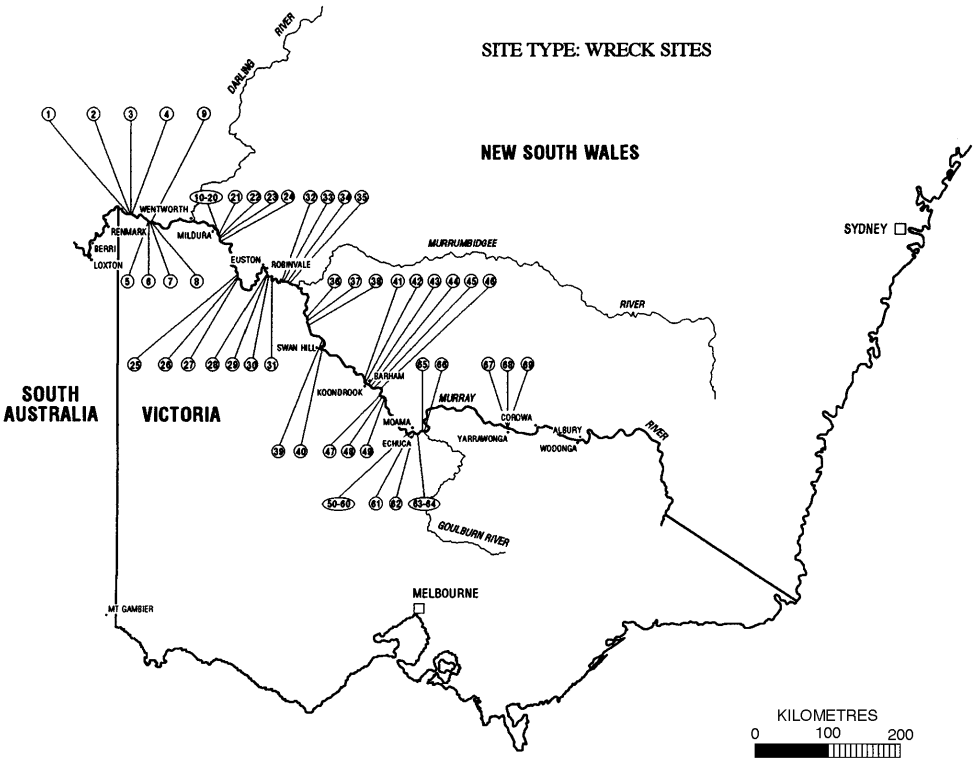

Figure 3. Wreck sites located in New South Wales and Victoria.

made their detection a painstaking process. Sites located in these 'muddy waters' differ from those located at sea in that they are rarely if ever used for recreational purposes and are not likely to be encountered unless very close to the surface or revealed due to low water. On the other hand, they are confined to a relatively discrete geographic region where the depth of water is never more than 20 metres. The climatic conditions are predictable and field-work can be scheduled with accuracy except in conditions where flow is altered through regulation, or during occasional flooding.

The exact location of submerged sites depended almost exclusively on remote sensing techniques with verification of anomalies by diving. Large magnetic anomalies due to the existence of boilers and engines or construction materials were the basis for assessment. The magnetometer proved the most valuable tool for initial location with further delineation as to the extent of remains established through the use of an echo sounder and then diving. When attempting to locate vessels of all wood or minimal ferrous content, the side scanning sonar had the occasional success. This technique, operating as it did in a heavily silted, relatively shallow waterway with numerous snags presented images that were hard to interpret. For further analysis on the operation of remote sensing equipment in the River Murray the reader is referred to Ramsy (in Kenderdine & Jeffery, 1994: 1–8).

Wreck site assessment takes on new meaning for the archaeologist in black water conditions. Without establishing survey lines and grids involving many hours of diving, it is difficult to get even the simplest of dimensions. Unseen snags and structure could easily distort measurements. Given these operating parameters, the identification of a wreck as a particular vessel cannot easily be confirmed, especially where clusters of sites occur together. Detailed analysis of construction techniques through *in situ* observation and partial excavation of a 25-ton wooden cutter *Water Witch* wrecked in 1842 forms the most extensive archaeological documentation undertaken in the river to date. For the difficulties and solutions in field-work methodology used as part this project the reader is referred to Jeffery (1987).

Perhaps the most useful way of assessing riverine wreck sites for management purposes is through obtaining data on deterioration. Corrosion potential measurements are relatively easy to collect with the use of a probe that relays data along a cable from the site to the surface to be displayed and recorded. The information collected as part of the survey in South Australia forms the basis for the comparative analysis of deterioration/preservation for river wreck sites (MacLeod in Kenderdine 1993a: 273–281). These results will be of great benefit to practitioners in other States when they are able to implement similar studies. How environmental constraints such as water quality, dissolved oxygen, low light levels and site turbulence operate in riverine environments could also lead to a better understanding of shipwreck deterioration in marine conditions.

Types of vessels

The wreck sites in the River Murray are reminders of a number of specific functions performed by river boats during the historic shipping period. Some vessels were exclusively designed for a particular purpose while others were relegated

State jurisdiction	Number of wreck sites
New South Wales	65
South Australia	61
Victoria	4

Table 1. Number of wreck sites in each State jurisdiction.

to a number of duties. Paddle steamers were employed as hawking vessels delivering goods to settlers; mail steamers provided the essential service following the overland routes to Melbourne; mission boats travelled the river offering the services of chapel and priest; as passenger vessels they revived a trade in decline and offered viable services as late as the 1950s. As commercial trading steamers, they were responsible for the transport of wool and timber, hides and wheat from the upper reaches to railheads of downstream ports; they were used for lock building and in irrigation developments; or developed as snagging steamers for the maintenance of a navigable channel.

Barges hauled the majority of produce from the upper river to transit points. Up to three at a time were pushed by steamers, towed or lashed alongside. They were used in lock construction carting tons of quarried rock to various construction points along the river. Also, they were converted to pump supports for use in the development of irrigation.

A host of small fishing schooners supported a major fishing industry in the lower lakes system. Small motor launches were used for milk collection in the pastoral districts of the lower river. Ferries or punts provided a vital link across the river at various points along it. Obsolete ferries were often put to use transferring livestock to richer pastures over the creeks and end branches of the surrounding river land.

The wreck resource

The total number of wreck sites identified in the River Murray at the completion of the second survey was 130. The proportion of wreck sites in each State's jurisdiction is shown in Table 1. The low number of sites recorded in Victoria is determined by a legal definition initially enacted in the *River Murray Act 1915* which gives jurisdiction over the river bed to the high water level to New South Wales. The number of vessels constructed between 1850s and 1920s consisted of 218 paddle steamers and 147 barges. The wreck resource identified comprises approximately one third (28.0%).

Further review of the wreck sites totals show paddle steamers and barges tend to predominate in the types of vessels that make up the resource (Table 2). The basis for this analysis was rig type as it was recorded at time of wrecking and does not account for the various construction changes that a vessel may have undergone during its operating period on the river, or the purpose for which the vessel was originally intended.

Figures 2 and 3 show the location of wreck sites identified in the two surveys, and Tables 3 and 4 detail vessel names, rig type and environmental status at the time the site was inspected (part submerged, dismantled, submerged or under restoration). Examination of the spatial distribution

State	Paddle steamers	Barges	Ferries	Other
New South Wales	18	37	1	9
South Australia	27	20	6	8
Victoria	0	1	3	0

Table 2. Number of vessel types wrecked in each State.

the wreck resource is further discussed below.

Wreck site environment

The wreck sites currently (at time of survey) reside in three basic environments (Table 5). These largely determine the nature of the archaeologist's site inspection, survey, excavation and recommendations for management. It is also the determining factor in the preservation of sites. Given the fluctuations in river levels it is possible that riverine sites are frequently exposed and then inundated. The field-work program (June, July, August 1993) for the NSW/Vic. survey was undertaken during exceptionally low water. Recent flooding (October 1993) in the region recorded levels comparable with the last historic flood of 1957 and caused millions of dollars worth of damage. All sites recorded as part of the survey, including terrestrially located sites, were inundated and subject to a new set of environmental parameters resulting in burial, siltation and possible destruction from flood waters.

There are basic geomorphic and hydrologic processes occurring in the River Murray that are of particular significance to the submerged sites: they are entrainment or erosion, transportation, deposition of debris and sediment, lateral and downstream migration of the channel and the cut-off at meander bends (for a full discussion on these processes see Kenderdine, 1993a: 14–16). The first problem that the archaeologist has to consider when assessing site integrity is how much of the original deposit is likely to remain *in situ*. Have materials from sites become entrained and re-deposited, and if so where? What is the extent of deposition of sediment around the site and how does this fluctuate during periods of change in river flow? What effects do periods of inundation have on partially submerged sites?

Activity associated with the regulation of the river and recreational users of the waterway also have potentially significant effects on sites. For example, the wash created from motor boats contributes to river bank erosion causing red gum stands to fall into the water. The possible effect that these sorts of activities have on the increasing lacunae in partially submerged sites are all part of the management concerns for riverine archaeology.

Process of wrecking

In order to make a significance assessment of vessels that form part of the wreck resource, and to formulate recommendations for these, it is useful to establish the mode of deposition or process of wrecking. This information is of particular relevance for vessels that have not been sighted

Ref. No.	Name	Last known rig	Position
1	*Melbourne*	paddle steamer	submerged
2	*Albert*	barge	dismantled
3	*Wilcannia*	paddle steamer	dismantled
4	Ex Narrung Punt	punt	part submerged
5	*Showboat*	twin screw motorboat	part submerged
6	*Renmark*	paddle steamer	submerged
7	*Uranus*	barge	part submerged
8	*Albion*	barge	dismantled
9	*Invincible*	paddle steamer	dismantled
10	*Waterlilly*	screw vessel	submerged
11	*Mosquito*	schooner	submerged
12	*Bullfrog*	cutter	submerged
13	*Sunbeam*	screw steamer	submerged
14	*Roma*	paddle steamer	submerged
15	unid. barge 1	barge	part submerged
16	*Pearl*	barge	submerged
17	*Murrundi*	paddle steamer	submerged
18	*William Davies*	paddle steamer	submerged
19	*Merle*	paddle steamer	submerged
20	*Eva*	paddle steamer	submerged
21	*Bijo*	paddle steamer	submerged
22	*Columbia*	barge	submerged
23	*Alfred*	stern wheel paddle steamer	submerged
24	*Tyro*	paddle steamer	submerged
25	*Bourke*	barge	submerged
26	*Queen*	paddle steamer	submerged
27	*Saddler*	paddle steamer	submerged
28	*Mary Ann*	paddle steamer	submerged
29	*Koondrook*	barge	dismantled
30	*Struggler*	paddle steamer	submerged
31	unid. Punt 1	punt	part submerged
32	*Water Witch*	cutter	submerged
33	*Swallow*	screw steamer	submerged
34	*Crowie*	barge	submerged
35	*Corowa*	stern wheel paddle steamer	part submerged
36	unid. Barge 2	barge	submerged
37	*Annie*	barge	part submerged
38	*Ormond*	barge	part submerged
39	*Loxton*	barge	part submerged
40	unid. Punt 2	punt	submerged
41	*City of Oxford*	paddle steamer	submerged
42	*Cobar*	barge	part submerged
43	*William R. Randell*	paddle steamer	part submerged
44	*J.G. Arnold*	paddle steamer	submerged
45	*Vesta*	paddle steamer	submerged
46	Derrick 1	barge	submerged
47	*Jolly Miller*	paddle steamer	submerged
48	unid. Punt 3	punt	part submerged
49	*Renella*	paddle steamer	submerged
50	*Archilles*	barge	part submerged
51	*Ajax*	barge	part submerged
52	*Undaunted*	ketch	submerged
53	*Ventura Ii*	paddle steamer	submerged
54	*Milang*	paddle steamer	submerged
55	*Jessie*	barge	submerged
56	*Kelvin*	paddle steamer	part submerged
57	Chowilla Punt 1	punt	part submerged
58	Chowilla Punt 2	punt	part submerged
59	*Bunyip*	paddle steamer	submerged
60	*Albermarle*	barge	part submerged
61	*Wardell*	steam snagging barge	part submerged

Table 3. South Australian wreck sites.

Ref. No.	Name	Last known rig	State	Status
1	*Croupier*	barge	VIC	part submerged
2	unid. ferry LI	ferry	VIC	part submerged
3	unid. ferry L2	ferry	VIC	part submerged
4	unid. ferry L3	ferry	VIC	part submerged
5	*Manno*	dredge	NSW	part submerged
6	*Success*	paddle steamer	NSW	part submerged
7	*Emerald*	barge	NSW	part submerged
8	*Sapphire*	paddle steamer	NSW	part submerged
9	90 ft derrick	derrick	NSW	submerged
10	*Jane Eliza*	paddle steamer	NSW	submerged
11	*Cowirra*	barge	NSW	dismantled
12	*A.11*	barge	NSW	part submerged
13	unid. barge BI	barge	NSW	submerged
14	unid. barge B2	barge	NSW	submerged
15	unid. barge B3	barge	NSW	submerged
16	unid. barge B4	barge	NSW	submerged
17	*Alpha*	paddle steamer	NSW	submerged
18	*Fairy*	paddle steamer	NSW	submerged
19	*Victoria*	paddle steamer	NSW	submerged
20	*Reliance*	paddle steamer	NSW	submerged
21	*John Campbell*	barge	NSW	dismantled
22	*Susan*	barge	NSW	submerged
23	*Daisy*	barge	NSW	submerged
24	unid. barge RC1	barge	NSW	part submerged
25	*Moorabin*	barge	NSW	submerged
26	*Alice*	barge	NSW	submerged
27	*Florence Annie*	barge	NSW	submerged
28	*Maude*	paddle steamer	NSW	submerged
29	*Maori*	barge	NSW	submerged
30	*Alert*	paddle steamer	NSW	submerged
31	unid. wreck ER1	?	NSW	part submerged
32	unid. ferry BB1	barge	NSW	part submerged
33	unid. barge BB1	barge	NSW	part submerged
34	*Canally*	barge	NSW	part submerged
35	*Hero*	barge	NSW	submerged
36	*Lil Ruby*	paddle steamer	NSW	submerged
37	*Alawein*	?	NSW	part submerged
38	*Kookaburra*	paddle steamer(sw)	NSW	part submerged
39	unid. wreck SH1	?	NSW	submerged
40	*Mundoo*	paddle steamer	NSW	submerged
41	*Banyula*	paddle steamer	NSW	part submerged
42	unid. barge KB1	barge	NSW	part submerged
43	unid. barge KB2	barge	NSW	part submerged
44	unid. barge KB3	barge	NSW	part submerged
45	unid. barge KB4	barge	NSW	part submerged
46	*Glimpse*	paddle steamer	NSW	submerged
47	unid. ferry BS1	ferry	NSW	dismantled
48	unid. barge BS1	barge	NSW	part submerged
49	unid. barge BS2	bargw	NSW	submerged
50	unid. wreck E2	?	NSW	part submerged
51	unid. barge M1	barge	NSW	part submerged
52	unid. wreck E1	?	NSW	submerged
53	*Free Trader*	barge	NSW	submerged
54	*Whaler*	barge	NSW	dry
55	*Impulse*	barge	NSW	dry
56	*Clyde*	barge	NSW	part submerged
57	*Riverina*	ketch	NSW	submerged
58	*Lady Augusta*	barge	NSW	submerged
59	B.22	barge	NSW	part submerged
60	*Murrumbidgee*	barge	NSW	part submerged
61	*Tam O Shanter*	barge	NSW	part submerged
62	unid. barge M2	barge	NSW	submerged
63	*Australien*	paddle steamer	NSW	dry (restoration)
64	*Edwards*	paddle steamer	NSW	dry (restoration)
65	*Murray*	barge	NSW	part submerged
66	unid. barge E3	barge	NSW	submerged
67	*Pilot*	paddle steamer	NSW	submerged
68	*Federal*	barge	NSW	submerged
69	*Rita*	paddle steamer	NSW	submerged

Table 4. New South Wales and Victorian wreck sites.

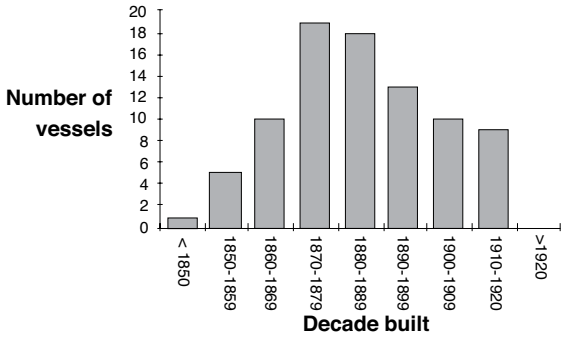

Figure 4. Number of registered vessels from the wreck resource built per decade.

and are known only through historical, archival and oral source confirmation.

The 'date of wrecking' so often applied to shipwreck sites at sea around Australia is not available in most cases for River Murray wrecks. The majority of vessels were recorded as having been 'abandoned' or to have 'sunk'. With no absolute date for wrecking it is impossible to speculate on the average life span of vessels. Within the survey region it appears that some vessels were not lost until the late 1940s and early 1950s, several decades after the recognised trade had finished. The use of these vessels in the tourism industry was perhaps a reason for the extended period of their operation.

An understanding of the process of wrecking is important because it relates to the expected condition of remains. Abandonment and eventual sinking implies that a vessel would have been stripped of all moveable items, and even the not so moveable but valuable boiler and engines. Cargoes and material remains of the crew would be unlikely to remain in the archaeological record. However, it is by examining the extant remains of vessels that potentially leads to an accurate chronology of design and a typology of machinery, boilers and engines which could reflect the environment, economy and function of these vessels.

Examination of the government documents on shipping casualties that record shipwrecks and other non-fatal accidents to vessels revealed few of these. Newspapers and personal accounts including oral histories and diaries, together with the records of shipping companies and the markings on river charts give an idea of the sorts of hazards that were commonly involved in vessel stranding and wrecking. These included numerous snagging, foundering and references to wind and dust storms, boiler explosions and burning. Unexpected floods and sudden drops in the river levels could leave a vessel stranded, with broken back, or filled with water.

Snags were early recognised as hazards to navigation and presented a formidable danger to all riverine craft, but the lightly constructed, powerful and overloaded steamboats were especially vulnerable. It is not known how many of the registered 'sinking' can be attributed to snags. Examination of sites could reveal such information.

Boiler explosions were especially destructive, although

Environment	Number of sites
Submerged	70
Part submerged	49
Dry (dismantled)	7
Dry (restoration)	4

Table 5. Number of sites located in different wreck environments.

no vessels in the wreck resource in New South Wales and Victoria are known to have been sunk from this cause. Fire was the most destructive of steam vessel disasters. Wood for the steam engine was stored in the strike hold, quite near the firebox. It was possible for sparks to settle and smoulder and later flare (Tucker, 1985: 70). The practice of carrying flammables such as gunpowder and kerosene was common, and could only contribute to the rapid and severely destructive fire. Fires would destroy a wooden or composite vessel at least to the water-line.

Dust storms in the river region often limited visibility to a few feet. Navigation during these times was especially hazardous. Floods in areas where the river-banks were devoid of trees also presented difficulties and navigators would be unsure whether they were still on the main channel or transversing the plains of the surrounding river land. Overhead cables, trees and other structures also presented hazards especially to those barges laden several tiers high with wool.

Spatial analysis and site distribution

Some predictable but informative indicators about the process of wrecking and the development and decline of the trade can be observed in the distribution of sites along the River Murray. An initial analysis of the clusters of sites tends to indicate the following:

- there are a greater number of wreck sites found per river mile in the lower South Australian section of the survey region perhaps suggesting that, as the trade declined, vessels delivered their last services downstream with no requirements to return upstream for further cargo;
- in the New South Wales and Victoria section of the river, clusters of sites occur adjacent to former sawmilling operations. A high proportion of barges were abandoned as the timber resource became more scarce and mills ceased to operate;
- the types of vessels that predominate in various areas of the river also indicate trends in historic shipping on the river. In the lower section, wrecks associated with the operation of milk boats and launches, and those involved in the lock building and barrage construction have tended to remain where they were last used;
- tributaries off the major river channel have acted as graveyards for vessels offering a disposal area that did not interfere with the navigation of the main stream;
- clusters of sites also occur in association with major ports usually at an area that can be identified from historical sources as the 'rotten row', a section of deep water and

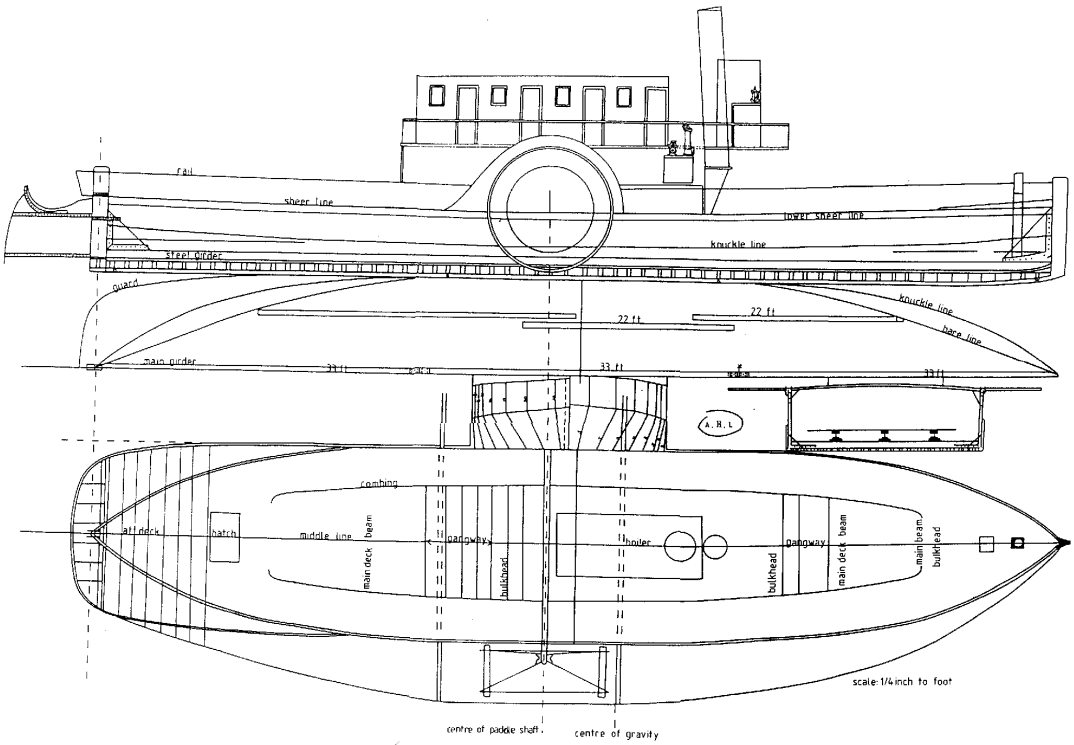

Figure 5. Lines plan for the PS *Tarella*, redrawn from the original, Kenderdine, 1993.

high flow downstream or upstream from the wharf or port, usually on the concave meander where vessels were either relegated at the end of their economic viability or were moored during low waters, often sinking on the first flood waters of the following season;

- the remains of ferries can be found in clusters in tributaries or at the point of major crossings. The use of ferries in the transportation of livestock across the backwaters and anabranches of farm land was common. This has tended to help in the preservation of the sites. Those that have survived are generally found in inaccessible areas;
- mid-stream, deep water areas associated with major ports are another area in which sites are concentrated. The wreck sites found at these points usually result from the operations of government departments responsible for maintaining the navigable waterway. They have often been subject to dynamite and dragging to deep water.

Wreck site distribution tends to reflect the dynamics of the decline in the river economy and trade, the advent of the railways and the building of bridges, and the adaptation of alternative forms of technology that helped supersede the River Murray steamer as a form of transport. The depletion of resources, especially of the red gum forests, and the changing value and nature of cargo types also contributed to the decline. The steamers were most suited to the transport of bulk, low cost, non-perishable goods, not the expensive wool clips destined for the overseas markets where speed of delivery was essential to successful competition in the arenas of trade.

The inefficiencies of the waterborne transport were confounded by the seasonality of the operation, the difficulties of operating in a riverine environment, the confusing interstate politics, parochialism and border disputes which contributed to the difficulties of maintaining the trading networks.

Port built and numbers of sites

The places of construction for the vessels generally reflect trends known to have existed through analysis of historical records for the number of vessels built per port. Table 6 shows a break-down of ports versus registered vessels that occur in the wreck resource. The large number of unknown ports for construction is due primarily to the lack of registration details for some vessels. Spatial analysis with regard to ports and wreck site distribution that may reveal aspects of the nature of wrecking and spheres of operation of vessels, has yet to be explored.

Decade built and number of sites

By placing vessels from the wreck resource into decades of construction it is possible to see that the wreck resource corresponds to a peak in the trade known to exist historically in terms of volumes of cargoes shipped. The continuing number of vessels constructed in the latter historic period is perhaps a reflection of the demands of the lock and weir construction, the development of agriculture and the continued demand for timber barges. The number of vessels represented in Figure 4 is restricted to those that have been documented in shipping registers.

Adaptation of technology

The riverboat was a particular expression of a combination of ecological, economic and technical factors which met the

Figure 6. A multitubular boiler on the remains of the PS *Banyula* wreck site, NSW. Kenderdine, 1993.

needs of the trade...(Murphy & Saltus, 1981: 169).

The River Murray steamer and barge were uniquely adapted to the conditions in which they operated. The design of the vessels was entirely in response to the local demands and economic and raw material constraints, and was not a tradition that drew from a pre-existing knowledge of riverine shipbuilding in Australia. Vessel construction was primarily undertaken by individual craftsmen. Many were immigrants from Europe, and those with boat building experience may well have gained this in the marine tradition.

The evolution of paddle steamer design is significant in the history of shipbuilding in Australia. Early speculations and proposals as to the form of vessel that could negotiate the riverine conditions was subject to debate.

> A proposal for navigating the Murray by means of large flat-bottomed boats, similar to the liy-boys of the Thames, and propelled by screw or paddles, worked by a windmill, was laid before several influential parties between two and three months since. I regret that your correspondent 'X' should find in me a rival claimant to the invention; and even I was disappointed in learning from Mr. Davy that the plan was actually tried in England some years since, when it was found that on smooth water the vessel might be propelled at a fair speed, even directly against the wind (*South Australian Register,* 15 July 1848).

Several patent applications proposed specifications for 'feathering floats of a paddle steamer to remove the

Port	Number of vessels built
Echuca	25
Goolwa	11
Morgan	11
Moama	7
Koondrook	3
Mundoo Is	2
Mannum	2
Overseas	2
Gunbower	1
Other	10
Unknown	58

Table 6. Number of vessels built at different ports.

obstruction of the backwater which checks the progress of the vessel' (Department of Patents, Commonwealth, ref. no. V 63/1857).

The proposed specifications for a new 'turning and steering paddle' was described as overcoming the problems associated with operating in the riverine environment.

> In river navigation its utility may be easily understood. In the rivers of these Australian Colonies, and elsewhere bends frequently occur and of many of these the angles are so acute that the corners are not turned without difficulty, danger and considerable delay in stowing, stopping or reversing the engine. At these turns often the steam strikes the vessel at her bow passes the point cants her head off and before she can be rounded again she is swept on the bank in the bight opposite sometimes getting snagged and damaging cargo all which a few strokes of the new turning and steering paddle if adopted might avert (Department of Patents, Commonwealth ref. no. V11/1857).

Despite the claims, both these patents were refused for reasons not stated.

Captain Randell claimed never to have seen a paddle steamer before he designed and constructed (together with two house carpenters and a blacksmith) *Mary Ann*, the first trading vessel on the river in 1853. This vessel was renowned for its square boiler bound with chains. The hull structure was subject to alterations immediately following its inaugural voyage. The other vessel that is credited as the first to successfully navigate for the inland waters trade purposes was *Lady Augusta*. Built at Pyrmont, Sydney, by a shipwright of marine tradition this vessel was initially described as being:

> ...a compact and beautiful little steamer. She is built in something like the style adopted on the American rivers, being very sharp, of light draft and fitted with a hurricane deck... (*South Australian Register,* 26 August 1853).

The vessel was steamed across from Sydney and through the Murray Mouth before commencing trade on the river. However the following observation was made about the vessel:

> …despite being professionally built to Cadell's design, proved unsatisfactory and her engines were modified and feathering floats added… (Parsons, 1990: 18).

Name	Const	Date Built	Port Built	Ton (Gr)	Ton (Nett)	Len	Bre	Dep	L:B	B:D	L:D
Success	Comp	1877	Moama	129	97	82.7	16.5	6	5.01	2.75	13.78
Sapphire	Comp	1904	Morgan	26	6	70.6	12.6	2.9	5.60	4.34	24.34
Jane Eliza	Iron	1867	Moama	120	97	106.4	21.1	6.9	5.04	3.06	15.42
Alpha	Comp	1899	Mannum	43	19	72.6	13.4	3.6	5.42	3.72	20.17
Fairy	Wood	1881	Moama	36	26	54.6	14.4	3.8	3.79	3.79	14.37
Victoria	Comp	1884	Mundoo Island	27	11	62.1	11.3	3.8	5.50	2.97	16.34
Daisy	Wood	1896	Echuca	20	12	51.5	11.4	4	4.52	2.85	12.88
Florence Annie	Comp	1882	Echuca	187	137	77.5	25.6	6.2	3.03	4.13	12.50
Maude	Iron	1885	Echuca	32	23	60	13.7	4	4.38	3.43	15.00
Alert	Wood	1879	Echuca	95	60	74	15.3	6	4.84	2.55	12.33
Canally	Wood	1907	Koondrook	93	53	92	21	6.4	4.38	3.28	14.38
Hero	Wood	1874	Echuca	137	108	92.2	17	6.3	5.42	2.70	14.63
Kookaburra	Comp	1911	Goolwa	350	233	141	16.8	9.3	8.39	1.81	15.16
Mundoo	Comp	1875	Mundoo Island	27	22	69.3	12.3	4	5.63	3.08	17.33
Glimpse	Wood	1886	Koondrook	27	21	60	13	4	4.62	3.25	15.00
Free Trader	Wood	1872	Cornella Creek	93	82	96.8	18.7	6	5.18	3.12	16.13
Clyde	Iron	1884	Echuca	44	38	65.4	16.6	4.6	3.94	3.61	14.22
Riverina	Iron	1866	Echuca	87	76	72	14.4	5	5.00	2.88	14.40
Lady Augusta	Wood	1852	Pyrmont	90	29	97.8	11	5.4	8.89	2.04	18.11
Murrumbidgee	Comp	1865	Echuca	108	77	83.2	16.6	4.6	5.01	3.61	18.09
Australien	Comp	1897	Echuca	58	37	78	16	5	4.88	3.20	15.60
Edwards	Wood	1875	Echuca	78	27	82.8	16	5.2	5.18	3.08	15.92
Murray	Comp	1867	Pt Adelaide	88	34	110.1	19.3	6.4	5.70	3.02	17.20
Pilot	Comp	1883	Goolwa	50	32	71.5	16.5	4.7	4.33	3.51	15.21
Mary Ann	Wood	1852	Mannum	20		55	9.4	6.4	5.85	1.46	8.59
Melbourne	Iron	1852	Glasgow	153	97	134.5	17	8.3	7.91	2.05	16.20
Bunyip	Wood	1858	Mannum	14	10	100	123	5.7	8.30	2.10	17.54
Queen	Comp	1865	Goolwa	103	75	81	18.3	4.2	4.42	4.35	19.28
Jolly Miller	Iron	1866	Goolwa	93	83	90.7	18.5	5.7	4.90	3.25	15.91
Alfred	Iron	1867	Echuca	116	79	92.3	13.7	4.6	6.74	2.95	20.07
Vesta	Wood	1867	Goolwa	29	22	72.4	11	4.2	6.58	2.62	17.24
Corowa	Iron	1868	Moama	96		94.8	19.9	6	4.76	3.32	15.80
W R Randell	Wood	1870	Bama	63	25	84.3	16.2	4	5.20	4.05	21.08
Tyro	Comp	1872	Goolwa	72	52	106.8	15.1	5.6	7.07	2.70	19.07
Murrundi	Comp	1875	Adelaide	135	80	106.8	16.6	6	6.54	2.77	18.10
Wilcannia	Wood	1875	Milang	128	88	107.3	18.2	7.5	5.90	2.43	14.31
Undaunted	Comp	1875	Echuca	27	23	62.7	13.5	4.2	4.64	3.21	14.93
Saddler	Wood	1877	Echuca	92	58	70.5	15.8	6	4.46	2.63	11.75
Milang	Comp	1878	Milang	43	33	72.4	13.6	4.5	5.32	2.96	15.74
Roma	Comp	1884	Moama	67	58	79.4	20.9	4.2	3.80	4.95	18.90
Invincible	Comp	1889	Echuca	84	44	91	20.2	5.5	4.50	3.65	16.55
Pearl	Comp	1889	U.K.	213	186	110	24.2	3.5	4.55	6.91	31.43
City Oxford	Comp	1890	Mildura	29	23	64.9	11.1	3.4	5.85	3.26	19.10
Eva	Comp	1891	Echuca	29	9	48	8.3	3.6	5.78	2.31	13.33
William Davies	Comp	1893	Echuca	62	39	80	16.3	4.1	4.91	3.97	19.46
Sunbeam	Comp	1895	Morgan	12	9	51	9.7	3	5.26	3.23	17.00
Ventura 11	Comp	1906	Morgan	117	87	85	15.9	4	5.35	3.95	21.25
Kelvin	Comp	1912	Goolwa	118	67	104	15.4	4.9	6.75	3.14	21.22
Renmark	Comp	1912	Goolwa	151	64	111.9	20.6	5.3	5.43	3.89	21.11
J.G. Arnold	Comp	1917	Mannum	104	30	98	18.1	4.7	5.41	3.85	20.85

Table 7. Register details for paddle steamers appearing in the wreck resource.

By 1869 the vessel had its engines removed and operated as a barge. Reports in 1875 indicate the vessel was broken up or had been abandoned several years previously.

The various design features of paddle steamers and barges including keel, bow and stern forms, rudders, bulkheads, towing posts and paddle wheels, and reasons for the adoption of side paddle wheels over stern ones; of wheels versus the viability of screws for operation in the river, are outlined in Kenderdine (1993a: 148–68). While examination of these design attributes are beyond the scope of this paper, characteristics of adaptation to the River Murray and operation of the trade can be reviewed in response to environmental, economic and technical stimuli.

Ultimately the development of a chronology of steamboat design and construction is sought. The archaeological resource is the last place in which the information required to make such an analysis resides. Contemporary records such as newspapers do have the potential to yield some technical data, however their systematic investigation was beyond the scope of the two projects. Several lines plans and half models are the only archival references that remain as examples of the design of these vessels. Figure 5 shows, as an example, the general lay-out plan for the composite paddle steamer *Tarella*, built in 1897. The plans bear the initials of the owner of the vessel (A.H. Landseer) and not those of the shipwright.

Given the diverse types of vessels undertaking numerous different activities on the river, and the fact that these vessels were constantly subject to alteration and repair, it is difficult to generalise about ship construction. Paddle steamers were often converted to barges and vice versa as the demands made on them changed and the ability of vessels to perform the functions required of them were realised. Steamers were converted from side paddles to screw, or were fitted out with diesel engines in the latter part of the historic period.

Adaptation to operating environment

As already stated, it was the physiological aspects of the river that had a direct influence on the operation and design of paddle steamers and barges. Most of the river's waters come from the Australian Alps from a height of 1 430 metres. If this is compared to the 7 000 metre drop from which the Ganges flow from the Himalayas it is possible to understand the low energy and flow of the River Murray. What also characterises the river's flow is the small catchment area compared to the size of the basin, and the fact that there are few tributaries adding to the total flow, especially as the river moves westwards through a semi-arid zone (Rutherford 1990: 17–8).

Near the sea, the river falls less than 1.6 centimetres per kilometre. The waters are shallow and seasonal. Another of its most interesting characteristics is the meandering nature of the river form. Navigators were aware that the length of their journey was often increased three times because of the torturous course dictated by the Murray. There were even suggestions in the 1880s that the necks of meander bends be cut through to make trips shorter. Natural retail cuttings were formed when the force of the river in flood time made a new passage for itself. These were narrow and hazardous for paddle steamers although effective in reducing travel time in a competitive and seasonally restricted trade.

Adaptation to the form of the river itself can be seen in the following basic design characteristics:

- the steering wheel was placed at a high forward vantage point so that a watch could be kept for shoals, sand-bars and snags, and large head-lamps were mounted on each side of the wheel-house (Sexton, 1975: 139);
- wooden hulls were able to absorb the impact of navigation hazards flexing under the force. The development of composites and iron topsides prevented the problems of shrinkage of hull timbers above the water-line subject to the harsh Australian sun. Iron hulls were avoided because of the difficulties of finding leaks between riveted plates and conducting repairs in remote locations;
- a flat bottom was essential to keep draught to a minimum so that vessels could avoid snags and keep operating until low water finally prevented navigation. Marine vessels have central keels to aid sailing to windward and this appendage is not generally necessary in riverine environments except in lake systems. Keels would have increased the draught of the vessel and dug deeply into the numerous sand bars and banks that were the predominant navigation hazards of the River Murray. The structural function of the keel therefore was most often served by a number of keelsons and of bulkheads set at intervals across the beam of the vessel;
- paddle wheels were almost universally adopted, their rugged simple construction well endured the heavy

Name	Const	Date Built	Port Built	Ton (Gr)	Len	Bre	Dep	L:B	B:D	L:D	L:D
Bourke	Iron	1876	Milang	77	103.00	17.70	5.50	5.81	3.22	18.69	13.78
Jessie	Comp	1877	Echuca	236	107.00	22.40	8.40	4.78	2.60	12.74	24.34
Albert	Comp	1882	Mundoo Island	11	41.00	11.20	3.20	3.66	3.50	12.81	15.42
Cobar	Comp	1882	Goolwa	113	100.00	20.10	7.20	4.97	2.79	13.88	20.17
Albermarle	Iron	1884	Goolwa	57	80.00	17.20	5.20	4.65	3.21	17.18	14.37
Uranus	Comp	1886	Moama	93	119.00	24.60	4.00	4.83	6.15	29.70	16.34
Annie	Comp	1894	Moama	106	85.00	20.00	5.00	4.25	4.00	17.00	12.88
Columbia	Comp	1901	Echuca	23	63.00	13.60	4.00	4.63	3.40	15.75	12.50
Ormond	Comp	1908	Echuca	61	81.00	16.10	4.90	5.03	3.29	16.53	15.00
Crowie	Comp	1911	Goolwa	290	152.00	29.90	7.90	5.07	3.78	19.20	12.33
Koondrook	Comp	1912	Koondrook	156	119.00	24.20	8.20	4.95	2.95	14.62	14.38
Loxton	Comp	1912	Goolwa	78	101.00	18.50	5.00	5.46	3.70	20.20	14.63
Croupier	Iron	1881	Morgan	87	120.00	20.10	3.80	5.97	5.29	31.55	15.16
Emerald	Iron & Steel	1899	Morgan	89	126.00	20.70	5.70	6.09	3.63	22.11	17.33
Cowirra	Iron	1923	Mannum	235	131.00	26.80	8.10	4.88	3.31	16.16	15.00
John Campbell	Wood	1877	Echuca	243	121.00	28.30	7.60	4.26	3.72	15.87	16.13
Susan	Comp	1884	Echuca	59	86.00	18.00	5.00	4.78	3.60	17.20	14.22
Alice	Comp	1867	Echuca	60	75.00	14.00	6.00	5.36	2.33	12.50	14.40
Maori	Comp	1883	Echuca	110	94.00	21.00	5.60	4.48	3.75	16.79	18.11
Impulse	Wood	1885	Koondrook	95	80.00	18.00	4.60	4.44	3.91	17.39	18.09
B22	Wood	1922	Echuca		82.00	17.00		4.82			15.60
Tam O'Shanter	Wood	1872	Gunbower Island	81	73.00	16.60	5.20	4.40	3.19	14.04	15.92
Federal	Comp	1899	Echuca	75	88.00	17.00	5.30	5.20	3.21	16.68	17.20

Table 8. Register details of barges in the wreck resource.

punishment given by numerous snags, floating logs and fixed obstructions. Frequently broken wheel arms and floats were easily repaired. In their simplest form the wooden floats were bolted directly onto the iron arms of the wheel. The greater the width of the float the more effective the wheel. However, supporting the extra weight was a limiting factor in this design. The depth of immersion of the paddle wheel was limited by the draught of the vessel. Any extension below the hull of the boat was obviously subject to hazard. Paddle shafts were connected and therefore could not operate independently.

In comparison to vessels on the American rivers such as the Colorado and Mississippi, River Murray steamers were much smaller and in most cases utilised side wheels. The several paddle steamers built with stern wheels, following the American prototype, were found not to be manoeuvrable in the twisting bends and shallow slow moving waters of the Murray; their design was more suited to the fast flowing rivers with gentle bends and long reaches. Stern wheelers did have certain advantages as the position of the wheel meant protection from driftwood logs and the overall width of the vessel could be reduced with the removal of the paddle wheels from the sides. With wider breadth of hull dimensions came increased cargo capacity and the ability to operate in shallow water. Dispensing with the heavy forward wheel-houses lightened the draught constraints, and the position of the wheels at the stern helped in getting the vessel off sandbanks and bars. The largest stern wheeler built on the River Murray in the American riverboat style was *Settler,* registered at 145 feet (44.17 metres) long with an overall length of 167 feet (50.87 metres). It left the river to be converted to a fore and aft schooner only one year after launch.

The ability to be able to manoeuvre backwards was an important consideration for vessels making bow-on landings every few miles along the river. Paddle wheels had the advantage over screw propulsion by enabling a vessel to turn about a central axis. Fine suspended sediments in river waters would have worn down propeller glands and bearings causing leakage. Also the relatively small working surfaces of screw propellers on shallow draft boats would have demanded different engines to supply high enough shaft speeds.

Vessels were usually designed according to the section of the river in which they were to operate. 'Top enders' were by necessity generally the lighter and smaller vessels, while 'bottom enders' could operate with increased draught and length (Sexton, 1975: 139).

Early vessels were fully decked and hulls most often painted black. The searing summer temperatures and lack of ventilation below decks led to the adoption of open engine rooms. Sponson housing over the paddle wheels offered some protection to the engines (Sexton, 1975: 139).

The hulls of the earlier vessels were generally made quite strong, perhaps as a carry over from the marine tradition but also as a reflection of the uncertainty of navigation in riverine conditions. A greater understanding of the effects of the river, the seasonality of flow and techniques of navigation manifest themselves in lighter hull construction.

Towing posts were set up by the funnel amidships and cables were connected to the these for towing barges in a way that allowed them to navigate the bends of the river.

The development of the lock and weir system meant a more permanent flow and stable pool level could be maintained thus easing the constraints on vessel design. This regulation of the river environment occurred predominantly in the 1920s however, and had little impact on a trade that had already been displaced by the development of railways.

Economic considerations

Utilitarian design was a major contributing factor to the economy of operating vessels that were constantly under repair. Seasons were short and the often remote location of vessels that became snagged or holed meant that members of the crew rather than experienced shipwrights were undertaking repairs to hulls. Other considerations included:

- the increasing necessity of reducing weight for speed and a shallower draught were factors in the reduction of hull weight. Also as a tradition of shipbuilding was developed along the river, perceptions as to the minimal resources required to produce a hull structure capable of operating successfully within the constraints of the trade would have been established;
- the effect various cargo types had on paddle steamer and barge design. The difficulties of loading wood through the small hatches of the earlier fully-decked steamers contributed to the adoption of open decks;
- the passenger trade which led to development of multi-deck steamers. In the 1910s saloons were added over the rear hold with more access for cargo maintained in other parts of the vessel;
- the barges were designed to be the bulk carriers of cargo and optimum strength with minimum weight, and therefore draught was the most desirable feature. A strong main beam and series of bulkheads were the main design features. The earlier barges, built of timber were narrow and had curved sides and rounded bottoms. The later built composites were rectangular and the sides met

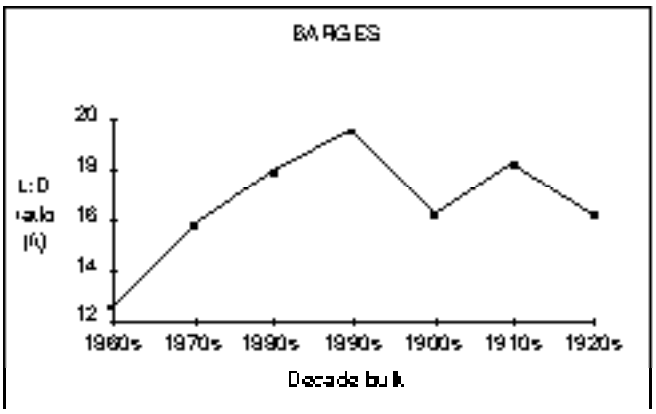

Figure 7. L:D ratio per decade built for registered paddle steamers in wreck resource.

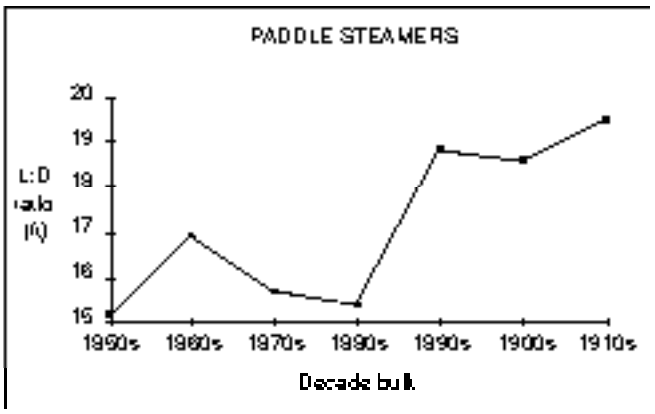

Figure 8. L:D ratio per decade for registered barges in the wreck resource.

at right angles. Iron topsides were further strengthened with iron girders and decks often projected outside the hull. Barges could be either hog or sway backed requiring different methods of loading cargo. Barges constructed for the transport of timber were either of the 'insider', incorporating log slides in the interior, or were of 'outrigger' type, where logs were attached to transverse beams for transportation (red gum does not float).

Machinery

The following points indicate the nature of river boat machinery:

- the development of steam plants in riverine trade vessels was more closely aligned to the agricultural and industrial steam engine than the those marine tradition. The most common types were the horizontal, diagonal/ inclined or portable in single, twin high pressure type or compound. The horizontal and diagonal inclined engines generally used industrial locomotive boilers or multitubular underfired boilers (Fig. 6). Condensing boilers were not a predominant feature of the steamer because they operated in freshwater conditions. Marshalls were the most common types of engine used in river boats and for all makes the ease with which spares could be obtained was a factor in favour of using semi-portables rather than marine plants. Often a spare crank-shaft was carried. Generally they did not have a flywheel but used heavy cast gears and direct driven paddles providing the sufficient momentum in conjunction with twin cylinders. Gear shattering in the confined engine room was a potential hazard. The occasional small boat was driven by an inefficient flat belt and earlier vessels had multiple rope-driven belts.
- the direct acting engine in Australia was an inclined adaptation of the horizontal direct acting engine where a cylinder and valve assembly was placed longitudinally at each side of the hull with the paddle shaft as the crank-shaft. The boiler was placed between the cylinder assemblies giving a compact engine room not much longer than the boiler itself. By the 1870s direct acting engines were operating at paddle revolution speeds of 30 approximately rpm and portables at between 120 and 150 rpm geared down to 30 rpm.
- after the 1870s most locomotive type boilers in use did not have a wet bottom.

Evolution of design and comparative analysis

Average hull dimensions can reveal trends in the evolution of hull design. Such analysis reflects only some of the complex of variables and should be viewed as an indicator to the nature of the resource and future research possibilities. For this analysis the first registered rig type and dimensions of vessels have been used, rather than those at the time of wrecking, as not all known wreck sites have had this information confirmed through site survey. Using register details also allows for the wreck resource to be compared to the total number of registered vessels.

For paddle steamers (refer to Table 7 and Figure 7) length and breadth increased over time while draught decreased confirming observations outlined above on design in response to economic and environmental factors. Building adapted to economic constraints, the availability of raw materials and the principle of least effort. The desire to transport produce on a least cost basis together with the accumulated knowledge of river conditions were a stimulus for these changes. Other factors that need to be explored in the analysis of this data beyond the scope of this paper include the intended sphere of operation, that is 'top enders' versus 'bottom enders', and vessel function (whether passenger, snagging or trading vessel).

From the analysis of details of the registered barges (refer to Table 8, and Figure 8) there appears to be an increasing length to depth ratio that stabilises after the peak of the trade in the 1890s. Shipbuilding techniques and the increasing construction of composite barges combined with the desire to ship increasing produce to ports and railheads would have been factors influencing barge design. Stabilisation of length after the 1890s may be the result of a maximum that could successfully operate in the riverine environment.

Management

The coordination of two surveys that documented tri-State cultural resources presented several logistical problems relating to the assemblage and storage of data. Eight different database systems for recording site information exist as part of the jurisdictional requirements of the state heritage and planning bodies. Each State has different pieces of planning and protective legislation which has resulted in discrepancies as to the level and scope of protection that individual sites receive. The methodology and guidelines used to assess significance criteria was also State specific although the definition of attributes for historic land sites have been standardised over the last few years and conform to the Australian ICOMOS Burra Charter (The Burra Charter 1981). Wreck sites in the surveys were assessed according to the nationally adopted criteria for significance of historic shipwrecks.

State provision for the protection of shipwreck sites ranges from individual site declaration as required in South Australia (*Historic Shipwrecks Act 1981*) to the recent 75-year blanket declaration for sites provided by Victoria (*Historic Shipwrecks Act 1981*) and the comprehensive 50-year blanket protection for all heritage sites in New South Wales (*NSW Heritage Act 1981*).

The difficulties associated with these pieces of legislation for the purposes of a holistic approach to the management of sites along the River Murray has been identified. As yet, no sites have been registered at a national level as part of the National Estate illustrating not only different legislative but also divergent nomination approaches undertaken by heritage bodies. The management of the River Murray shipwreck sites can adequately serve to reflect the nationwide situation where dissimilar CRM programs are undertaken by all States under the umbrella of a 'National Historic Shipwreck Program'.

The River Murray is a multi-State, multi-user environment that has in the past suffered from what has been described as the 'tyranny of small decision'. It is essential for the future protection of sites and cultural resources identified in the survey regions that historic parochialism be overcome at both State and community level. This effort is being fostered by the Commonwealth through the Murray Darling Basin Commission. In response to institutional barriers of lands and waters under the jurisdiction of five States and one Territory the traditional role of the Commission has been expanded from the regulation of water to include all natural and cultural resources. This has stimulated the development of a global information system which will eventually include all database information on historic sites. Heritage bodies can assist in this integrated management by continuing to support interstate projects and by encouraging the pooling of limited resources at local levels. The development of a database of cultural resources by the Federal Government that operates Australia wide is in the planning and development stage. Ultimately this approach will give access to site information to all interested groups and potentially provides for the most effective management of sites.

Conclusion

This paper has attempted to draw together significant elements of a shipwreck resource that has potential for research and interpretation beyond the year 2000. The cooperation between all States in the protection of this vulnerable cultural material represents 'New Horizons' in the management of the Murray Darling Basin and for maritime archaeology as a discipline in general.

Acknowledgements

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The *Nelcebee*: a South Australian coastal steamer

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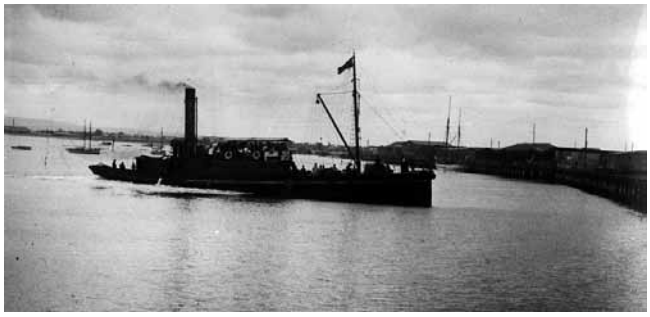

Figure 1. An early photograph of the *Nelcebee* under steam in Port Pirie and carrying a large group of excursionists. *Frizell Collection, SAMM:3877.*

Figure 2. The *Nelcebee* at the Port Pirie wharf, the presence of the ship *Baldersby* dating the photograph between 1913 and 1918. Clearly to be seen is the iron house extending back from the saloon—the pump room (ex-galley) and the present engine room trunk are remnants—and the widened base to the house in the area adjacent to the boiler which was later converted to form an after hatchway. Also visible is the lifeboat carried on the port side, and the towing hook mounted on top of the house. *SAMM:7365.*

Introduction

The 144-ton iron screw steamer *Nelcebee* was constructed by Seath at Rutherglen, on the Clyde upstream of Glasgow, then assembled in Port Adelaide by Cruickshank the following year, 1883. After a long working life she is now owned by the South Australian Maritime Museum.

Underwater examinations of wrecked ships often yield information about the structure and even the shape of wooden hulls, but less about the shell of an iron or steel ship, which suffers more severely from corrosion. On the other hand, massive items such as anchors, boilers and engines may survive, often under heavy concretions and weed growth. In contrast to the usual problems in assessing fragments of wreckage, we have in the *Nelcebee* a surviving vessel that can be measured to establish her outline and shape, and details of construction can still be seen in their proper context. However she has undergone considerable repair and modification over the years, the most dramatic changes occurring in 1927 when the original engine and boiler built by William King and Company of Glasgow were replaced by a diesel engine, and a second mast was added to convert her to an auxiliary schooner.

As a first step in an underwater archaeological survey, reconstruction of the probable details of the ship for use as a basis against which field observations can be tested always involves a review of the information available in a variety of documentary and pictorial sources. Such research was equally necessary here to assist in interpreting traces of original details still to be seen, and in devising boiler, engine and deck machinery consistent with both historical records and the evidence offered by the ship herself.

Sources of information

When searching for information about a ship, the first thing to establish is the date and place of construction, often from such published works as *Lloyd's Register* or the *Mercantile Navy List*. Next to be sought are newspaper accounts of launch, trial trip, and the first visit to regular ports of call. These often provide an overall picture of construction, ownership, and intended trade, complementing that obtained from more formal sources. It soon becomes clear from press reports that in the case of the *Nelcebee*, as with many other ships imported in frame and assembled in the colonies, the official record that she was built in Port Adelaide in 1883 by Cruickshank is inadequate to say the least.

Reports of accidents often shed light on technical details of a ship. However, the date of dramatic incidents that might have focussed press or even official attention on the ship are more difficult to trace, and recourse may have to be made to a variety of secondary sources.

Because of the wealth of information concerning the *Nelcebee* in early press reports, an account of her construction will be given largely as it appeared in newspapers of the day. The references to technical details of the ship to be found in official, insurance, and miscellaneous records will then be discussed.

Newspapers

Captain Alexander Wilson was born in Peebles in 1828 and obtained his Masters Certificate at Leith in 1856 (*Lloyd's Captains' Register*). He commanded the ship *Scythia* on a voyage from Calcutta to Port Adelaide in 1875, and left her the following May to settle in South Australia and commence his association with Port Pirie (*Advertiser*, 12 Jan. 1877; *Observer*, 16 Sept. 1887). For the purpose of engaging in the coasting wheat trade in Spencer's Gulf, Wilson ordered a 99-ton steamer from builders in Hull,

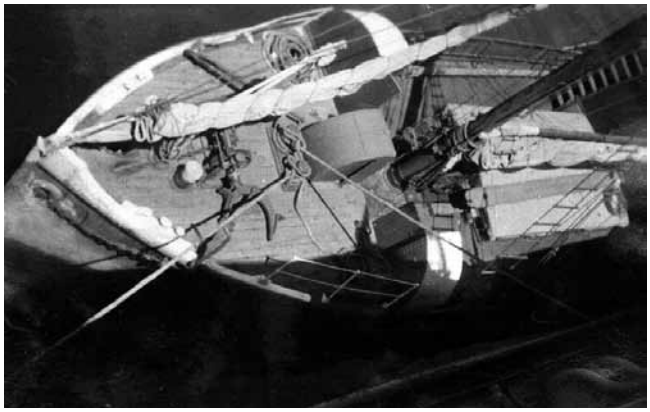

Figure 3. Early photographs of the *Nelcebee* as a motor ship include many features from her steamer days. In this view down on the forecastle, a glimpse is obtained of the original windlass, the Trotman Patent anchors and the crane used to hoist them inboard, the bollard set transversely just forward of the forecastle companionway, and the wooden bow-chocks. The iron forecastle deck has been planked over to protect it from the heat of the sun. *SAMM:8113*.

and had Cruickshank assemble her in Port Adelaide in 1877. Upon launch she was named the *Star of Hope* (*Reg.*, 29 March 1877). He found that she became too small for his purposes, and in 1882 returned to Scotland to obtain a new vessel.

The order for the *Nelcebee* was placed with T.B. Seath of Rutherglen. Thomas Seath was born at Preston Pans in 1820 and came to the Clyde with his parents about eight years later (Walker, 1984). He took over a shipyard at Partick in 1853, and three years later moved upstream to Rutherglen where he continued to operate until just before his death in 1903. Amongst other vessels he constructed was the paddle steamer *Brighton*, built in 1883 as a Manly ferry for the Port Jackson Steam Ship Company, and the screw steamer *Coomonderry* in 1886 for the New South Wales south coast trade. Seath had built 99 ships by 1869 and 180 by 1878, and the *Nelcebee* was the 229th (*Reg.*, 21 June 1883).

Wilson personally superintended construction of hull and machinery (*Rutherglen Reformer*, 5 Jan. 1883). The vessel was wholly erected in the builder's yard, and while temporarily bolted together was launched on 29 December 1882. In a week she had been painted, marked and numbered to allow the parts to be easily re-assembled, then taken apart and shipped on board the *City of York* at Glasgow. She was described as a 'fine little iron screw steamer' of 160 tons and measuring 115 ft by 19 ft by 9 ft 6 in (35 x 5.8 x 2.9 m). Hull, deck and deckhouses were all constructed of iron, and the machinery was 'of the most modern description, being compound surface-condensing of 300 indicated horse-power with horizontal tubular boiler 80 lb working pressure which will give a speed of 11 knots per hour'.

The 1195-ton sailing ship *City of York* departed on 8 January 1883 and arrived at Port Adelaide on 3 April. She had a general cargo, and the published manifest merely gave the value of various types of commodities in the categories required by Customs.

As with the earlier *Star of Hope*, assembly of the *Nelcebee* was undertaken by Thomas Cruickshank. He was born in Aberdeen in 1824 and arrived in South Australia by the *Winscales*, which came from Sydney in 1848 to obtain copper ballast (*Stratton*; *Observer*, 29 Aug. 1903). Cruickshank was not amongst the passengers, and may perhaps have been the ship's carpenter. By 1850 he had established a shipyard at Birkenhead and with John McDonald had built the ketch *Caledonia* (CHR 10/1850). The account of the *Nelcebee*'s launch on the Clyde had said that the 'principal man that will be engaged in the putting together of the steamer at Adelaide is a townsman of our own, brought up in our ship yard'. Although surely referring to Cruickshank, he had certainly been born elsewhere, and wherever trained, had left Scotland before Seath established his yard.

Work proceeded well, taking two months instead of the expected three, and the *Nelcebee* was again launched on 20 June. She was built of iron throughout, with an iron deckhouse extending to the after part of the engine room. Her loaded draught was reported to be about 8 ft 6 in (2.6 m). The vessel was named after the Port Pirie waterworks—although the locality is spelt 'Nelshaby'—and while complimenting the builder, Captain Wilson observed that he had found it no saving in cost to bring the ship out in sections (*Reg.* & *Advertiser*, 21 June; *Chronicle*, 23 June; *Port Adelaide News*, 26 June 1883).

Next day the *Nelcebee* was taken under the South Australian Company's crane to ship her boiler and engines, the weight of which put her down several inches, but it was 1 August before the compasses were adjusted at the North Arm and the vessel proceeded on her trial trip (*Reg.*, 22 June & 2 Aug.; *Advertiser*, 3 Aug. 1883). Her length was again given as 115 feet (35 m), and the dimensions of William King's engines were correctly reported. The run from the North Arm to the Lighthouse occupied only 28 minutes while making 93 revolutions per minute and carrying 52 pounds (360 kPa) of steam rather than the normal 80 pounds (550 kPa). There was a slight delay prior to arrival at the Semaphore when bearings became heated. The engine was stopped, but the *Nelcebee* was soon able to proceed on her way to Tasmania.

The local newspaper in Port Pirie was satisfied to reprint items from the Adelaide press concerning construction and maiden voyage, including comment that in the course of her 20-day passage from Circular Head the donkey pump feed-pipes had been choked with rubbish (*Port Pirie Gazette*, 31 Aug. 1883). However, there was an excellent account upon her first arrival at Port Augusta (*Port Augusta Dispatch*, 26 Sept. 1883):

> At noon on Monday there arrived at the Port...one of the neatest little specimens of the shipbuilder's craft it has ever been our lot to see. She is only about 115ft. in length, 19ft. across the beam, 9 1/2ft. depth of hold, and carries barely 100 tons, and her sleeping accommodation, after providing for the wants of the crew, numbering about a dozen, is nil, yet the Nelcebee—named, by the way, after the freshwater springs at Port Pirie—is a regular model of its kind. She was specially constructed for lightering and towing between Ports Pirie and

Figure 4. Visible in this photograph is a seat fitted along the inside of the handrailing, the belfry mounted on the skylight, and the timber frame on iron stanchions which supported the canvas awning. The binnacle cover has been removed and placed on deck next to the engine room telegraph. *SAMM:8101.*

> Augusta...with the exception of the wooden house-deck, she is iron from stem to stern, the boiler, however, being made of steel. Iron decks look the very acme of strength... The engines are the work of Mr W. King of Glasgow. They are of 60 h.p., and give a speed of over eleven knots... The vessel was built by Mr T.B. Seath, Glasgow, last year, and, after being taken to pieces, was shipped to Port Adelaide on board the City of York. There she arrived in April last, and was put together again by Messrs Cruickshanks... Captain Wilson expects to carry no small quantity of the wool from Ports Germein and Pirie. His arrangements for discharging are of the most perfect kind, a steam winch fed from the main boiler enabling him to discharge his whole cargo in three hours. A water ballast tank, forward, carries fourteen tons of water, the whole of which he could discharge into another ship in an hour and a quarter, ballasting himself in the same time by taking in salt water for the fresh discharged... Needless to say that there is no waste room in the ship, but that every inch of space is utilised for some purpose or other... The total cost of the Nelcebee was £7 000.

Documentary

Custom House Register

The most basic document associated with a ship is her Custom House Register, which establishes identity and ownership, and to guard against fraud, provides dimensions and a description of hull and rig.

When registered at Port Adelaide on 1 August 1883 by joint-owners Alexander Wilson and the Adelaide Milling and Mercantile Company, the *Nelcebee* was allocated Official Number 79347 and signal letters QPJW (CHR 16/1883). She was described as an iron screw steamer, clincher-built, with one deck, an elliptic stern, and no head or gallery. She had one mast, and was cutter-rigged. The hull measured 107 feet (32.6 m) from the fore side of the stem to the after side of the sternpost, 18.8 feet (5.7 m) extreme beam, and 9.2 feet (2.8 m) depth of hold. The statement that the *Nelcebee* was built by Thomas Cruickshank at Port Adelaide in 1883 no doubt reflects the information given on the builder's certificate submitted to Customs.

The tonnage—a volume measurement at the rate of 100 cubic feet per ton—was 130.43 tons under the deck. To this was added a roundhouse of 9.03, forecastle break of 3.80, and a hatchway excess of 0.77 to give a gross tonnage of 144.03. Rather than measuring the engine room, the deduction on account of propelling space was the nominal 32 per cent of the gross tonnage allowed under the *Merchant Shipping Act* of 1854, i.e. 46.09 tons, resulting in a net register tonnage of 97.94.

The vessel was fitted with compound direct-acting engines built in 1882 by William King and Company of Glasgow. The cylinders were 17 1/2 inches (445 mm) and 34 inches (864 mm) in diameter, the stroke 24 inches (610 mm), and the estimated combined horsepower 60. The engine room was 28 feet (8.5 m) long.

It was not until 1907 that the tonnage was modified due to changes long made to the Act that allowed space occupied by the crew as a deduction. The tonnage of the forecastle was increased to 9.88 and roundhouse (deckhouse) to 21.23, resulting in a gross tonnage of 162.31, and the deduction comprising these amounts and the propelling space gave a net register of 85.11 tons.

Mercantile Navy List

This annual compilation by the Registrar General of Shipping and Seamen, based on Custom House returns, tabulates all British vessels in alphabetical order. At this time, steamers and sailing ships were listed separately, entries for the former including dimensions, means of propulsion, and horsepower as well as Official Number, signal letters, gross and net tonnages, material, place and date of build, and name of the managing owner. The *Nelcebee* appeared in the 1884 volume, the owner named as Alexander Wilson of Port Pirie, and the place of building Birkenhead.

Lloyd's Register

Although actually built in Scotland, the *Nelcebee* was not surveyed by Lloyd's there or upon final assembly in South Australia, and did not appear in their *Register* until 1890–1. The entry is consistent with information in the Custom House Register, the forecastle and house being noted as 4 and 10 feet (*sic*) respectively.

Underwriters' Registers

The *Register of Australian and New Zealand Shipping* was published jointly by underwriters' associations in the various colonies from the 1870s. Information was provided by Customs, and the *Nelcebee* appeared for the first time in 1884–5. In the 1926–7 volume, the tonnage had been amended to 162 tons gross and 85 net register, but while repairs were supposed to be noted for the information of subscribers, the entry included reference only to the tail shaft being examined in September 1911, and the provision of a new propeller in June 1912!

Pictorial Records

Plans

The business records of T.B. Seath do not seem to have survived, and only one of his plans have been found: the sheer plan of the 178-ton screw steamer *Agate*, Yard No. 180, built in 1878 and also given engines constructed by King (Waine, 1980:67; *Lloyd's Register* 1890).

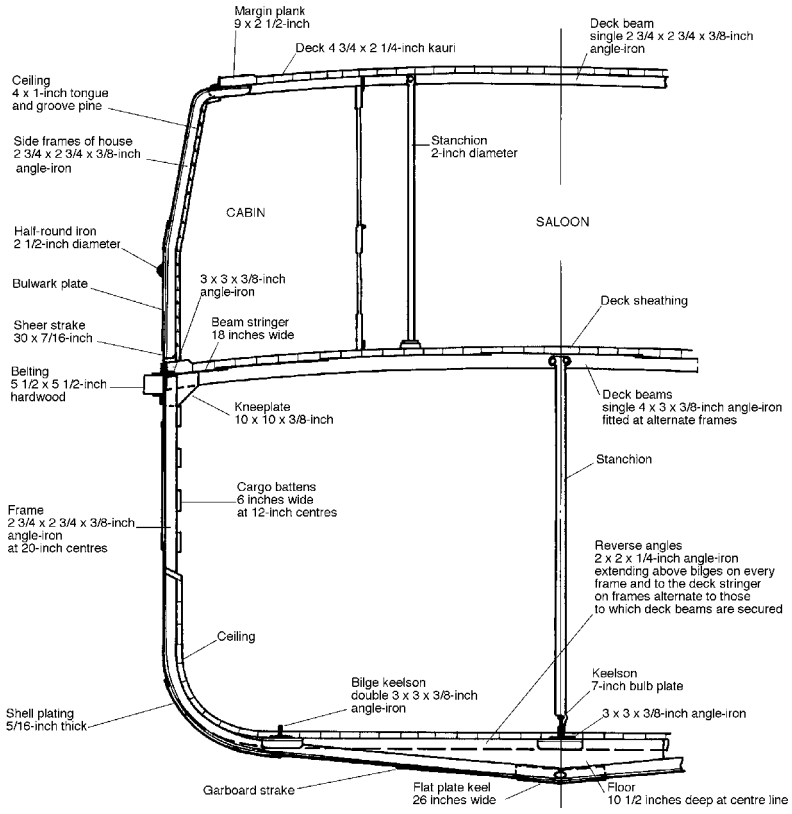

Figure 5. Midship section of the *Nelcebee*.

The plans provided to assist Cruickshank in assembling the *Nelcebee* were retained by his family, but were destroyed with other records when a shift was made from house to home unit about 1981 (A. Rice, pers. comm.).

Photographs

Five photographs have been found showing the *Nelcebee* as a steamer, all taken in Port Pirie.

The first is a broadside view, with perhaps 15 people on the main deck and 40 or so including children crowded under the canvas awning of the deckhouse (SAMM:3877/ Frizell Coll.). The date is unknown, and although the occasion might be a goodwill trip offered by the owner of a new vessel, it could just as well be an excursion such as that to Port Germein and Point Lowly Station with 'Shooting and Fishing Galore' advertised for New Years Day, 1899. Return fares were a shilling or one and sixpence (Robinson, 1976:243).

There are three pictures of the *Nelcebee* alongside the Pirie wharves with other shipping. Two are commercial postcards including one post-marked from the town in 1909 (Rice Coll.), and the third a view looking down along the vessel from some distance astern (SAMM:7365). Although again undated, limits are fixed by the ship moored ahead. This is the *Baldersby* of West Hartlepool, a Ropner ship built in 1913 and torpedoed in 1918.

The fifth shows the *Nelcebee* at work, hauling around the stern of the French four-masted barque *Atlantique*. It was probably taken during her visit to load wheat for Falmouth in March-April 1925 (Rice Coll.).

There are many photographs showing the *Nelcebee* as an auxiliary motorship at a time when she retained a number of features of the steamer (Frizell Coll.; Rice Coll.; Edwardes Coll., vol. 36:137–8; SAMM:4456, 8098–8124).

Miscellaneous Records

Harbour Registers

Since her maiden voyage was made to another colony, the arrival on 26 August 1883 of the 98-ton SS *Nelcebee*, Wilson, was noted in the Customs register of incoming shipping and the port records of arrivals and departures (State Records GRG 41–1 & 51–55). There was a crew of ten.

Agreement and Account of Crew

The crew was re-engaged every six months, and this official record of transactions connected with them—in the form of a booklet—was afterwards lodged with the local Superintendent of Mercantile Marine. In the case of the *Nelcebee*, the series of surviving copies commences in 1905, with a break from 1921–8.

As well as naming the crew and recording payment of wages, the Agreements set out the expected sphere of activities, ration scale, and regulations for maintaining discipline. On only one occasion, in 1939, was the bill of fare entered up in the space provided: oatmeal, bacon and eggs for breakfast, roast beef and plum pudding for dinner, and cold meat, salad and fruit for supper.

The Agreements consistently note that the accommodation was certified for eight men. This certification was contingent upon a space of 72 cubic feet

(2 m^3) and 12 square feet (1.1 m^2) clear deck area being available for each man, and a privy provided for their use (*Merchant Shipping Act* 1867).

In 1905 the ship carried a master, engineer, mate, cook, two firemen, and an able-bodied seaman. After conversion to an auxiliary motorship, there was typically master, engineer, and two seamen (both A.B.s).

The position of the load line disk was always recorded—1 ft 7 in (483 mm) below the edge of deck—and from 1928, when the old Marine Board document was superseded by a new version for ships engaged in the intra-State trade, an Official Logbook was added. The date and time of arrival at each port was entered up, and the draught and freeboard upon leaving. The light draught was often 3 ft 6 in (1.1 m) forward and 5 ft (1.5 m) aft, and when fully laden 7 ft 6 in (2.3 m) and 8 ft 9 in (2.7 m) respectively.

Engineer–Surveyor

Diaries of inspections kept by Engineer–Surveyors employed by the Marine Board and later the Harbors [*sic*] Board have survived and cover the period from 1907 to 1940. Entries appear first at the back of a register of riverboat inspections, continuing in the Engineer–Surveyor's 'Journal' and finally a 'Record of Ketches' (State Records GRG 51–90, 94 & 237). The notes give an impression of the never-ending round of maintenance and repair necessary to keep the vessel in good working condition, and also indicate that an appearance of age is not a perfect guide to the what is original on the present vessel.

The Journal is the only place to have noted that the engines were inverted, and that the one multi-tubular boiler had two spring safety valves. As well as the officially-estimated 60 horsepower, it recorded the 48 horsepower calculated from the Board of Trade formula, stated here to be a thirtieth of the sum of the squares of the cylinder diameters.

The very first entry, in December 1907, noted an inspection of the tail shaft, and the following year a new shaft and propeller were fitted. In 1912, the propeller was yet again replaced. However, the boiler was of prime and continuing concern. Steam pipes were tested to 160 pounds per square inch (1100 kPa) and the safety valves regularly tested to check that they floated at 80 lb (550 kPa). In 1909 two patches were put on the front of the boiler and later in the year the caulking of seams was mentioned. From time to time rivets were replaced in port and starboard furnaces (1911–2). Corrosion was also noted in the front seam of the shell plate on the port side of the mud-hole ring (1911), and this may have been the problem later solved by welding with 'oxa-acetylene [*sic*]' (1913).

In addition, repairs to the hull were noted: a new plate in the port bunker and another in the forecastle (1911), plates seen to be thin as well as frames and reverse bars in bad condition in the starboard bunker the following year, and a new plate fitted in the port side of the hull forward in 1913. Docking notes record that sea-cocks were regularly inspected, and rudder pintles were refurbished as required (1914). The forepeak, fore hold, stokehold and after peak were inspected from time to time, it being commented for instance that the frames and bars in the hold were in fair condition when the ceiling was lifted in 1919. The propeller shaft was brought in at this time and found to be much corroded between the liners, the smallest diameter being 6 11/16 inches (170 mm), and various shell plates were replaced or patched: under the counter on each side, in the way of the starboard bunker, on both bows, and at the watercloset discharge. In addition, shoes were fitted under the keelplate fore and aft and under the propeller aperture, frames and reverse angles were replaced in the starboard bunker, three new plates fitted in the top of the forepeak tank, the lower part of the after engine room bulkhead renewed, and the bulwarks at the after end of the vessel repaired.

Inspections of the engine were also undertaken—valves, pistons, cylinders, cranks, bearings, circulating and air pumps all receiving attention—and the condenser doors were mentioned as being taken off in 1912. Amongst necessary repairs, a new high-pressure piston was fitted in 1913, piston rods turned up so that the low-pressure rod was now 3 1/4 inches (83 mm) in diameter (1921–2), and the high-pressure stuffing box repaired (1921).

But of overriding concern was the boiler, with increasing evidence of corrosion by way of scale and pitting, rust, redness in the chambers, and the buckling of plates. From time to time there was a need to replace rivets and stays, and to cut out and patch wasted areas. Finally, in May 1926, an inspection at Port Pirie showed that amongst other problems the port combustion chamber was leaking badly. A patch on the back of the chamber was found to be only 1/8-inch (3 mm) thick, and a hammer went through metal less than a 1/16th (1.6 mm) thick at the landing of the furnace mouth. The ship was condemned, and given temporary repair to permit her to continue for a week while being replaced.

A Fairbanks Morse crude oil engine of 100 brake horsepower was subsequently installed, and reports in the 'Record of Ketches' have greater emphasis on hull and equipment (CHR 3/1928; State Records GRG 51–94). An inspection of cables in 1935 showed there were 90 fathoms (165 m) of 7/8-inch (22 mm) and 75 fathoms (137 m) of 1-inch (25 mm) chain, and 14 floors and 17 reverse angles in the main hold as well as a number of shell plates were replaced at this time. The following year a new bottom angle was fitted on the starboard side for the timber belting, and in 1937 the engine was shifted to permit replacement of five deep floors—together with frame and floor angles—in the engine room.

Certificate of Survey

A Certificate of Survey dated February 1936 is held with the appropriate Crew Agreement. As well as recording safety equipment, it noted that there was one boat of 95 cubic-foot (2.7 m^3) capacity, capable of accommodating nine people.

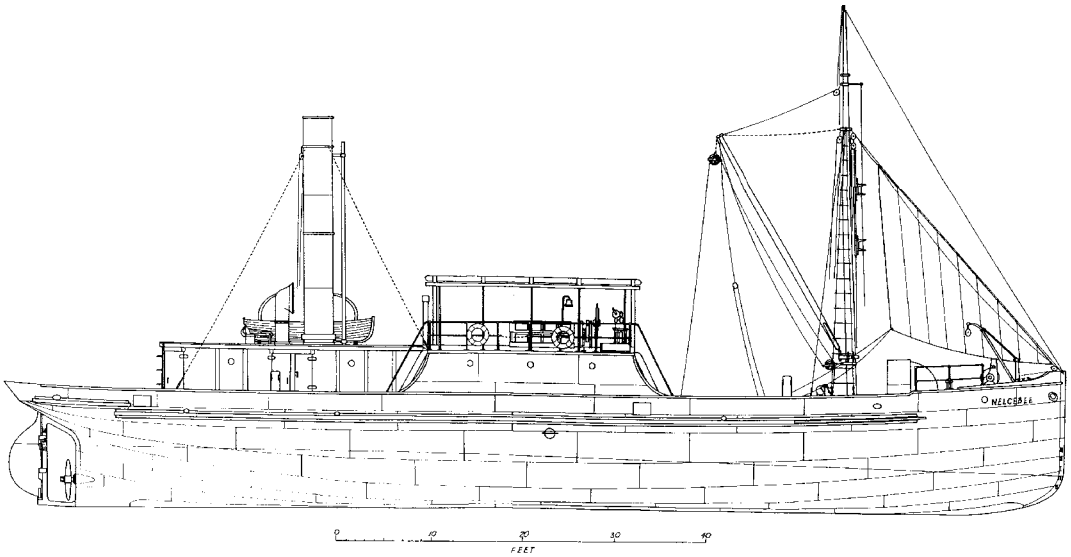

Figure 6. A reconstructed sheer plan of the *Nelcebee* as she might have appeared in 1883.

Sailmaking Records

In March 1892, Port Adelaide sailmaker Henry Weman made a fore staysail for the *Nelcebee* (Weman records). It was sewn up from nine cloths—requiring 32 yards (29 m) of No. 2 Lawson Crown Extra canvas of standard 24-inch (610 mm) width—with the leach cut 17 ft 6 in (5.3 m), the rise of clue 5 ft (1.5 m), and the stay gore 20 ft 9 in (6.3 m).

Oral history

While there are many people who served on the *Nelcebee* and can pass on their recollections, it is believed that there are none now from her steamer days. One most significant piece of oral history collected in the past by Chris Frizell was that the ship had side-bunkers.

The *Nelcebee* observed

General description

The *Nelcebee* has a single deck with a break over the forecastle, which is forward of the collision bulkhead. Below the forecastle is the forepeak ballast tank, now used as a chain locker. There are small inward-facing houses on the main deck each side set against bulwarks and break.

The deckhouse with its saloon flanked by cabins is amidships, and extends across the full width of the hull: access fore and aft is via ladderways now only to port, but originally provided on both sides. The after bulkhead of the saloon is set within the house so that some protection is afforded the saloon doors each side as well as those into what was the galley, located centrally under the overhang of the deck, and now containing pumping gear for liquid fuel cargoes. Rust pitting behind hinges long since removed indicates that these were the typical doors split at half-height, and surprisingly, that they interfered with the outward-swinging saloon doors.

The wooden frame on round iron columns to support a canvas awning over the deckhouse was reduced when a second mast was added, and completely removed when the present small wheelhouse was erected.

An iron house was originally provided over the engine room, the 28-foot (8.5 m) length of which extended from the after bulkhead, still in place, to the galley, where traces of the forward bulkhead remain. With a smaller engine room sufficient for the diesel, the forward bulkhead was shifted back the length of a new hatchway constructed over the area formerly occupied by the stokehold, another watertight bulkhead provided near midships to subdivide the hold, and a low trunk formed above the after part of the remaining engine room.

The after peak is still reached via its original access hatch, but has been reduced in size by a watertight compartment in the lower part which extends back to the stuffing gland of the tail shaft. There is direct access to this lower compartment from the engine room through a hole cut in the bulkhead. The accessible area in the after peak is further reduced by the presence of the ship's fuel tank, and by concrete filling the bottom.

Dimensions and tonnage

The official length of the *Nelcebee* from the fore part of the stem to the after part of the sternpost, 107.0 feet (32.6 m), was in fact measured to what might properly be considered the sternpost of the hull, but was referred to by Lloyd's as the propeller post, 3.5 feet (1.1 m) short of the post on which the rudder was hung. Hint of this might have come from the reported length of about 115 feet (35 m), which is close to the deduced overall length of 114 feet (34.7 m), but not the clearly-excessive 120 feet (36.6 m) which also appeared in the press.

When calculating the under-deck tonnage of a vessel of this size, the internal length was divided into six equal parts to locate the required cross sections. Breadths at each cross section were measured to the inside of ceiling at the quarter points of its depth after reducing this depth to allow for the lesser area bounded by the camber of the deck. Simpson's Rule was then used to calculate the volume and hence the tonnage, allowing 100 cubic feet per ton. Following this procedure, the tonnage of the *Nelcebee* as

drawn was found to be within 30 cubic feet of the 13 043 cubic feet or 130.43 tons determined by Customs.

The volume of a space such as the forecastle or above the break in the deck was found by measuring mid-height breadths at ends and middle, using Simpson's Rule to calculate the area, then multiplying this by the average height. The 380 cubic feet of the break and the 988 cubic feet of the forecastle were confirmed from the reconstructed drawings, but the surveyor was wrong in adding the latter to the under-deck tonnage when determining the amended gross tonnage because the lower part was already included. On the other hand, the original measurement of hatch excess—the volume of hatchways above half a percent of what would otherwise have been the gross tonnage—is apparently an arithmetic error since there is no indication that the hatch has been enlarged.

The 'roundhouse' in the original calculation of gross tonnage is precisely the open area of the saloon, and the 21.23 tons of deckhouse in the amended gross tonnage calculation represents both saloon and side cabins.

The calculated volume of the peak tank was found to take comfortably the 14 tons of freshwater ballast.

Structure

Lloyd's Survey Certificates, now held by the National Maritime Museum, Greenwich, provide an invaluable source of information about the structure of many vessels built in Britain. Although the *Nelcebee* was not surveyed by Lloyd's, it is instructive to compare her details with the scantlings that would have been recommended in their Rules, which reflect what was found by practical experience to be good practice.

Scantlings of the frame were by this time regulated by a number based on the size and shape of the midship section: the sum of half the moulded beam, the centreline depth from keel to upper deck, and the girth of the shell measured from keel to upper deck stringer plate. Longitudinal members were determined by another number resulting from multiplying the first by the length of the ship. For the *Nelcebee*, these numbers are 37 and 4050.

Such a vessel was to have a frame spacing of not more than 20 inches (508 mm), plate floors 11 x 5/16-inch (279 x 8 mm) at their midpoint, frames 3 x 2 1/2 x 5/16-inch (76 x 63 x 8 mm), reverse angles 2 1/2 x 2 1/2 x 1/4-inch (63 x 63 x 6 mm), stem 6 x 1 1/4-inch (152 x 32 mm), stern frame 6 x 2 1/2-inch (152 x 63 mm), and solid pillars of 2 1/2-inch (63 mm) diameter supporting the deck beams. For a vessel to 80A classification, sheer strakes were to be 30 x 7/16-inch (762 x 11 mm) plate, shell plating 5/16-inch (8 mm) thick, flat plate keels 30 x 1/2-inch, and the plates either side of them the thickness of garboard strakes, i.e., 3/8-inch (10 mm). A 3 x 3 x 3/8-inch (76 x 76 x 10 mm) angle-iron was used to secure the deck beam stringer plate to the sheer strake, and pairs of such angles back to back were required for side keelsons and hold stringers. Beams of 18 to 20-foot (5.5-6.1 m) length had to be of 5 to 5 1/2 x 3 x 7/16-inch (127-140 x 76 x 11 mm) angle-iron, iron decks 3/8-inch (10 mm) thick, and beam stringers an inch in width for every seven feet of the ship's length, i.e., 16 inches (406 mm).

The spacing of frames is therefore appropriate and their scantlings probably acceptable. A check of thickness at a number of points by the Engineer–Surveyor in 1934 suggests that the shell plating was generally 5/16-inch thick, with the sheer strake 7/16-inch. The garboard strake was found to have worn to 5/16th thickness as well at the time, but probably originally met 80A requirements. Although the plate keel is only 26 inches (660 mm) wide rather than the recommended 30 inches, a width of 24 inches would have been accepted under the rules of the *Underwriters' Registry for Iron Vessels, Liverpool.*

There are however a number of features that are at odds with Lloyd's Rules. First, it was a requirement that although a keelson standing on the floors could be fitted in association with a bar keel, flat plate keels such as that of the *Nelcebee* had to be well secured directly to a keelson by a pair of angle-irons. This could be either a through-keelson, a continuous plate to which the heels of the floors were joined, or an intercostal keelson, formed of short lengths of plate between the floors to which they were secured by vertical angle-irons. The intercostal plates were to be further tied together along their top edges by a pair of 3 x 3-inch (76 mm) angle-irons and a bulb plate two inches deeper than that required for main deck beams: seven inches (178 mm) in this case. In effect, the intercostal plates were here omitted, leaving the associated tie plate and angle-irons as the sole keelson.

Secondly, while double-angle bilge keelsons of the correct size were fitted, there should have been a similar hold stringer above the turn of bilge about half way between bilge keelson and deck to stiffen and strengthen the sides of the ship.

Next, the deck beams of single 4 x 3 x 3/8-inch (102 x 76 x 10 mm) angle-iron are of considerably less depth than specified. The 10-inch (254 mm) deep knee plates securing their ends to the hull frames are the required two-and-a-half depths of these lesser beams. Of more serious import, however, the beams were provided at alternate frames. Being used in association with an iron deck of 3/8-inch (10 mm) thickness, they should have been at every frame, and even with thicker plating or when the deck was planked, the wider spacing was permitted but considered undesirable. Half-beams were in any case required at every frame adjacent to hatches. Frizell has commented that there was in fact heavy vibration of the deck when the *Nelcebee* was fully laden and working against a head sea.

Original pillars of 2-inch (51 mm) diameter are fitted in the forepeak tank and in the saloon, but those at present in the holds are replacements, so there is no indication of size or even the number provided.

Hull reconstruction

Plating

Although most of the shell has been replaced by welded plating, enough butt plates remain inside to indicate that the plates were 12 ft 3 in (3.7 m) long, with the butts in alternate

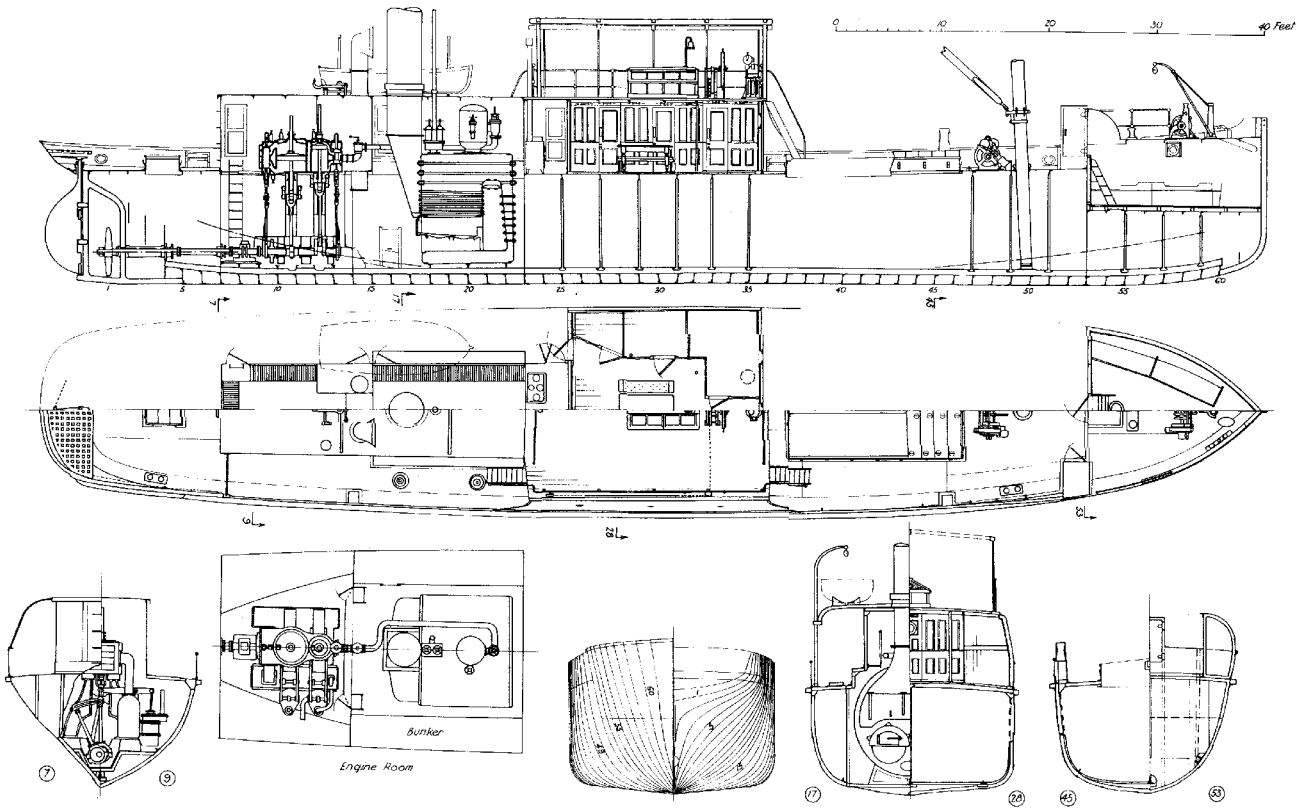

Figure 7. Hull plans of the *Nelcebee* based on measurement of the existing ship, with further details reconstructed to show her in original condition.

strakes shifted by a frame-spacing as required by Lloyd's. There is inevitably a break in pattern at the bows and more particularly at the stern where, despite conflicting evidence resulting from old repair work, it would appear that it was necessary to resort to the minimum spacing of two frame-spaces between adjacent butt joints to complete the strakes.

Aft, the garboard strakes are riveted to the stern frame and to its forward extension which forms a vertical keel, and the after end of the flat plate keel is transitioned to this localised upright shape by being folded up around the garboards. A boss plate fitted over the propeller tube acts as a stealer by reducing the breadth of plate required for the garboard strake.

There has been heavy repair at the fore foot, much of it by welding, and a protective plate added. It is not clear now whether there was a 'shoe plate' fitted around stem and garboard strakes, similar to the 'coffin plate' aft, or whether the stem was forged to provide two legs of suitable moulded shape to which the garboard strakes and keel plate could be riveted. Any internal detail is obscured by concrete to the level of the underside of the keelson.

Longitudinal joints in the shell plating are single riveted, but the butt joints, and those between shell plating and both sheer strake and keel plate are double chain-riveted. Plating is secured to stem and stern by double riveting in a zig-zag pattern.

Bulwarks

The bulwarks are formed by a single run of iron plate riveted to the sheer strake, which extends nine inches (229 mm) above deck and continues at this height aft where the knuckle of the counter is developed. The plate is widened locally at forecastle, wing houses, and deckhouse. Two-inch (51 mm) diameter half-round bars were riveted each side of the upper edge, except where the tow rope might be expected to rest on them at the stern. Here there seems to have been only a broad angle-iron fitted on the inside.

Repairs were necessary to bulwarks aft as early as 1919. That all beyond the forward end of the engine room have been replaced is immediately obvious not only by their welded construction, but through them being three inches (76 mm) higher than the general run of the bulwarks. Across the stern they are now at a more upright and less attractive angle.

There are no bulwark stanchions at present, and those to be seen in photographs of the vessel after 1927 are not of an old-fashioned pattern.

Heavy timber belting protected the sides, and a second run slightly overlapping the main belting was provided on each quarter. The quarter belting was located immediately above the knuckle of the counter, and was widened out at its after end to match the flaring width of the bulwarks.

There is a freeing port and centre-hung lid of old-fashioned construction just forward of the deckhouse, and another can be made out forward of the quarter belting in later photographs (SAMM:8108). Oddly enough, while there is one pair of scuppers serving the well deck forward and two for the area aft, there is another at the appropriate spacing but falling within the length of the house and therefore blocked off. This together with the manner of framing the house may suggest that Seath built his hull to a standard design which could be adapted to suit accommodation and engine room requirements.

As a motorship, there were deck-bollards on each quarter,

no doubt from her steamer days since an adjacent mooring pipe to serve them can be just seen in the *Baldersby* photograph (SAMM:7365 & 8123). The mooring pipe just aft of the side houses forward may also be original (SAMM:8105). In addition, there was a heavy timber bollard inside the bulwarks fore and aft of the house. This was carried in an iron sleeve, presumably framed internally with angle-iron (SAMM:8123).

At present the bulwark plating rises three inches (76 mm) above its general height to form the ship's side adjacent to the forecastle, with a yet higher section forward riveted to the stem to form a bow chock. A photograph looking down on the forecastle shows that early in life as a motorship when the anchor crane was still fitted, the chocks were timber, with another timber on the inside to lift a set of fairleads to the appropriate height (SAMM:8113). Thus the existing chocks are presumably a welded addition. This photograph also shows that the forecastle deck had been sheathed to protect the accommodation from the heat of the sun, and confirms that a heavy transverse bollard—just discernable in the 'excursion' photograph—was fitted forward of the companionway.

Forecastle

With the ceiling removed, it could be seen that the original forecastle deck was set at the general level of the bulwarks, and that the present deck has been welded to the shell plates just above the still-existing 3 x 3-inch angle-irons which secured the original margin plate to them.

The sections cut out of the first deck beam to accommodate the original hawsepipes, and the plates welded into holes left when they were superseded by pipes installed to suit self-stowing anchors can be observed from the inside. However, there is no sign of the portholes at mid-length each side of the forecastle.

The remaining clear floor space after providing two bunks each side and also for a companionway ladder controls the number of men for which the accommodation was certified.

Deckhouse

The deckhouse has iron sides sloping inwards, the upper edge of rounded form, and is roofed with 2 1/4-inch (57 mm) kauri planking. After negotiating the curve, the side frames are lapped with angle-iron deck beams, and the side plating continues several inches beyond the angle-iron stringer against which the heavier margin plank is set. The beams fore and aft of the skylight are supported by pairs of pillars, thus leaving the central area clear. With the ceiling removed for refurbishment, it could be seen that the side frames are not an extension of the hull frame, but separate lengths of angle-iron riveted to the bulwarks.

The iron deck within the house is sheathed with timber, with a heavier margin plank all round, then ceiled within the cabin areas with horizontal tongue-and-grooved boards fixed to timbers bolted to the side frames and to the stiffening angles of the iron bulkheads at each end. The areas visible fore and aft within the saloon are 'panelled' to match the bulkheads partitioning off the cabins each side of it, while bulkheads separating these cabins from each other are simple vertical matchboarding with a rail each side at mid-height to stiffen them. It was interesting to find under layers of paint that these decorative bulkheads and matching doors are not proper panelled work, but built up over broad thin boards of some light-coloured timber. The rails of the 'panelling', the stiles covering the joints between the boards, and the battens with ventilating holes filling the gap between boards and deck above are all teak. But rather than remaining a contrasting colour, the boards were stained to match the teak. Another indication of economy in construction is that the rails of the panelling are carried horizontally across transverse panels rather than following the camber of the deck.

A table with fixed benches either side, surely original, is located below the teak skylight in the centre of the saloon. The forward half of the skylight was removed some time ago, perhaps due to general deterioration, and an item that probably disappeared with it was the belfry (SAMM:8101). However, other original features on the deck over the house which have been retained are the steering wheel and its mounting, the binnacle, and the side railing. The engine telegraph to port was presumably removed when the engine controls were removed to the bridge in 1936 (Engineer–Surveyor).

Steering gear

The standards for the steering wheel carry reduction gears and a driving wheel with teeth that mesh into a length of flat-link 'pitch-chain'. A thin metal guard once covered the gears (SAMM:8101), but the whole unit is now protected by a wooden case.

The effort from the wheel is carried back by rods to the rudder, with short lengths of ordinary chain allowing about three feet (914 mm) of movement each way at the various iron-cased guide wheels. While the steering chains now work on a quadrant, it is of welded construction and seems to be built up on a simple bar tiller which may well be in the style of the original.

Towing gear

Photographs show that the towing hook was on top of the engine room house, just aft of the stokehold ventilators. It appears to be a simple hook shackled to a short horse, such as that shown on an old drawing of ironwork prepared by William Simons of Renfrew (Thomas, 1983:211), The hook rests on a bar mounted between brackets to maintain it in a horizontal position.

Steps up the after face provided access onto the house, and to prevent the hawser catching there was a guard bar sweeping out from the corner of the house down to the bulwark.

Engine room and machinery

House and bulkheads

The most obvious features of the engine room house to be seen in the 'excursion' photograph are the funnel, with waste steam pipe forward and two stokehold ventilators aft of it, and two side doors next to each other at mid-length.

When the house was removed in 1927, the lower portion aft was obviously modified to form a trunk over the new engine: it is 8 ft 6 in (2.6 m) wide and thus matches the width of the

galley; the bottom part of another side door at the after end to starboard was retained as a fixed part of the structure; and the external butt plates of the back face—to be seen in the '*Baldersby*' photograph—are still in evidence. It would appear from the remains of butt plates along the sides that this manner of joining the plates, with a stiffening angle fitted on the inside, was used here as well.

At the seventh frame from the after engine room bulkhead there is a deep floor rising to the level of the iron decking in the engine compartment, and to starboard, a short length of the original bulkhead within the hull separating this compartment from the stokehold. A vertical angle-iron remaining on its forward face once secured after end of the bunker bulkhead, and some of the angle-iron that once connected bunker bulkhead and deck can be seen on the port side. The deck beam was then angled backwards about nine inches (229 mm) to clear the stokehold ventilators, and the central transverse section—matching the breadth of the house above—had riveted to it another length of bulkhead. The lack of rivet holes in the angled sections of the beam suggest that these were door openings, the floor plates no doubt continuing out to the deep floor and steps provided thence down to the flooring in the stokehold.

It was a surprise to observe in the '*Baldersby*' photograph that the forward part of the house had a wider base section matching the length and breadth of the hatchway installed in 1927, of sufficient length in fact to have encompassed the deduced position of the funnel and the forward side door. This door no doubt provided ventilation for the stokehold as well as giving access to an open ironwork gallery around the boiler from which the safety valves and main and auxiliary steam valves could be reached.

Since there was a second door immediately aft of the other, there must have been a bulkhead between them at this level, perhaps extending the full width of the house. From inside the present engine room, the forward panel of the trunk appears to be of the same construction as the sides except for a central portion about three feet (914 mm) wide that has been welded in. Thus it seems probable that the after side doors led into small compartments so as to leave a clear space in the middle and allow the engine to be brought as far forward as possible. A circular roof vent to be seen in the '*Baldersby*' photograph suggests that the compartment to starboard was the engineer's privy. The stokehold ventilators would have passed through these compartments to deliver fresh air to the working area, but there is no trace of them in the existing deck.

Boiler

It is clear from comments during inspection and repair that the *Nelcebee*'s horizontal multi-tubular boiler was of the two-furnace Scotch marine type, working at the 80 pounds per square inch (550 kPa) typical of steel boilers at that time.

From the location of the funnel, the furnaces faced aft, and since provision of a house over the hull resulted in sixteen feet (4.9 m) clear height above the keelson, there is no doubt that a large dome was fitted to the top of the boiler to collect the steam. There were two spring safety valves, possibly straight under the waste steam pipe forward of the funnel.

The depth of the boiler was deduced by allowing suitable clearance between bulkhead and back of boiler, and assuming that the front face reached the near edge of the funnel so that the uptake collecting the smoke returning through the fire tubes from the combustion chamber was positioned directly below it. It was found that the resulting length of furnace suited neatly the length of irons that could be handled in the space back to the engine compartment bulkhead, and that the floor furthest forward on which a boiler seating might have been mounted still has doubled reverse angles along its upper edge.

Allowing similar clearance to the coal bunkers each side, it was seen that a boiler of about 10-foot (3 m) diameter could be installed, and the reason for the widened lower section of the house became apparent. Not only does this boiler require a wider opening to get into the hull, but once installed, the greater width of house was retained to maintain clearance.

With no opportunity to fit coaling hatches over the bunkers, there must have been coal shoots set in the deck above, two loading points being desirable to reduce the need for trimming. Lloyd's recommended that where practicable coal bunker pipes were to rise a foot (305 mm) above the deck. Although flush covers seem called for in this location, the frames can be seen in the '*Baldersby*' photo to be mounted on deck rather than being set into it.

While often depicted on plans, only one detailed drawing of a cast iron cover has been found (Holms, 1917: plate 28). This example was provided with a bayonet fitting and made watertight with rubber packing, but the means of rotating the cover to lock it down was not indicated. Such covers are seen in some ship plans to have a cross bar set in a central hand hole (Scott Russell, 1864: plates 65 & 127).

Engine

The basic dimensions of the engine are known—cylinders of 17 1/2 and 34-inch (445 and 864 mm) diameter, with a 2-foot (610 mm) stroke—and also that it was an inverted direct-acting compound engine with a surface condenser. Minor scraps of information from the Engineer-Surveyor's inspections are that the piston rods were about 3 1/4 inches (83 mm) in diameter, and the tail shaft something under seven inches (178 mm).

The propeller is three feet (914 mm) above the keel, which both limits the diameter of the propeller that can be fitted and establishes the level of the engine crank-shaft since all mountings are of uniform height. There is no sign of the stern frame having been modified, and the boss plate blends in so well with the upper sweep of the garboard strake that it is surely original. The diesel engine was shifted in 1937 to permit the replacement of the five deep floors in the engine room, and it can only be presumed that they were the same shape and detail as the originals to permit the prompt re-installation of the engine. These floors rise 3 ft 6 in (1.1 m) above the keel, evidently to a level that would accommodate an engine base of sufficient width within the ever-narrowing engine room. Thus a pair of bed plates must have been provided, with cranked cross members to connect them and carry the main bearings.

Texts on the design of marine engines (Sennett, 1885;

Seaton, 1890) tend to discuss the various components and leave it up to the individual designer to assemble them in a manner to best suit his purpose. Books giving an overview of engine design, however, often have drawings showing actual examples of complete engines and ancillary gear (Paasch, 1890; Byrne & Spon, 1874; Lineham, 1890). From a review of actual engines, the length of the connecting rod was commonly just over twice the piston stroke, which fixes the height of the cylinders above the crank-shaft. Since there would have been advantages in lowering house and towing hook, its height over the engine suggests that the pistons had tail rods projecting above the cylinders.

In devising an engine such as might have been fitted in the *Nelcebee*, an attempt has been made to arrive at a unit with as short a base as possible so it can be located well forward, not only to take advantage of the greater width of hull there but also allow enough space aft to instal a thrust bearing and permit the tail shaft to be withdrawn from its casing, then manoeuvered into the engine room. Another requirement is that the cylinders be spaced so that the connecting rods are to one side of the floors, which could be, and were, shaped to clear the crank arms. One of the many variations that might have been adopted is the placement of the low-pressure valve between the cylinders, but the arrangement selected seems to be more compact—there are only three main bearings—and the high-pressure exhaust passes through a steam jacket around both cylinders. However, the choice of a piston valve for the high-pressure cylinder was prompted by the narrow space available for the engine between the stokehold ventilators. A main steam pipe can feed from forward into the steam chest for a piston valve, whereas there would have been barely sufficient room for pipe, throttle and auxiliary stop valve that are brought into the side of the steam chest for a common slide valve.

The condenser is shown carried on one of the bed plates, the usual arrangement in smaller engines. The unmistakable splash of circulating water being discharged in the 'excursion' photograph indicates that it was to starboard, and that the outlet was at the forward end of the engine. This discharge can also be seen in the '*Atlantique*' photo, which confirms that the outlet was so high that unless the outflow was directed upwards, the discharge pipe was carried across deck and out through the bulwarks, joining the coal shoots as one more underfoot obstruction for the unwary. Circulating and air pumps were commonly mounted on the back of the condenser casing, being driven by pump levers working on gudgeons mounted on the piston rod crossheads. Because of the limited height available for the unit, the cooling water probably made only two passes through the nests of tubes—with inlet and outlet at the same end—and it thus seems likely that it was the circulating pump which was forward and worked off the high-pressure crosshead. The pump levers could also work bilge and boiler feed pumps, but in the case of the *Nelcebee* there is mention of the inlet pipe of a donkey pump being blocked.

Other necssary engine fittings were the valve gear—most likely Stephenson's—the turning wheel operated by a worm and used to rotate the crank-shaft during repairs or daily while lying in port, and the starting valve which bypassed steam to the low-pressure steam chest should the high-pressure piston happen to be at dead centre and thus unable to turn the engine over at starting.

Deck machinery

Windlass

The windlass is obscured by one of the crew in the 'excursion' photograph, but the frame seems to have a vertical front edge, surmounted by a bitt head, and cannot be more than two feet (610 mm) long. This windlass was retained on the motorship for a time, and a glimpse of it in the photograph looking down on the forecastle (SAMM:8113) confirms that the frame had a bitt head, and suggests that the after edge swept out to develop a knee, with a circular section cut out of the base to form two legs. Such a windlass was provided on the boat *Manatee*, built by White at East Cowes in 1909 (Thomas, 1978). Tie bar, drive shaft, and main shaft carrying warping drums as well as cable holders to grip the chain cables can also be discerned. The chain cable is seen to come directly from the hawsepipe, and in the absence of a controller, there may well have been a compressor at the pipe leading to the chain locker. This windlass was later replaced by another with an A-frame in a position slightly further aft.

Winch

The original cargo winch worked by steam cannot be seen in any pictures, and must have been replaced in 1927 with the elimination of the boiler. Although not mentioned, a drive chain could no doubt be led forward to work the windlass.

Winches commonly have systems of pinions and spur wheels to provide either high gear operation directly to the main shaft, or low gear through a subsidiary shaft. The drive shaft is normally worked by steam, but a second drive shaft geared to it and carrying crank handles will allow the winch to be operated by hand with either low or high power. Diagonal steam engines carried each side of the winch frame—with crank pins mounted on flywheels at the ends of the drive shaft—form a compact arrangement that can be seen for instance in a steam fishing vessel built at Hull about this time (*Engineering*, 10 Aug. 1883).

Masting and rigging

The 'excursion' photograph shows that the standing rigging consisted of three shrouds to the hounds of the mast, a forestay, and a stay to the head of the mast. What appears to be a backstay in the *Baldersby* photograph may be just the flag halyard. Batten ratlines were fitted to the foremost two shrouds.

The derrick had a chain span leading back to the hounds of the mast, with a topping lift to the band carrying the lamp bracket, and was controlled by guys with purchases on their lower ends. The runner led through a gin block suspended by a short chain from the head of the derrick and down to the steam winch via another block shackled to the lower band securing the support for the boom gooseneck.

In addition to red and green side-lights, carried here on the upper deck each side of the helmsman and not in the rigging, steamers were required to carry a white mast-light. A second lower light was shown when towing another vessel, together

with a guide lamp hoisted on the funnel by a halyard and visible only from astern. While there was a bracket to sustain the pair of taut wires running down to the deck on which these mast lamps were threaded to steady them and maintain their proper orientation, it seems that the lamps were supported by means of a halyard block lashed under the forestay. Further, they were clipped into pairs of forward-projecting brackets which appear to have been mounted on a batten which kept the lamps six feet (1.8 m) apart and when hoisted to the block, maintained the upper one at its correct position 20 feet (6 m) above the hull.

There is no sign of a gaff or of peak and throat halyards, so a staysail such as that made by Weman was presumably the only sail carried despite the 'cutter' rig.

Equipment

Boats

The *Merchant Shipping Act* of 1854 required that a sea-going steamer of 60-120 tons should carry a boat measuring 14 ft x 5 ft x 2 ft 2 in (4.3 x 1.5 x 0.7 m) and either a launch or two other boats. Such a boat was considered to be 91 cubic feet (2.6 m^3) on the basis of 0.6 times the product of length, breadth and depth: only one boat, of 95 cubic feet (2.7 m^3), was in fact carried in 1936 according to the survey certificate. This may be the square-sterned clinker-built boat to be seen in the '*Baldersby*' photograph. It was carried to port on skids mounted on top of the iron house over the engine room. The skids are silhouetted in both 'postcard' views (Rice Coll.), and their outer ends can be seen to curve down and terminate with a supporting bearing for the davits, which were stepped on deck.

Anchors

Lloyd's required a ship with a second number of 4 051 to have 135 fathoms (247 m) of 13/16-inch (21 mm) bower cable, 45 fathoms (82 m) of 9/16-inch (14 mm) stream cable, and two bower anchors each of 5 cwt (254 kg). In 1935, the Engineer–Surveyor reported that 90 fathoms (165 m) of 7/8th (22 mm) and 70 fathoms (128 m) of 1-inch (25 mm) chain were carried. About this time the anchor is seen from a photograph to be Trotman's Patent, and still handled by a crane mounted centrally on the forecastle deck (SAMM:8113).

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Maritime archaeology and Metromix—results of the EIS

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Introduction

The results outlined in this paper are part of a group of studies undertaken for the building material company Metromix, investigating the feasibility of extraction of marine aggregate from extensive deposits off Cape Banks and Providential Head, south of Sydney. In 1991, at the AIMA conference in Adelaide, I presented a paper describing work in progress and some preliminary results. Since that time, I have been periodically involved with the project as new data has come to light and reassessments have been necessary.

This report therefore is a summary of the results of the investigations, in so far as they pertain to the shipwrecks. This incorporates my work and that of a number of other consultants, in particular Ian MacLeod (WA Museum) who assessed the impact of the proposal on the shipwrecks. Discussion is limited to aspects of the proposal which directly affect the shipwrecks. The end result has been the formulation of a management strategy for groups of shipwrecks rather than one shipwreck in isolation.

Background

Kurnell dunes have for many years been the source of fine sand for the Sydney building industry. Government planning requires extraction from these dunes to cease by 1998. The Sydney Regional Environmental Plan developed for the extractive Industry (REP 9), has identified a number of sources of fine sand which could serve the Sydney Region and a planning mechanism for their development. There are a number of sensitive social, ecological and planning issues associated with the development of onshore sand deposits. The REP therefore recommended the investigation of offshore deposits as a potential source of fine sand.

Metromix engaged a team of 13 firms of consultants to advise on constraints, safeguards, impacts and management procedures of extracting marine aggregate from the seabed. The team was involved in all aspects of the proposal, from the location and shape of the extraction area itself to the direction and shape of the extraction tracks and the frequency of extraction. The environmental sustainability of the proposal has been a paramount factor.

The proposal encompasses two extraction areas, Cape Banks and Providential Head. Cape Banks encompasses an area of 8.2 km^2 and Providential Head an area of 7.4 km^2. The two extraction areas form part of a larger Study Region which encompasses the entire locality examined for the proposal. Over the life of the proposal, approximately 50 years, the two extraction areas would yield approximately 56 million tonnes of concrete grade fine sand and another 40 million tonnes of general construction purpose material.

The studies

Extensive study of the coastal and marine ecological processes associated with the Study Region has identified the nature of the current and wave actions which affect sand movement along this section of the Sydney coastline. Specifically, sand transport analysis showed that the rates of sand transport on the inner shelf are very low, beyond 25 m water depth and are negligible beyond 35 m water depth. Overall, the nett rates of sand transport in the Study Area are negligible in the natural environment (Geomarine, 1993). This is significant for the maintenance of the stability of shipwrecks in the area.

Within the Study Region there is a range of rocky shores, reefs and shipwrecks to be found which all support a variety of marine life, as does the sandy substrata. Thus the shipwrecks serve an important function as natural reefs, apart from their intrinsic value.

The maritime archaeological component of the studies identified 18 shipwrecks within the Study Region (see Table 1). Based upon current knowledge of their location and the potential impact of the proposal, the shipwrecks were divided into four groups. These are:

Group 1 shipwrecks located in deep water and in close proximity to the proposal;
Group 2 shipwrecks located in shallower waters, inshore of the extraction areas;
Group 3 shipwrecks located well beyond the extraction areas, to the north of the Cape Banks extraction area and to the south of the Providential Head extraction area;
Group 4 unlocated shipwrecks which are thought from historic sources to have sunk within either the Cape Banks extraction area or Providential Head extraction area.

Constraints

The *Woniora* at between 60 and 64 m depth and the *Tuggerah* at 45 m depth, fall into the first grouping and as such were seen as being particular constraints upon the proposal, both in its planning stages and throughout its operation. The *Kelloe* in Group 2, due to its proximity to the northern boundary of the Cape Banks extraction area was also a constraint. The *Woniora* and *Tuggerah* were used in particular as the benchmarks for assessing the impact of the proposal on shipwrecks. Safeguards and management options were developed using data based on the position and extent of deterioration of these two vessels.

Beside the positions of the *Woniora* and the *Tuggerah* there were a number of other constraints identified by the various consultants. These determined areas in which the proposal may have an adverse impact. The studies therefore focussed on these areas to ensure safeguards and management options minimised any potential impacts.

They constrain the proposal in a number of ways:

- The *Historic Shipwrecks Act 1976* itself was a constraint.

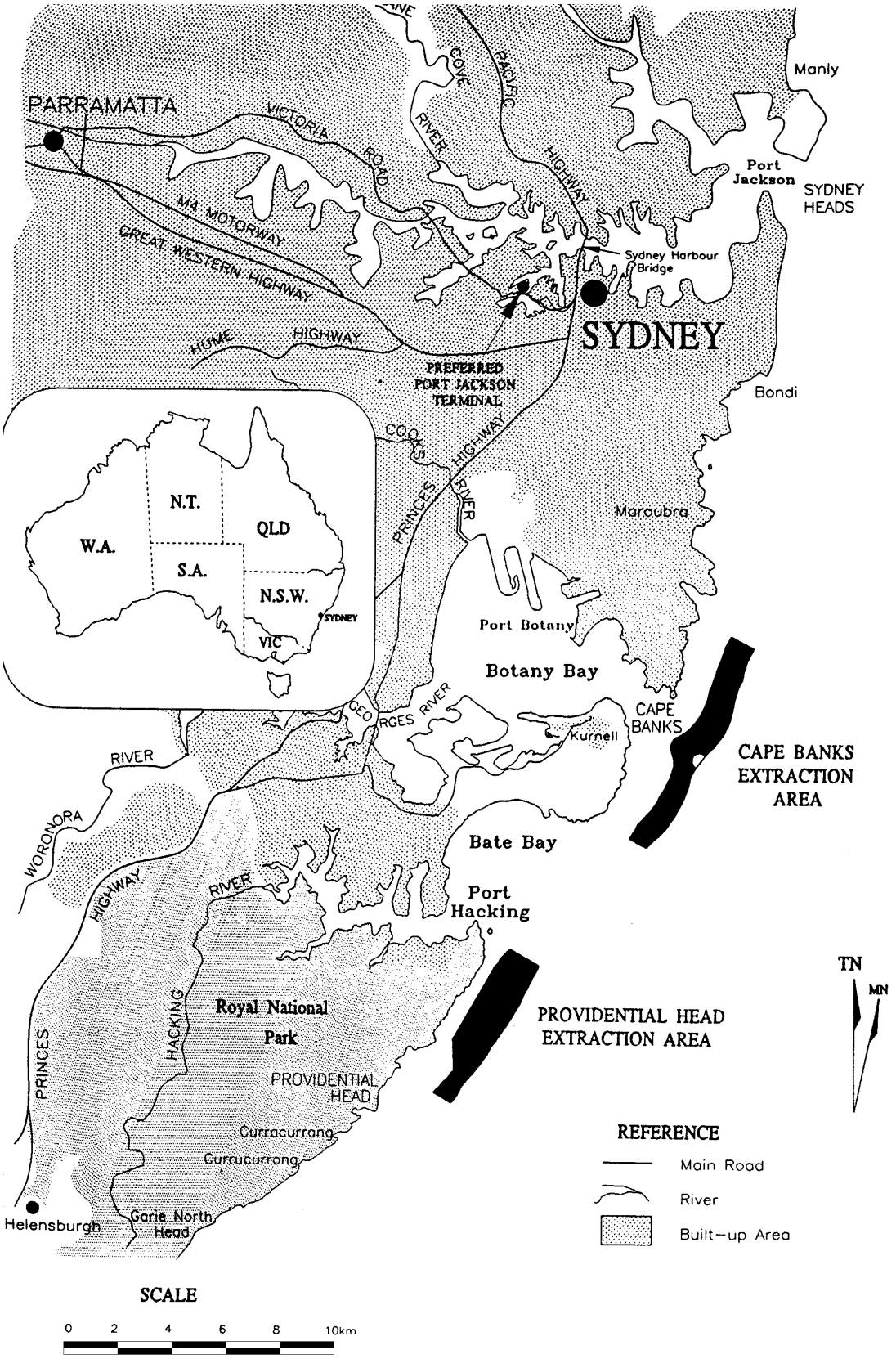

Figure 1. Sydney Maritime Aggregate Proposal, maritime archaeological studies (courtesy Metromix Pty. Ltd.)

GROUP	NAME OF SHIP	DATE	TYPE
Group 1	Woniora	1863–1882	Iron single screw steamer, collier
	Tuggerah	1912–1919	Iron single screw steamer, collier
Group 2	Hilda	1878–1893	Iron single screw steamer, collier
	Kelloe	1866–1902	Iron single screw steamer, south coast collier
Group 3	Belbowrie	1911–1939	Twin screw steamer, coastal trader
	Goolgwai	1911–1955	Steel fishing trawler
	Hereward	1877–1898	Iron clipper, trader to the colonies
	Malabar	1925–1931	Diesel motorship, passenger and cargo
	Minmi	1927–1937	Single screw steamer
	Tekapo	1881–1899	Iron single screw steamer, passenger and cargo
	Undola	1909–1918	Iron single screw steamer, Illawarra coal trade
Group 4	Emmanuel	1884–1890	Wooden ketch, coastal
	Magnet	1848–1874?	Wooden ketch, coastal?
	Merchantman	?–1882	Collier
	Sea Spray	1881–1904	Iron single screw steamer, collier
	Viceroy	1864–1878	Wooden brig, collier
	Nemesis	?–1864	Wooden brigantine
	William Broughton	?–1820	Wooden sloop, coastal

Table 1. Charted and uncharted shipwrecks in the Cape Banks and Providential Head Study Area.

Since the 75-year ammendment was introduced in April 1993 none of the shipwrecks can be interfered with. Prior to the introduction of this protection, assessments of significance were determined for each shipwreck and only those of most significance, and most vulnerable, that is the *Tuggerah* and *Woniora* were to be protected.

- The wrecks have the ability to damage the extraction equipment. General practice in the extraction industry is to avoid known wrecks thus protecting both their structure and cargo. Based on the manoeuvrability of the extraction vessel, a distance of approximately 200 m can be safely maintained between the extraction head and a known wreck.
- Undercutting created by excessive sediment movement away from the base of the wreck could cause destabilisation and degradation of the structural integrity of the wreck.
- Destabilisation and degradation of the wrecks could also result from localised erosion and/or accretion of sand. Exposure or covering of shipwreck components as a result of sediment movements to and from the wreck may influence the rate of degradation.
- Ian MacLeod determined by electrochemical modelling, a minimum 250 m diffusion zone around the *Woniora* and *Tuggerah*. Avoiding this zone would minimize the potential to alter the corrosion rate of materials on the shipwrecks (MacLeod, 1993).
- Siltation arising from the dispersion of fine sediments from the released excess water should not cause significant changes to the marine growth on the vessels, reefs or rocky shores.
- Further constraints relate to the rate and method of dispersal of plumes, released with the excess water.
- Finally, as the shipwrecks are a recreational source used by divers and fishermen, this should not be interfered with.

Environmental safeguards

Given these criteria, a range of design and operational safeguards have been proposed to ensure the constraints are all addressed without causing an unacceptable level of impact.

- The extraction areas have been designed to exclude all shipwrecks.
- A buffer zone of 250 m would be maintained between the limit of extraction and the *Woniora* and *Tuggerah*. This would ensure that the corrosion rate of the wrecks would not be interfered with, the marine life on the wrecks would not be adversely affected and undercutting of the wrecks would not occur. Studies of sand transport have indicated that a buffer based on sand transport would only need to be 25 to 30 m from the *Woniora* and conservatively 50 m from the *Tuggerah* to ensure that undercutting did not occur (Geomarine, 1993). [Of course this does not take into account the dispersal of cargo or the degree of structural integrity of the wreck.]
- During the first five years of operations, extraction is to be confined to 500 m from the *Woniora, Tuggerah* and *Kelloe* to monitor the suitability or otherwise of the 250 m buffer zone.
- All buffers would be plotted on the extraction vessel's navigational instruments on the vessel to alert the master of the buffer's location.
- While operating in the extraction areas, excess water

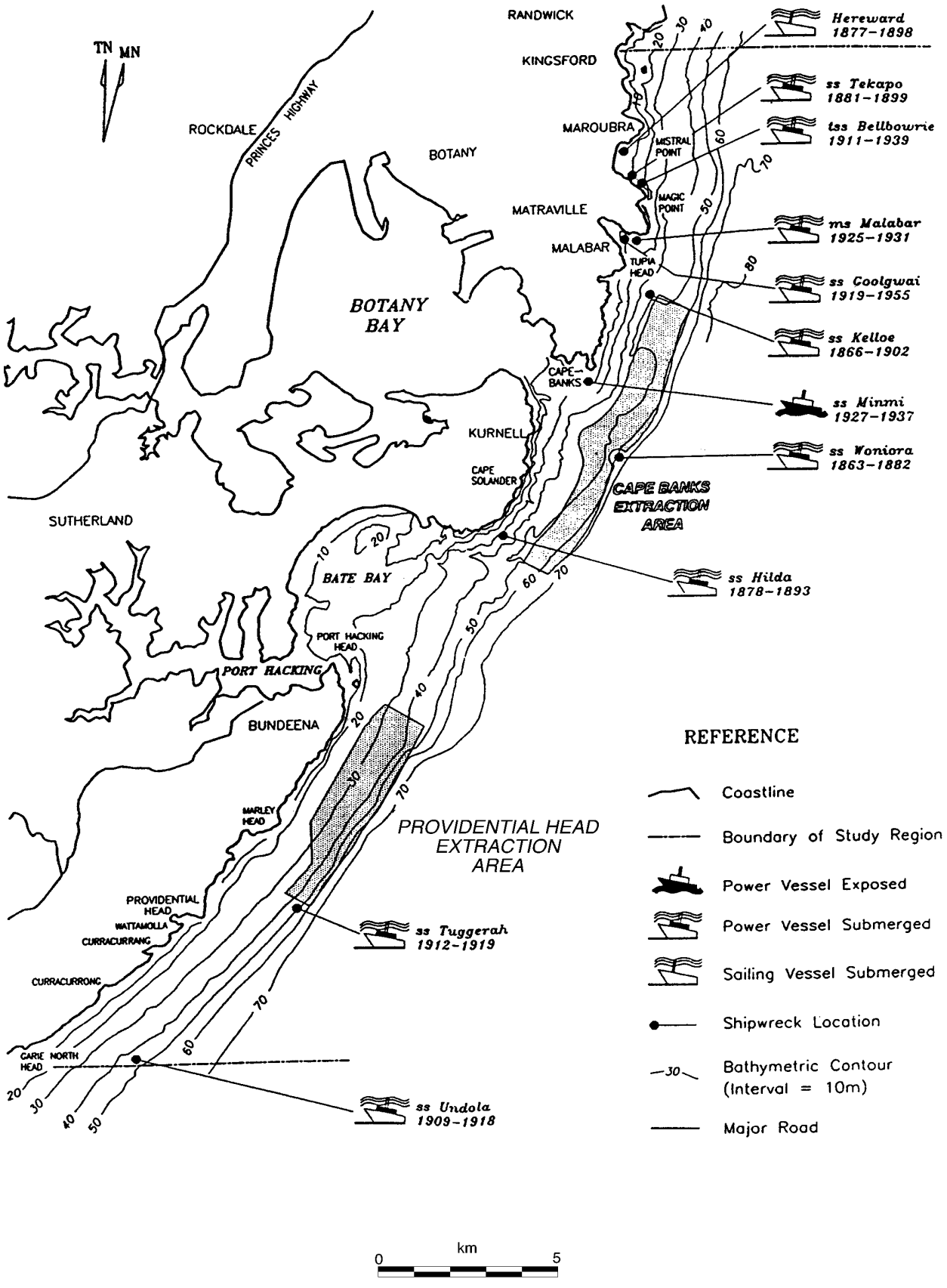

Figure 2. Maritime archaeological study region. (Source: R.W. Corkery & Co. Pty. Ltd.)

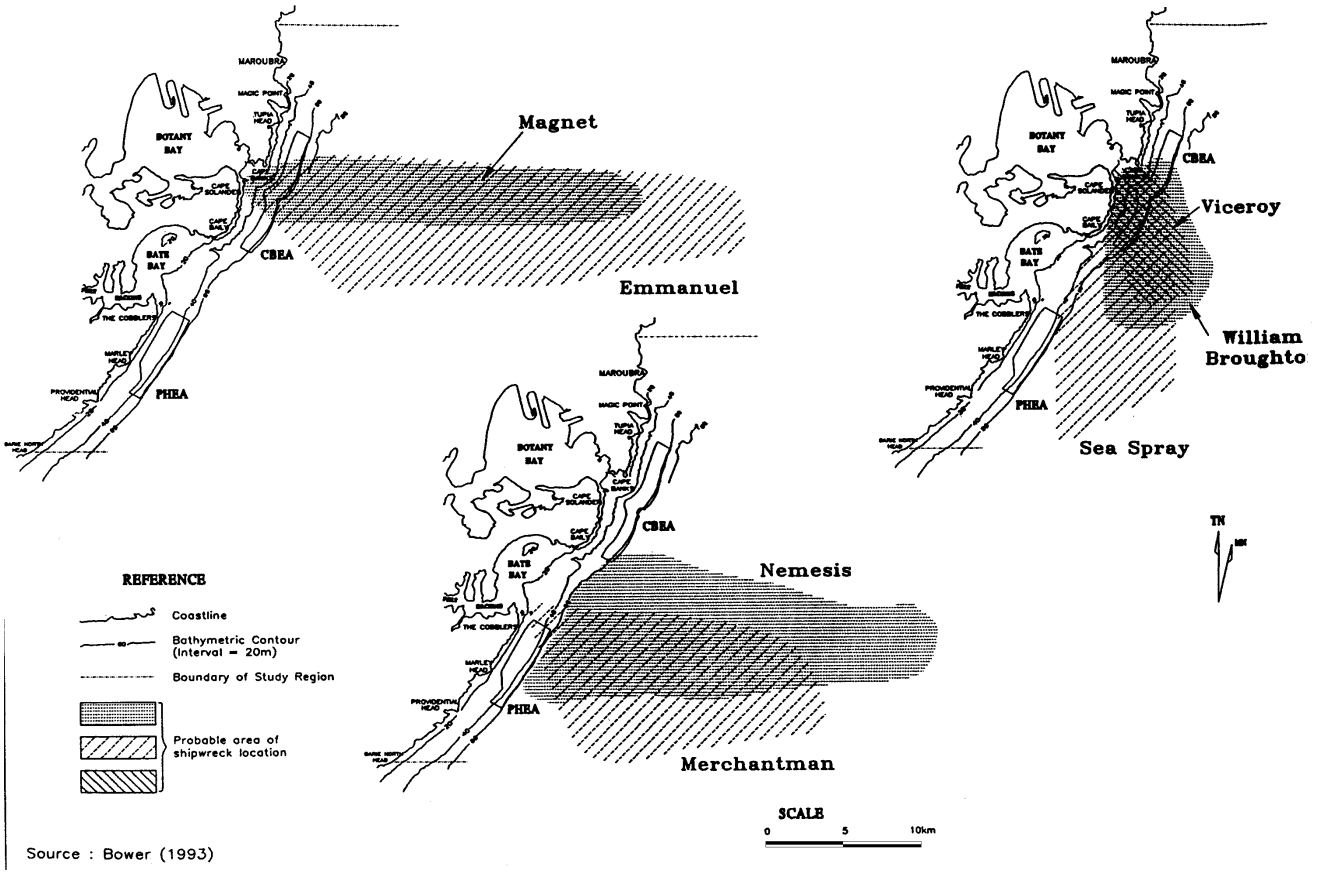

Figure 3. Uncharted shipwrecks. (Source: R.W. Corkery & Co. Pty. Ltd.)

is to be released at a depth of 10–20 m below the sea surface, ensuring the fine sediments pass well above the wreck of the *Woniora* and *Tuggerah*.

- A diffuser pipe, specifically developed for this proposal, would be attached to the overflow pipe. This would achieve the near background level of fine sediments found in the excess water released from the vessel. The diffuser pipe is a modification of those used at the major ocean outfalls near Sydney to disperse concentrations of fine sediments.
- In the event that an uncharted wreck is found within either of the two extraction areas the Department of Planning would be notified immediately, buffers would be installed and recorded on the extraction vessel's navigation equipment.

Management procedures

There are a number of management procedures which would be adopted to overcome or lessen impacts on the shipwrecks which may occur on rare occasions.

- Extraction tracks during the same trip would be at least 200 m apart if more than one pass is necessary to fill the vessel's hopper. This would prevent separate plumes mixing.
- There would be an onboard Current Profiler to establish the current direction at the time of extraction. In the event of onshore currents at between 10 and 20 m which may affect the inshore shipwrecks, the vessel could avoid extracting marine aggregate.
- Extraction would be restricted to the northern two thirds of the Providential Head extraction area when prevailing currents are flowing generally in a southerly direction. This would decrease the likelihood of any plume affecting the *Tuggerah*.
- Extraction is to cease before 5 p.m. on a Friday or the day before public holidays to ensure concentrations of suspended solids above the *Tuggerah* are dispersed to background levels by the following day for divers.

Assessment of impact

Ian MacLeod has noted that the natural degradative forces have already brought about major changes to the *Woniora* and *Tuggerah*, the closest wrecks to the Extraction Areas (MacLeod, 1993). The upper plating of the *Woniora* has almost disappeared and any of the 10 mm plating on the vessel would most likely be only one third of its original thickness. Only the thicker structural components are currently well preserved.

The design and operational safeguards and management options have therefore been devised to either avoid potentially adverse impact or to achieve a level of impact considered to be acceptable. They are also designed to comply with defined or developed standards or criteria used for assessing impact.

Given that these safeguards are in place, the following is a summary of the assessment of impacts of the proposal specifically on the shipwrecks.

- Extraction would create a depression up to 5 m deep on the sea floor. The edges of the depression would gradually flatten over thousands of years.
- The bulk of the fine sediments released with the excess water would move slowly to more tranquil areas in deeper water off the coast.
- It has been predicted that fine sediments would pass above the wreck of the *Woniora* irrespective of the location of extraction, at least 20 m above the sea floor. Fine sediments would pass above the *Tuggerah*, up to 13 m above the sea floor. In the event plumes from more distant locations pass through the *Tuggerah* they would be at concentrations consistent with background levels.
- The *Hilda* and *Kelloe* would lie in the path of the fine sediments onshore. However the likelihood of persistent onshore currents is very low. In this event the increased wave activity would disperse the plume rapidly.
- At the completion of extraction at Cape Banks, the predicted plume would be about 7.2 km long, between 50–170 m wide and 1–12 m thick. Within 3 hours of extraction there would be no concentration of fine sediments higher than 5mg/L. Within 16 hours the fine sediments would have reached background levels.
- It has been predicted that the prevailing currents may cause the fine sediments to drift directly above the *Woniora* for between 15 minutes to 1 hour for a plume of 150 m wide and 6–24 minutes for a plume 50 m wide. Prevailing currents may cause the suspended solids to drift across and above the *Tuggerah* for a period of 17–70 minutes for a plume of 150 m wide and 9–35 minutes for a 50 m wide plume.
- Dependent upon the number of trips and the direction of the prevailing current, it is expected that if extraction occurred exclusively in either of the two areas, then it would be likely that less than 50% of the suspended solids would cross the site of the *Tuggerah* and *Woniora*. This would be less if extraction occurred in both areas (Metromix, 1993).

The effectiveness of the safeguards according to MacLeod (pers. comm.) will ensure that the wrecks will last into the 21st century and thus the level of impact is deemed acceptable (Metromix, 1993).

Monitoring

Before extraction commences, during the life of the proposal and after extraction ceases, it is the intention of Metromix to undertake extensive monitoring of the study area. The shipwrecks are to be monitored in all three phases of the project.

Before extraction commences:

- The exact locations of the shipwrecks are to be fixed and transferred to all charts and navigation aids used for planning extraction tracks and navigation at sea.
- Video and still photography of the *Woniora, Hilda, Kelloe* and *Tuggerah* will be taken and copies lodged with the Department of Planning.
- Side-scan sonar and magnetometer surveys are to be undertaken to ascertain the position of uncharted wrecks.
- Electrochemical surveys of significant structural sections of the *Woniora* and *Tuggerah* will be undertaken in conjunction with the Department of Planning.

During the course of extraction:

- Monitoring of the concentration of suspended solids in the sediment plume is proposed on a regular basis, with the onboard current profiler.
- An electrochemical survey of structural components of the *Woniora* and *Tuggerah* would be undertaken regularly as would observations of the extent of erosion and accretion adjacent to the wrecks.

After extraction ceases:

- The monitoring programme will continue to complete assessment of the effectiveness or otherwise of the range of safeguards adopted throughout the extraction operation.

It is beyond the scope of this paper to debate the relative merits of this proposal as a whole. However, as a guide for the appropriate methods to take when managing such a large cultural resource, particularly in the context of development, it has been invaluable. The assessment and management proposals for the shipwreck resource found within the Metromix Environmental Impact Statement are more advanced than any this consultant has seen in any other study of the impacts of extraction, both in Australia and overseas. It is hoped they will be used in the future as a basis for developing a national strategy for commercial development and the underwater cultural heritage.

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Recent changes to historic shipwrecks legislation in Victoria: something borrowed and something new

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Introduction

For many years legislation protecting shipwrecks around Australia focussed upon preservation of the property rights of owners and the collection of excise payable on imported goods. The *Navigation Act 1912* and *Customs Act 1901* of the Commonwealth both contain provisions dealing with the disposal of wreck and the legal obligations of those involved.

The introduction of the *Historic Shipwrecks Act* by the Commonwealth in 1976 recognised the historical and cultural values of shipwreck remains and sought to protect them in the interests of the national heritage (Strachan, 1989). Some 425 historic shipwrecks are located in Victorian coastal waters below the high water mark and fall under the jurisdiction of the Commonwealth Act. The declaration by the Commonwealth in April 1993 of blanket protection for all shipwrecks aged greater than 75 years saw the number of protected shipwrecks in this jurisdiction rise from 31 to 343.

As a consequence of the Commonwealth initiative and in order to ensure the protection of the remainder of the State's maritime heritage resource, the Victorian Government passed legislation which encompassed those shipwrecks directly under its jurisdiction. The Victorian *Historic Shipwrecks Act 1981*, which generally mirrors the preceding Commonwealth Act, applies to historic shipwrecks and historic relics located in waters within the limits of the State. This includes all inland waters and major bays, estuaries and ports around the coastline including Port Phillip and Westernport Bays, Corner Inlet, and a number of pre-federation ports such as Portland, Warrnambool and Port Fairy. Victoria has 258 recorded shipwreck sites in this jurisdiction and the greatest density lies within the vicinity of Port Phillip Heads.

Following recent enforcement activities undertaken by the Victoria Police and staff of the Victoria Archaeological Survey, it became apparent that a number of deficiencies existed in the legislation which needed to be addressed. Additionally, the 1985 amendments to the Commonwealth Act contained new initiatives which created major disparities between the respective levels of protection afforded the maritime heritage resource under Commonwealth and State legislation. It was believed these differences would cause confusion for client groups such as recreational divers and tourism industry operators as well as increasing the difficulty of enforcement for inspectors. Cabinet gave approval-in-principle on 15 March 1993 for the preparation of a Bill to amend the *Historic Shipwrecks Act 1981.*

This paper discusses a number of measures contained in Victoria's Historic Shipwrecks (Amendment) Bill which reflect the changes made to the Commonwealth Act since its inception. These include: the introduction of automatic (blanket) protection of all shipwrecks which are of a certain age; extension of the life of provisional declarations to five years; restoration of parity between pecuniary and custodial penalties for offences; provision for indictable offences to be tried summarily; and introduction of the notion of rewards other than those of a financial nature.

New initiatives introduced by the amending legislation to improve the operation of the Act are also discussed in the paper. These include: representation of the diving tourism industry on the Historic Shipwrecks Advisory Committee; prescription of several new offences in relation to taking, possessing, interfering with or going equipped to interfere with a historic shipwreck or relic, or entering a protected zone; introduction of penalty infringement notices; new provisions for search and seizure and other increased powers for inspectors; and the introduction of certain evidentiary and onus of proof provisions to facilitate proceedings.

The Bill passed through the Victorian Parliament with bi-partisan support during the 1993 Spring Session and increased the number of shipwrecks protected under the *Historic Shipwrecks Act 1981* from 7 to 164.

The review process

Since 1985 when the Commonwealth introduced a number of changes to the *Historic Shipwrecks Act* 1976, the maritime archaeology staff of the Victoria Archaeological Survey (VAS) had been concerned that the State *Historic Shipwrecks Act 1981* was lagging behind the Commonwealth Act in the levels of protection which could be given to the maritime cultural resource. VAS staff and members of the Victoria Police had also encountered a number of difficulties in enforcing the legislation, particularly with respect to offences against section 19 of the Act involving illegal interference with, or damage to a historic shipwreck or relic. There are inherent difficulties in proving an offence which occurs at some depth beneath the sea in the absence of direct observations of the fact by an investigating officer.

Legislation issues and the need for change were formally raised with the Historic Shipwrecks Advisory Committee (HSAC) in a policy discussion paper presented in April, 1989 by the Maritime Archaeology Unit of VAS (Strachan, 1989: 3–4). The HSAC is a statutory committee established to consider and advise the Minister on all matters in relation to historic shipwrecks and relics. It is comprised of representatives

of major client groups including recreational divers, tourism and fishing industries, museums and other archaeological practitioners, and various relevant State and Commonwealth government departments. The HSAC provides an invaluable communication link between the bureaucracy and the diverse interests represented by its members. This greatly facilitated consultation processes during the preparation of the Bill and was no doubt responsible for the broad support the draft legislation received from the many client groups impacted by its proposals.

VAS recommended the use of automatic (blanket) protection for shipwrecks over 75 years old and argued that a major benefit would be heightened community awareness of the cultural significance of all shipwrecks rather than just a select few. It also proposed that the onus of proof that artefact material recovered by a diver was not from a historic shipwreck should lie with the diver. Maritime archaeology staff reasoned that making it easier for inspectors to take action against individuals intercepted with artefacts, in circumstances where it was not possible to provenance the items to a specific wreck, would constitute a major deterrent to looters.

The HSAC accepted these recommendations and established a sub-committee to prepare a detailed proposal for submission to Cabinet by the Minister. The final submission from the sub-committee team incorporated the various changes introduced by the Commonwealth in 1985. It also contained a number of new initiatives designed to improve the administration of the Act and hence the protection of historic shipwrecks and relics within the jurisdiction of the State. Despite a change of government, and a later shift in portfolio responsibility during the preparation and passage of the Bill through Parliament, the *Historic Shipwrecks (Amendment) Act 1993* received the Royal assent on 30 September 1993.

Commonwealth changes in the mirror

The most significant Commonwealth initiative for the protection of historic shipwrecks since the introduction of the original Act was presented in the *Statute Law (Miscellaneous Provisions) Act (No. 1)* No. 65 of 1985. This saw the inclusion of a provision allowing a declaration of protection by the Minister of all shipwrecks over 75 years old which are situated in Australian waters. Not all of the States were in full agreement, however, and it was not until 1 April 1993 that this substantial increase in protection of the maritime heritage resource came into operation. The underlying philosophy of such a protection measure had been strongly supported by the HSAC, and the amended State Act now provides that all shipwrecks and relics that have been situated in Victorian waters for more than 75 years are historic from the date of assent. (This period can be reduced to not less than 10 years by Order of Governor in Council).

Leonie Foster (1987: 1) describes the area within a 10 nautical mile radius of Port Phillip Heads, Victoria as being unparalleled in Australia as a repository of the underwater cultural heritage in terms of the number of shipwrecks which have occurred, the range of vessel types and cargoes, and the extent of preservation of the remains so far discovered. This area, with its great diversity of underwater attractions, is by far the most popular location for SCUBA divers in Victoria. The richness (120 plus) and accessibility of the shipwreck resource around Port Phillip Heads has turned wreck diving into one of the major recreational activities in the region. Prott and O'Keefe (1984: 287) asserted that the major importance of a (sic) shipwreck lies in the fact that it is a 'time capsule' but unfortunately disturbance to these wrecks and the removal of artefacts has remained prevalent and much of the reference value lost by the irresponsible actions of a few within the sport diving community. This has occurred despite a vigorous campaign to educate divers with respect to both the cultural importance of the wrecks *in situ* and the implications of their unlawful removal. The usual defence offered by divers found with shipwreck material has been their purported misunderstanding of either the jurisdiction of, or the legal obligations imposed by, the relevant legislation and it is expected that the introduction of the 75 year rolling date will remove much of the alleged confusion in this area.

Protection is also given by the recent amendment, to remains and articles older than the specified period which have been removed from Victorian waters, except where the removal was not contrary to any law in force at the time. Thus a comparable high level of protection is afforded historic shipwrecks and relics within the Victorian jurisdiction but the property rights of individuals have been largely preserved. The ethical dilemma created by the desire to ensure the protection of what can reasonably be regarded as the community's cultural property on the one hand, and the necessity to uphold the principles inherent in the concept of private property on the other has been a major problem facing legislators in Australia. Addressing a 1986 UNESCO seminar in Brisbane on the role of the Australian Government in protecting Australia's moveable cultural heritage, the then federal Minister for the Arts, Heritage and Environment the Hon. Barry Cohen MP told delegates that 'It is important that Australian legislation is not seen as abrogating the rights of private owners of cultural property' (Prott & Specht, 1989: 5). Judy Birmingham (University of Sydney) while speaking to this issue at the seminar noted that it was equally important to regard artefacts from an historical site as part of the assemblage and not as an individual item (Prott & Specht, 1989: 105). Previous reliance upon the *Navigation Act 1912* for the protection of the majority of our underwater cultural sites can now be seen to have been highly inappropriate as it provided no facility to preserve the situational context of any of the associated artefacts.

The advent of 'blanket' protection under the State Act has substantially reduced this reliance upon the *de facto* protection of cultural heritage values through

the application of the *Navigation Act 1912*. Although a number of provisions of this legislation serve to protect the integrity of a wreck, the true purpose of the *Navigation Act* is to determine ownership and ensure the orderly salvage of a wreck and its cargo. As Bill Jeffery (1987: 12) has pointed out previously however, the provisions of this Act leave little opportunity for shipwreck material to be legally obtained unless purchased from an owner or the Receiver of Wrecks.

It is expected that the adoption by the State of a blanket protection philosophy in common with the Commonwealth Act will serve to minimise confusion amongst client groups including maritime archaeology practitioners, general recreational divers and the fishing industry. Blanket declaration clearly defines the protection which is afforded to all articles at a site. It also simplifies the tasks of those responsible for the enforcement of the legislation and should soon lead to improved levels of compliance.

Although it recognised that the need for provisional declarations would diminish as a consequence of the introduction of the automatic (blanket) declaration of protection for all wrecks more than 75 years old, the HSAC decided to seek an increase in the period of provisional declarations from 12 months to 5 years in line with the amended Commonwealth provision. The argument that this longer period was necessary to ensure that archaeological investigations could be completed and the data properly assessed prior to making a recommendation for permanent protection or otherwise was accepted by Cabinet and incorporated in the Bill.

In 1985 the Commonwealth took the opportunity to restore parity between pecuniary and custodial penalties and to introduce specific penalties for offences by corporations. Similar provisions were introduced in Victoria's amending legislation by bringing it into conformity with the *Sentencing Act 1991*. Changes were also made which permit indictable offences to be tried by a court of summary jurisdiction. The incorporation of this provision in the State Act is expected to facilitate the efficient conduct of proceedings and substantially reduce costs of actions for both the Crown and defendants.

The issue of the granting of rewards to discoverers of shipwrecks must surely be one of those most often raised in philosophical debate amongst practitioners of maritime archaeology. There is an aura of romanticism surrounding shipwrecks through their association with treasure and the life-styles of early seafarers. Jeffery (1987: 17) postulated that historic shipwrecks legislation has, to a certain extent, perhaps promoted this romantic image by providing for the payment of a reward to finders of shipwrecks. That this is not the case with terrestrial Aboriginal and historical archaeological sites, despite their potential to contain materials of high monetary value, is certainly indicative of common public perceptions. Perhaps this expectation of a reward also explains why the notion of 'finders-keepers' with respect to shipwreck materials has been long regarded as acceptable in many quarters. As early as 1964, following the discoveries of the *Vergulde Draeck* (1656), the *Batavia* (1629) and other Dutch shipwrecks off the West Australian coast, legislation was enacted which rewarded a person who first reported finding a shipwreck sunk prior to 1900. The *Museum Act 1964* of Western Australia exhibited a number of shortcomings and was subsequently replaced by new legislation in 1973. This was longer and more complex, particularly in relation to the granting of rewards (Hosty, 1987: 21). The depth of feeling over the reward issue can be gauged from the action by Alan Robinson in mounting a successful challenge in the High Court in 1977. As a direct result of this, the *Historic Shipwrecks Act 1976* of the Commonwealth was proclaimed with respect to Western Australia, the first State to do so (Ryan, 1977: in Hosty, 1987: 22).

In amending its legislation, Victoria has now adopted the concept of granting awards to discoverers of shipwrecks as a preferred alternative to issuing rewards. This allows recognition of the contribution that a person finding a shipwreck has made to the archaeological record, but avoids placing a financial value on cultural heritage materials and the consequential incentive to exploit it.

Victoria's new initiatives

The diving tourism industry makes a very important contribution to Victoria's economy. The industry association, Dive Australia, estimates the number of certificated scuba divers actively participating in the sport in Victoria at more than 100 000 persons and its direct annual value as exceeding $15m. The association represents more than 350 businesses involved directly in the dive tourism industry including equipment manufacturers and agencies, dive retail outlets, and training and charter operations. There are currently 55 000 new divers being trained nationally each year and this figure is growing at a rate of more than 20% p.a. (McDonald, 1992). In Victoria, training and dive charter operations are mainly centred on the southern Port Phillip Bay region where the rich and accessible maritime heritage resource is a major attraction. The diving tourism industry is therefore a major stakeholder in the resource. Controlled access to, and adequate protection of, shipwrecks is essential to ensure the long-term viability of both the resource and this important Victorian industry. Government recognizes that the industry is ideally placed to reshape community attitudes towards our maritime heritage, and a recommendation that the number of members of the HSAC be increased by one to permit the appointment of a representative of the dive tourism industry was subsequently incorporated in the legislation.

As discussed previously in the paper, investigating officers have experienced difficulties in proving offences in relation to interfering with, damaging or removing historic relics after the fact. The committee examined Victoria's natural resource protection legislation

including the *Fisheries Act 1968* and the *Wildlife Act 1975*, and recommended that (i) further offences of 'take' and 'possess' be prescribed in the amendment and (ii) that the onus of proof of taking be reversed where possession exists in certain circumstances. The proposed incorporation of this 'reverse onus' provision became a major issue in the development of the legislation as fears were expressed regarding the possible denial of common law rights in relation to the presumption of innocence of an accused. It is interesting to note that the original wording in the Bill severely limited its area of operation and the provision was amended to its current form on the motion of the Opposition. This certainly demonstrates the bi-partisan nature and high level of support the Bill received in the Parliament.

The provision states:

> Evidence that a person had possession of a historic shipwreck or relic in or near a protected zone or historic shipwreck; or in or on a vessel or vehicle on or in proximity to Victorian waters; or on a jetty, dock, wharf, beach, landing or similar place or in an area next to such places, without a permit under section 21 is evidence, and in the absence of evidence to the contrary, is proof, that the person took the shipwreck or relic in contravention of this Act (*Historic Shipwrecks (Amendment) Act 1993*).

This shift in the burden of proof does not excuse the prosecution from establishing all other relevant points of proof, but it does recognise that the offences are occurring in an environment where observation is highly unlikely and where it is possible that only the defendant may possess direct knowledge of an event. During debate on this provision in the Legislative Assembly, the Hon. the Minister Rob MacLellan said:

> It appears to the government, as it does to the opposition, that the person who is the subject of interest in the matter should have available to him or her all the information necessary to explain how he or she came to be in possession of the items that are the subject of a prosecution or interest. Since the information has been available to them, it seems appropriate that they are able to offer the court or the prosecutor some explanation about the matter and for the case to be disposed of by providing a satisfactory explanation (Victoria, 1993).

Technological developments in more recent years have given the determined wreck 'basher' unparalleled ability to locate and access shipwrecks for their contents. Modern methods of salvage have vastly increased the speed at which sites and their contents can be destroyed or damaged (Nutley, 1987: 29). The MAU has intelligence of the use by known offenders of magnetometers to locate shipwrecks by their ferrous metal content; global positioning systems and other advanced satellite navigation equipment to precisely fix wreck locations and enable systematic pilfering over extended periods; special breathing mixtures and changes to tank design and construction which allow divers to explore greater depths and remain submerged for longer periods; and explosives, thermal lances, eductor dredges and air-lifts which have greatly facilitated the rapid dismemberment of wrecks and collection of items from them. It is now an offence against the Act for any person to possess, on or near any historic shipwreck or historic relic without reasonable cause, any equipment which can be used to damage or effect salvage or recovery of that historic shipwreck or relic. This is a similar construction to offences in other legislation such as the Summary Offences Act 1966 and the *Fisheries Act 1968* and should prove a substantial deterrent to organised looters.

The use of Penalty Infringement Notices to deal with less serious offences has become a widely accepted practice amongst enforcement agencies in Victoria and Jeffery (1987: 18) noted that the system had merit for historic shipwrecks protection in South Australia. Penalty Infringement Notices (PIN's), along with summary proceedings, provide a further option from the extremes of either prosecution in the superior courts or an administrative warning. Payment of a penalty does not constitute an admission of guilt and does not preclude the alleged offender from seeking due process if so desired. The PIN system greatly improves the efficient administration of the Act and substantially reduces costs for both the offender and the Crown. It has the added benefit that imposition of the penalty is usually contemporaneous with the detection of the offence by the investigating officer which is a major deterrent factor for potential offenders. PIN's have now been introduced for a number of offences against the Act and the Regulations, and these will attract 'on-the-spot' fines of between $100 and $500 for individuals, and twice that for corporations.

Powers of inspectors were revised to reflect those available under other resource protection legislation. In Victoria the majority of appointed inspectors are either Fisheries and Wildlife Officers or coastal-based Rangers from the Department of Conservation and Natural Resources. Their inspectorial roles and powers under historic shipwrecks legislation are similar and complementary to those associated with their normal duties which serves to ensure that high professional standards of enforcement practices are maintained. Members of the Police Force are inspectors as of course under the Act. A warrant to search a private dwelling can now be issued by a magistrate, and searches without warrant can also be made of personal gear, boat cabins, tents and caravans subject to reasonable grounds existing for the inspector to do so. An inspector may require persons to give their name and address and produce any document that might be relevant to the commission of an offence or which may provide proof of identity. These increased powers were offset, as it were, by Parliament repealing the former existing power to require a person to answer questions. It was argued that exercising such a power may deny a person's right not to say anything which may be self-incriminating.

An evidentiary provision was inserted to ensure that the place of an offence could be established. It allows the

statement of an inspector as to the place of an offence; the accuracy of maps, photographs and other documents; and as to any navigational data, including distances and directions, to be regarded by the court as prima facie evidence of the fact. Although no prosecution under the legislation in Victoria had failed on this point, the experience of South Australia with respect to proving entry into a protected zone (Jeffery, 1987: 18) and the advice of officers dealing with offences under the *Fisheries Act 1968* and *Marine Act 1988* were instrumental in the decision to incorporate this provision.

Finally, the new legislation prescribes the conduct of proceedings. Only the Protector of Shipwrecks, the Director of Public Prosecutions or an inspector may now bring proceedings for an offence against the Act, and proceedings brought by an authorised person may be conducted by any other authorised person. A legal opinion provided by the Victorian Government Solicitor in 1992 discouraged any declaration by the Minister/Protector of an amnesty from prosecution concurrent with the then proposed Commonwealth amnesty, as the Act was deemed to be a public Act and unless otherwise prescribed 'any person may file a charge for the enforcement of a public Act' (Hallet, 1992). The significance of this was that no one was in a position to be able to say that proceedings for an offence would not be brought in any particular case. The amendment now rightly places responsibility for due process with the competent authorities.

Conclusion

The new legislation has already stimulated renewed debate on the need and appropriateness of the 'heavy hand' in relation to the protection of our maritime cultural heritage. It has also initiated some creative thinking on what additional measures to safeguard the resource should be included in the next amendment!

That specific legislation is necessary is itself unarguable. As Greta Bird (1980: 44) explains:

> The Australian system of law is based on the common law which traditionally has sought to protect individual rights through the courts. Cultural heritage is a collective right and as such cannot be adequately protected by common law doctrines. Protection of heritage must therefore come from legislation which is specifically designed for the purpose, and which is sensitively interpreted by the courts.

The 1993 amendments to the *Historic Shipwrecks Act 1981* take us one step further in establishing acceptable community standards which will ensure the survival of this great collective asset—our maritime heritage.

Epilogue

> Legislation expresses the community's expectations with respect to the management of our resources. Enforcement is about ensuring compliance with the legislation. To ensure compliance does not simply mean detecting and prosecuting people found offending. Implicit in this role is the need to educate and inform those people about the wise and proper use of the resources. The resource manager must regard enforcement as being one of several tools available to wisely and properly manage those resources (Anon).

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Training and its role in law enforcement

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There is an expectation from the community that any person who is empowered to enforce legislation, take proceedings in a court of law on behalf of the crown and, if the case requires, take away a person's liberty, should be well trained. This is certainly the case in many police forces throughout the world (not all) and many conservation departments.

On a recent trip to Canada, United Kingdom and Europe, I had the opportunity to evaluate some police and conservation training programmes and compare what was offered in Victoria. This was particularly directed towards conservations officers, but as police procedures and many acts of parliament are used by both police and conservation, the study was complementary.

Prior to 1986, there was no course dedicated to law enforcement training for conservation enforcement officers. Recruited on the basis of their various backgrounds, training consisted of 'on-the-job' training under direction of a senior officer. The mistake in this process is that the trainee inherits the trainer's traits, good and bad. There was no consistency across the state. Officers were generally good in detecting offences, because of their backgrounds and generally were successful in prosecutions. This was helped by the assistance given to conservation officers by the police, who would assist a conservation officer in tidying up procedures, i.e. arrest procedures. Courts were also more benevolent to conservation officers, because they were enforcing a 'popular law' and were given leeway in court procedures because they were not police and had not received training to the same degree. Magistrates often 'protected' conservation officers from 'aggressive' barristers but were not so lenient towards the police. I suppose the best way to sum it up would be this way; 'The Police are full time professionals, the conservation officer is only a part-timer'.

The attitude has changed. Poaching a natural resource, shipwrecks included, is now a lucrative business. Large monetary gains can be made out of plundering a natural resource. It is nothing short of stealing and should be treated accordingly. Likewise, organised poachers are criminals.

The illegal poaching of Victoria's abalone resource has been linked with organised Asian crime syndicates operating out of Melbourne and overseas centres. There is also a further link with prostitution and drug offences. It is not unacceptable to assume that illegal abalone divers are also associated with the plundering of our valuable shipwreck resource. High monetary gains are available to these criminals and government must afford protection through trained enforcement officers supported by responsible legislation. The higher the monetary gain, the more risk involved. Poachers are becoming more sophisticated and the sophistication must also be available in the enforcement officer through resources and training. It is therefore a natural result of all this monetary gain and sophistication that court cases will be vigorously defended by skilled members of the legal profession. Yes, the role of the conservation officer has changed in so far that he/she is now expected to perform to a higher degree. The courts are now insisting on conservation officers applying all the rules of evidence in and out of the courts. Magistrates now treat conservation officers as professional full-time enforcement officers. The unofficial protection is not available.

Between 1986-90, the Department of Conservation introduced and funded intensive law enforcement training to most of its new enforcement staff. This training not only covered departmental legislation, but other supporting legislation, which often governed the rules to be applied in general enforcement. The training covered other topics such as police procedures, company interviews, self defence, conflict resolution, court prosecutions, arrest and survival at sea. The training in Victoria was the most intensive in Australia and became accredited with the TAFE Board. Sadly, the training in this department has now been drastically reduced. An intensive course as previously described has not been run for over two years and little interest has been shown in running it any more. In contrast, Canadian authorities in Saskatchewan place a huge emphasis on training and update training for senior officers. They emphasise cross cultural and human relations training, which is a very important factor in 1990 style training. Canada has had problems but appears to be far more advanced in meeting these problem than Australia (Edwards pers. comm.). There is a reluctance in Victorian authorities to introduce cross cultural training for conservation enforcement officers and this is essential to enable conservation and Aboriginal issues in Victoria to work in harmony. Cross cultural training should also extend into Asian communities, who are users of our natural resources.

Police officers in Ireland are trained in cultural and community needs, in fact all trainees at the Garda Police Training College in Templemore, Ireland are required to work in the community on a specific community task prior to graduating. Community involvement continues on after graduation and is a significant role in the Garda in Ireland. All trainees now have to speak English and Gaelic, and are taught German prior to graduating from the Academy (Finnerty pers. comm.). The Royal Canadian Mounted Police trainee is required to speak English and French prior to graduating from the Academy in Regina, Saskatchewan to meet cultural and community needs.

Victorian conservation officers and shipwreck inspectors must be in a position to receive ongoing training in the field on interviewing, including company interviewing and court-room presentation. This is especially important for the Shipwreck Inspectors as most of their work is reactive, that is, they usually do not catch the offender in the act and are required to provide a follow-up interview and investigation. It is very important that they know the rules of evidence and the rules governing the interviewing of indictable offences. Training is only effective if management is supportive. In Saskatchewan, the Minister down to the Senior Department Management were supportive of conservation enforcement officers' duties.

Enforcement is not a popular responsibility of public service and is often shunned by senior management due to their lack of understanding, lack of knowledge and the general nuisance value it creates. Nevertheless, it is a conservation tool and this must not be forgotten. Canadian authorities are keen to use private consultants in enforcement, not only to provide specialised training to field staff, but also to management. In one recent case, Canadian management engaged a private consultant to speak on critical stress assessment, prior to conducting the same course for the field staff. This enabled management to understand and work more closely with field staff on enforcement issues. As a result, the New South Wales Fisheries Department have recently adopted the same principal using the same private consultant, with outstanding results (Walker pers. comm.).

In summary, training is not something that is turned on and off to meet the crisis at hand or the politics involved. It is more cost effective to have onward going programmes run by professional training officers supported by consultants if the need arises. The law is dynamic, likewise associated matters, and if training is not ongoing, the image of a department is quickly tarnished and this is hard to retrieve. Sound legislation is ineffective if there are not technicians to implement its purpose.

Myths, threats and critical incidents: implications for training and development of enforcement personnel

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For those tasked with the day-to-day protection of historic shipwrecks, enforcement and ultimately charging of those who would destroy or steal from these crucial links with our past, this paper will be of crucial importance.

An indication of the importance and public interest in historic shipwrecks can be found on the front cover of the October 1993 issue of *Time Australia*: 'The Race for Sunken Treasure' referred to a keynote article (Gibbs, 1993: 50). As protection increases and tougher laws are passed more aggressive criminal activity will surely follow.

This paper should be taken as a cautionary note. As the prize becomes more valuable, the risks will also increase to those tasked with enforcement. While the safety of the historic wreck and its contents are on the front burner, the selection, training and enforcement policies for enforcement personnel is too often on the back burner. The consequences could be fatal.

Police Officers fully understand the risks facing them on the job; they are trained and oriented to such work. Enforcing laws which protect fish, fauna, wildlife, or historic shipwrecks can be problematic as the risks are not often fully understood, the work is not perceived as being dangerous and critical incidents are considered to be rare. Myths such as 'It will never happen here' or 'we only patrol during the day, and not very often' are common.

Consider the following myths often reported by enforcement officers in non-police enforcement organisations. Variations of these have been articulated in my courses over many years and in many countries.

IT COULDN'T HAPPEN HERE. IT'S A SUNDAY AFTERNOON
PEOPLE LIKE THAT DON'T DO THOSE KIND OF THINGS
NO ONE WOULD ASSAULT ME OVER SHIPWRECKS
THERE ARE LOTS OF BOATERS AROUND, I'LL BE OK
IT'S ONLY A MINOR INFRINGEMENT…
NO ONE HAS EVER BEEN HURT BEFORE
THEY WILL ALL SETTLE DOWN IN A MINUTE
I KNOW THESE GUYS ONLY GO SO FAR
IT'S JUST AN OLD MAN AND A KID
THEY ARE JUST RECREATIONAL DIVERS
THEY WILL RESPECT MY UNIFORM
HE IS POLITE AND QUIET

When one considers that Historic Shipwreck Legislation calls for significant penalties, confiscation of boats and gear, heavy fines and possible jail sentences the risks and the rational for assault are apparent.

Individuals involved in stealing from historic wrecks may be part of organised gangs heavily financed in such expensive operations by major criminal affiliates. Abalone poachers doing a bit of wreck stealing on the side often have connections to crime and to drugs. In over thirteen years of working with Fisheries Officers in North America, Australia and New Zealand I am no longer surprised at the Police records of individuals doing 'a little poaching'. I anticipate it. If they are stealing fish, they are often doing drugs, have access to firearms and have criminal records. In some cases doing random checks of infringement notices, a high percentage of individuals have been shown to have criminal records.

For example, in the La Ronge area of Northern Saskatchewan a random check of 100 infringement notices found that 75% of those checked had criminal records and 90% of these were noted as violent to police. Workshop after workshop has identified extremely violent individuals who non-police enforcement officers deal with regularly. Most of these agencies have very limited intelligence capabilities.

Danger flash points and the ten fatal errors

Search

Historic shipwreck officers, by legislation, will have significant powers such as:

(a) stop a ship;
(b) require a person in charge of a ship to take steps to facilitate boarding;
(c) open, or require a person to open, any cabins, compartments, cargo holds or containers on any ship boarded in accordance with paragraph (a) and inspect the contents of any such cabins, compartments or containers;
(d) require any person found in or on any ship boarded in accordance with paragraph (a) to produce any permit in force under this Act that is in his possession;
(e) stop and search any vehicle;
(f) require any person found in or near any vehicle stopped in accordance with paragraph (e) to produce any permit in force under this Act that is in his possession; and
(g) require a person to produce any document that might be relevant to the commission of an offence against this Act;
(h) search any parcel, basket, bag, box or other receptacle;
(i) search any premises that are not a private dwelling or any tent, land or caravan (other than a caravan in a caravan park within the meaning of the *Caravan Parks and Moveable Dwellings Act 1988*).

***Historic Shipwreck Act 1981* with Amendments 1993**

These powers allow the inspector to stop a ship, search a vehicle, open containers or compartments, order people to present documents and papers and search any premises that are not a private dwelling such as a warehouse.

When dealing with criminals involved in stealing valuable artefacts each one of these activities has its

own dangers. Stopping vehicles and boarding ships are particularly dangerous. Trained police officers have been shot, assaulted or threatened while making searches. The penalties involved have been comparatively minor in many cases. Few Police Officers confiscate gear worth thousands of dollars.

Many years ago after a record number of police in North America were killed in the line of duty a list of fatal errors was produced. I have used this as a teaching and planning tool for many years with hundreds of Conservation and Fisheries Officers. Not one has stated that this list did not apply. There are differences of course as some agencies do not make arrests or use handcuffs.

When you are planning operations or policy these can be a useful checklist to ensure that officers are not being placed at risk.

The ten law-enforcement fatal errors

- lack of knowledge, complacency or apathy
- taking a bad position
- failure to recognise danger signals
- poor or no search
- failure to handcuff or restrain
- failure to watch hands
- relaxing too soon
- false perceptions
- tombstone courage [the John Wayne syndrome]
- fatigue/stress

Conservation, Fisheries and even experienced Police Officers make these errors on a regular basis. Their minds are often firmly set in the cement of a myth and by luck they have got away with it. Conservation enforcement activities often clash with resource management duties and officers have been faced with threatening situations when their minds are on other matters.

Selection and training

It is critically important to consider what policies and funds you have in place to select and train your Historic Shipwreck Inspectors.

Too often a kind of organisational daydreaming often parallels significant increases in penalties and levels of enforcement. As penalties increase so do risks. Enforcement officers are caught in serious ambiguities regarding resource development and its protection. Management often does not want to deal with the realities of enforcement activity. Managers from scientific or resource backgrounds are often very uncomfortable with enforcement issues. Some organisations have major philosophical clashes about enforcing conservation laws and would prefer to have advisory policies rather than enforcement powers. Unfortunately, the enraged or stressed hunter, fisher person or wreck diver/salvage operator often does not know the difference and could not care less.

Training, development and planning of enforcement activities must not be set by recommendations coming from the Coroner's office. Your policies and budgets for the development of enforcement personnel must, at the very least be in line with your protection of shipwreck policies and certainly not lagging far behind as has often been the case.

Arrest

Inspections have the power of arrest as per:

(1) An inspector may, without warrant, arrest a person if the inspector reasonably believes
  (a) that the person has committed an offence against section 19 or 28A or against regulations made for the purposes of section 20; and
  (b) that proceedings against the person by summons would not be effective.

(2) Where an inspector (other than a member of a police force who is in uniform) arrests a person under sub-section (1), the inspector shall—
  (a) in the case of an inspector who is a member of a police, produce for inspection by the person arrested, written evidence of the fact that the inspector is a member of a police force; or
  (b) in any other case—produce his identity card for inspection by the person arrested.

(3) Where a person is arrested under sub-section (1), an inspector shall forthwith bring the person, or cause him to be brought, before a Justice of the Peace or other proper authority to be dealt with in accordance with law.

(4) Nothing in this section prevents the arrest of a person in accordance with any other law.

***Historic Shipwreck Act 1981* with Amendments 1993**

When we ask Shipwreck Inspectors to make arrests do we consider the 'Ten Fatal Errors'? Have we trained them thoroughly in arrest procedures? Do their boats and vehicles have facilities to transport prisoners? Do they have radio contact and police backup immediately?

The reality is that most of the time there is no way to transport those arrested or the inspector has no right to search the suspect before making an arrest; a potentially fatal piece of ambiguous legislation. In North America and Australia Police Officers generally work in pairs, carry spare handcuffs or plasticuffs, have vehicles with safety cages in them for transporting prisoners and yet they still get assaulted during this most dangerous procedure.

When you are developing policies and asking inspectors to carry them out are you fully aware of the potential myths and related risks they may be facing?

Seizure

Shipwreck Inspectors have the right to seize as per:

(1) An inspector may seize any ship, vehicle, equipment or article that he reasonably believes to have been used or otherwise involved in the commission of an offence against this Act and may retain the ship, vehicle, equipment or article until the expiration of a period of 60 days after the seizure or, if a prosecution of an

offence against this Act in the commission of which the ship, vehicle, equipment or article may have been used or otherwise involved is instituted within that period, until the prosecution is terminated.

***Historic Shipwreck Act 1981* with Amendments 1993**

The confiscation and seizure of gear is one of the most punitive aspects of getting caught. The technology used in stealing from historic shipwrecks could be worth hundreds of thousands of dollars. Police officers have been beaten and killed over parking tickets, yet Conservation, Fisheries Officers and shipwreck Inspectors can levy penalties vastly higher than any average police officer on duty.

Do you have policies in place to make seizures safely? Do your officers have the right communication skills and attitudes to do it safely?

Extremely assaultive behaviour

In all of my training of law-enforcement officers nothing fascinates them more than to realise who may be the most dangerous. Consider the following section from my lecture notes:

The extremely assaultive individual

...is often a fairly mild mannered long-suffering individual who buries his resentment under rigid but brittle controls. Under certain circumstances he may lash out and release all his aggression in one, often disastrous act. Afterwards he reverts to his usual over controlled defences. Thus, he may be MORE OF A MENACE that the verbally aggressive 'chip on the shoulder type' who releases his aggression in small doses (Bach & Goldberg, 1989).

Time after time this statement has been validated by the experience of field officers. The very behaviours that put us most at ease may in fact be those that are most likely to be assaultive.

Officers let their guard down around people who are quiet and apparently inoffensive and quiet, yet when the assault happens there is a vicious vindictiveness about the end result. Stress gives the offender strength and the ability to withstand pain. Even the most experienced officer, highly trained in the use of a baton or self-defence skills will have trouble with this individual if he or she is not aware and does not have a professional approach to all enforcement checks. Being aware of body language, having a good intelligence system (many enforcement agencies have none or it is *ad hoc* at best) and knowing who you are dealing with are all critical training points.

Critical incidents

We often think of critical incident stress to be something that Ambulance, Fire and Police Officers suffer in the line of duty but we forget that the Conservation, Fishery or Shipwreck Inspectors face similar risks. In many case it is one too many threats, a dead diver too often, the psychological aftermath of being confined in a small space or assaulted.

Symptoms which often show up within one or two days include:

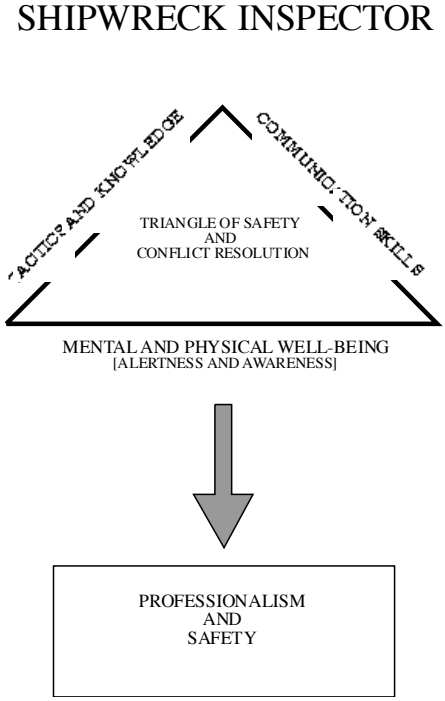

Figure 1. Key Factors in the development and training of shipwreck inspectors.

- intense fear/anxiety
- second guessing
- depression
- total exhaustion
- nightmares, night sweats
- insomnia
- emotional instability
- preoccupation with incident/victims

Quick access to counselling, the support of colleagues through a peer support network can minimise these symptoms quickly. In my own counselling experience four or five sessions is often sufficient. Access to help is essential and once again organisations that do not assess the impact of increased enforcement policies often do not have in place any plans for critical incident stress support.

Conclusion

As policies and penalties are modified to meet new demands upon a valuable resource it is imperative that training, procedures, and support for officers go hand in hand. Too many fine, committed and talented officers have had their psychological and physical health severely impacted upon by situations that should have been accounted for. The legal exposure your organisation faces may ultimately make training and support seem to be a minor cost factor. Your training policies must not be designed in the Coroner's Office

References

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Gibbs, N., 1993, The Ocean goldrush. *Time Australia,* **8**. 43: 50.

NOTES TO AUTHORS

All authors are required to present completed manuscripts, together with illustrations. The manuscripts should follow the style of this edition. Original illustrations should accompany the manuscripts together with a caption list. The manuscripts must be typewritten, properly titled and referenced. Essentially, the *Bulletin* follows the style of the *International Journal of Nautical Archaeology*. Where there are discrepancies or ambiguities, authors are referred to Commonwealth of Australia, 1988, *Style manual for authors editors and printers* (Fourth edition) Australian Government Publishing Service, Canberra. Spelling is to conform with the *Shorter Oxford Dictionary*, and where there is an alternative, the first (preferred) spelling will be adopted. Additional guidance may be obtained from Oxford English Dictionary Department, 1981, *The Oxford dictionary for writers and editors*. Clarendon Press, Oxford. All foreign words are to be italicised, together with titles of publications. Where authors do not have access to an italicised typewriter font, italicised words should be underlined.

Footnotes in the text should be avoided, except where essential, and then should be listed by number on a separate sheet.

Measurements should be given in metres where appropriate. However, it is appreciated that 19th century British shipping measurements, for example, were given in feet and inches and some workers still may record in these units. Authors should indicate where measurements are made this way by giving the measurements in feet and inches and then the conversion into metres in parentheses, likewise for measurements taken from published sources. Otherwise, metric units should be given with Imperial conversions, where required or appropriate, in parentheses.

References should use the author-date system and in the text can either appear as: 'Jones (1986) discovered water at...' or 'water was discovered at Cambden (Jones, 1986)'. Authors can refer to specific pages; thus (Jones, 1986: 223) or Jones (1986: 44). The list of references should be listed at the end on a separate sheet of paper and must conform to the following format:

Jones, C.W., 1986, Water in the transport system. *Bulletin of the Australian Institute for Maritime Archaeology*, **6**(1): 44-86.

Adams, C.F., 1984, *Restaurant at the end of the Universe*. Penguin, London.

(Please note, titles are un-capitalized and where possible include the publisher and place of publication of books.)

At present no particular style has been decided for unpublished material and such decisions will be made at the editor's discretion. Authors are particularly requested to present references correctly as they are sometimes difficult for editors to correct.

In the case of illustrations, drawings must be originals, either inked on plastic drawing film or paper, or good quality photographs. Presentation must take into account reduction to the size of the *Bulletin*. Thus, where reduction is anticipated, line thickness and lettering size should be carefully considered. As a general rule, the thinnest reproducible line is 0.1 mm. Photographs should be presented to fit the format page size of this issue of the *Bulletin*. All illustrations must have their figure numbers included in pencil. A list of illustrations with captions should be included on a separate sheet of paper. All original drawings will be returned to the authors. It is essential that proper acknowledgements are given in the text to material by other authors, and where copyright material is used, permission from the publishers must be obtained.

This edition of the *Bulletin* has been set entirely on a Macintosh computer using Microsoft Word (5.1) for text, Page Maker (5) for typesetting, the graphics were scanned using a Umax 1200SE scanner and Adobie Photoshop 2.5, some illustrations were produced on Aldus FreeHand 3.1. The completed publication was printed to negative on a high resolution commercial pre-press printer.

It would be appreciated if authors, with access to a wordprocessor could provide text on a disk either on 3.25 inch PC or Mac disks or alternatively, on MSDOS 5.5 inch double density disks (Note NOT HIGH DENSITY DISKS). If authors have access to a modem, please contact the editor on 09-431-8440 to discuss transfer of text by telephone.

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