National Assessment of Boating Fatalities in Australia 1992 - 1998

The findings of phase 2 of the assessment of fatal and non-fatal injury due to boating in Australia

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Further information

As it is not possible to anticipate all information needs, the results presented are only a sample of those that could be made available. Requests for further analysis of the available data should be to the CEO of the NMSC.

The National Marine Safety Committee Inc is an Intergovernmental committee charged with achieving uniform marine safety practices throughout Australia. It is comprised of the Chief Executive of each of the marine safety agencies in Australia.

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Foreword

In October 1994, Australia's Transport Ministers endorsed a review of maritime safety arrangements in Australia. This review[1] identified a number of deficiencies in the administrative arrangements for maritime safety in Australia, including the "*inadequate measurement of safety outcomes due to a lack of a common database or agreed approach to analysis and interpretation of data* ".

At a meeting of the Australian Transport Council in November 1995, Ministers asked that proposals be developed to address the identified deficiencies. As a result the National Marine Safety Strategy was developed and in 1997 and the National Marine Safety Committee formed to drive national reform based on the goals set by the strategy.

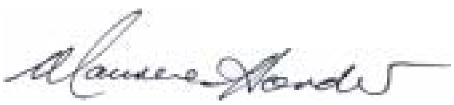
One of the key focuses of the National Marine Safety Committee over the last few years has been to improve the level of empirical information available regarding the nature and causes of marine incidents. This has been done by developing common standards for the collection and coding of marine incidents at a jurisdictional level, as well as by undertaking national research into fatalities and serious injuries.

In 2001 the National Marine Safety Committee contracted Flinders Consulting to undertake an initial study into the extent of boating fatalities and serious injuries in Australia (O'Connor 2002). This study provided broad data on the number of boating fatalities and serious injuries in Australia based on ATSB and hospital admission data. While this information has proved valuable in providing an overview it could not illuminate the causal factors behind these incidents. In 2002 the NMSC contracted Flinders Consulting to undertake a further in-depth study into the nature and causes of boating fatalities based on coronial records. This report presents the findings of this research.

The information in this report remains compiled at a National level. The report does not draw out local variations in the nature or causes of fatalities, nor does it always distinguish between incidents occurring on commercial or recreational vessels. It is hoped that these important variables will be looked at in future studies undertaken into boating incidents.

Because of this care should be taken in drawing policy conclusions from this National data. The waters and environmental conditions, as well as boating practices vary greatly around Australia and it may be that certain factors that are significant nationally may not be significant in certain regions or locations around Australia. While the information in this report will inform the development of national safe boating strategies there is still a need for state and territory based strategies to deal with localised safety issues.

Overall the report provides a very useful overview of the level and cost of marine fatalities in Australia and raises interesting questions for further research. The report also provides new indicators of key safety issues and will provide a benchmark for future studies and the work of the NMSC.



CEO, National Marine Safety Committee Inc.

[1] Thompson Clarke 1995 Review of Maritime Safety Arrangements in Australia Phase 1

Contents

Executive Summary

Boating fatalities and serious injuries cost the Australian community in excess of $370 million per year. Over a recent five-year period, boating caused more harm than rail accidents and air crashes combined and was second only to road transport as a cause of transport-related injury (O'Connor 1992).

The principal outcome of this project has been the creation of a national database focussing on boating fatalities. The improved information base will enable boating to benefit from the developments that have been possible in other areas of transport, such as in road transport and air safety, where the routine monitoring of fatalities and other serious injury has been well established for some considerable time. It is anticipated that the database will receive considerable use in answering a wide range of new questions, well beyond those addressed in this report. In addition, progressive refinement of the data collection will overcome some of its limitations and improve its capacity to answer these questions.

This report presents new information, much of it unique even in world terms. However, it needs to be considered that it is not possible for a single report to anticipate or answer all questions about the safety of boating in Australia.

The main findings

Alcohol and drugs

Among the risk factors studied, alcohol and drugs was one of the most important. It was found that alcohol was involved in at least 35% of fatalities, and other drugs in 9%. The contribution of alcohol to boating deaths (28% in excess of 0.05 gm/100ml) was similar to its contribution to road deaths (26% in excess of 0.05 gm/100ml: ATSB, 2001). Relatively few vessel operators (i.e. where the operator survived the incident) were tested for alcohol and drugs, particularly in the case of jet-ski operators.

Over-powered vessels

Thirty-one per cent of dinghies, other open motorboats and half cabin motorboats were overpowered when considered against the method for calculating the maximum engine power of existing vessels defined in the Australian Standard (AS 1799.1).

Vessel stability and buoyancy

The study found that there was a relationship between absolute vessel length in metres and stability/buoyancy for dinghies; other open motorboats; and half cabin motorboats, which together made up 57% of all vessels involved in fatal incidents.

Inadequate stability or buoyancy was a contributing factor in 12% of the fatal incidents involving these vessels when they were less than 6 metres in length compared to only 6% when these vessels were 6 metres or more. Inadequate stability or buoyancy was an even stronger feature of these vessels when they were less than 4 metres in length.

Overloading of vessels

When considered against the method described in AS 1799.1, it was found that 24% of common vessel types (dinghies, other open motorboats, half cabin motorboats and cabin cruisers) were overloaded. Overloading was particularly a feature of dinghies.

Personal flotation devices (PFDs)

People who survived a fatal boating incident were more than two times more likely to have been wearing a PFD. On this basis if PFD use increased to 50%, 2-3 lives could be saved nationally each year. If PFD use increased to 75%, 5 lives could be saved, with a cost saving to the Australian community of nearly $8 million per year[2]. The saving of 5 lives per year would reduce the annual boating death toll by 13% based on the current annual toll: a very substantial reduction. The benefit of such an increase would accrue most substantially to recreational boaters who make up the vast majority of those killed.

It was also found that 45% of vessels involved in fatal incidents had an insufficient number of PFDs for the number of people on board, suggesting the need for more active monitoring of safety equipment.

Work-related boating fatalities

The assessment of work-related boating fatalities indicated that there has been a substantial drop in the death rate of fishermen, representing an enormous achievement for an industry reported by the National Occupational Health and Safety Commission as having one of the worst safety records. However, the study indicated that fishermen have a higher level of risk and/or risk taking/acceptance with respect to environmental conditions. Presumably, in order to make a living they must often be prepared to work in less than ideal conditions. In addition, alcohol and drugs was a factor in the deaths of fishermen and nearly a third of the fishing vessels involved did not have sufficient PFDs for all occupants.

Analysis of other risk factors

Dinghies

As a vessel type, dinghies were over-represented with respect to overloading, capsize, alcohol involvement, and failure to wear a PFD. If a range of measures focussing on the known risk factors achieved a halving of the level of involvement of dinghies, the overall number of fatal incidents would be reduced by 5-6 per annum: a 14% reduction in fatal incidents. The number of fatalities saved would be even higher as dinghies have a higher relative occupancy.

Capsize

Capsize was the most common initial event in fatal incidents. Among the potentiating factors considered, overloading/improper loading, environmental conditions and specific risks of dinghies, were shown to be important.

Fall overboard

In contrast to capsize, the analysis did not indicate what factors were involved in incidents where the initial event was a person falling overboard.

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[2] Based on NMSC (2003, Table A.1, p. 31) information on average cost per fatality.

Recommendations

There are a number of recommendations that should be considered in order to improve the monitoring and surveillance of boating deaths and injury in Australia. These are:

1. The national collection, analysis and reporting of data on fatal and non-fatal boating injury should be ongoing. The foundation for this is provided by the Australian Boating Injury Database: Fatal Injury (ABID:FI) and Australian Boating Injury Database: Non-Fatal Injury (ABID:NFI) developed by the Author. The ABID:NFI has been developed as a component of the National Transport Injury Database for ATSB based on hospitalisations.

2. Alcohol usage among the boating public should be assessed in the circumstances in which it can provide a valid indicator of exposure, but also considering practicalities eg. at boat ramps when the vessel is still on the water. This information is essential for determining relative-risk.

3. Consideration should be given to modifying the NMSC data standards in order to capture new information relevant to current and emerging risk factors.

4. Consideration should be given to the surveying of vessels involved in fatal incidents with a view to including this data in the ABID:FI so that reliable information on such factors as maximum power and occupancy can be considered relative to actual levels and more detailed information on other vessel factors can be analysed and reported.

5. The level of breath and blood testing for alcohol of vessel operators and other injured survivors in fatal incidents should be substantially increased. The results should then be incorporated into the ABID:FI for each incident.

This report makes no specific policy recommendations. As it is not possible to anticipate all information needs, the results presented are only a sample of those that could be made available from the database created. Requests for further analysis of the available data should be forwarded to the CEO, National Marine Safety Committee Inc, PO Box 1773, Rozelle NSW 2039.

National Assessment of Boating Fatalities

Background

This study constitutes the first comprehensive national level analysis of fatal and non-fatal injury due to boating in Australia. It was undertaken in two phases. The report on Phase 1 presented a basic analysis constructed upon the readily available data from the Australian Bureau of Statistics (ABS) and Australian hospitals. The ABS data was also used to identify the people who had died in boating incidents so that a more in-depth analysis (Phase 2) could be undertaken through access to the Coroners' files.

The Phase 1 report (O'Connor, 2002) showed that boating activity, whether recreational or commercial in nature, caused a meaningful level of harm to the Australian community, measured in terms of mortality and serious injuries. Indeed, it reported that boating caused more harm than rail and air crashes combined. In contrast to the other transport sectors, particularly the road sector that has invested heavily in accident information systems, the level of investment in such systems in the boating sector has, until recently, been relatively poor from a national perspective. In the road sector, the collection, coding and reporting of precise data on fatalities and serious injuries from Coroners' files, the Police and hospital data systems has been well established for some considerable time. With an improved information base, boating is now set to benefit from the developments that have been possible in the other areas of transport.

The Phase 1 report showed that there were on average about 80 deaths and nearly 1000 people admitted to hospital each year as a result of boating incidents in Australia. It was reported that many more received minor injuries that did not require admission to hospital. It showed that while the number of fatalities had declined over recent years, hospitalisations had not. A number of the people admitted to hospital suffered from serious and potentially life threatening injuries. Some injuries were debilitating and required lengthy periods of hospital stay; particularly those with lower limb fractures and fractures of the neck and trunk. Those admitted to hospital consumed nearly 4,000 hospital bed days each year. The report indicated that boating injury was clearly both a transport and a health sector concern.

The Phase 1 report discussed the difficulties that have been experienced in the past in establishing a national incident monitoring system based on State and Territory marine authority data. It indicated that Coroners' files provided the best available source of detailed information on boating fatalities in Australia and recommended that the study proceed to a Phase 2 in-depth assessment based on Coroners' files. Three recent State-based studies, using Coroners' files (Waterways 1999; Marine and Safety Tasmania MAST 2000; O'Connor 2001), demonstrated the rich information that can be gathered from this source.

Phase 2 of the study is concerned with the extraction, analysis and reporting of data in a common format and according to relevant national data standards (NMSC 1998), using information in the Coroners' files. The resulting database is known as the Australian Boating Injury Database: Fatal Injury (ABID:FI). Ongoing maintenance of the database will contribute much to an improved understanding of the causes and prevention of fatal incidents.

Phase 2 also includes updated information, based on significant recent development focussed on the monitoring of serious non-fatal boating injury in Australia: the Australian Boating Injury Database: Non-Fatal Injury (ABID-NFI).

Study aim

The aim of this report is to present information on the nature of fatal boating incidents in Australia gathered from files maintained by the Coroners[3]. The files were identified from death registration information from 1992 to 1998 recorded by the ABS. One of the planned outputs of the study was the creation of a national database of boating fatalities. The report also presents information relevant to the ongoing monitoring of fatal and non-fatal boating injury in Australia.

Methods

The study was undertaken in a number of steps[4].

Step 1: Negotiation of administrative arrangements

In Phase 1 of the study, the ABS death data was used to identify cases for in-depth assessment using Coroners' files. The names of the people killed were identified via the Registrar of Births, Deaths and Marriages in each State. The lists of names were provided to the Coroners in each jurisdiction along with a letter requesting access to the relevant files. The offices of the Coroners indicated their willingness to facilitate the study. Where necessary, the marine safety authorities assisted by providing letters of support for the study in order to ensure the best possible administrative arrangements for the study.

Approval was granted for the Project Director (Dr. O'Connor) to access all available files. However, various restrictions were placed upon access, the most important among them being that the recording and publication of information, including the resulting database of information, would not be provided to any other person or authority except as aggregated statistical tabulations and related charts. The purpose of this restriction was to ensure that any information provided would not identify, or be used to identify, any individual. However, this does not restrict the availability of statistical information. Ad-hoc enquiries of the database may be conducted on request.

Access to the files took a number of different forms. All states/territories except Western Australia (WA) and South Australia (SA) allowed photocopying of the full contents of the files and in one State this was undertaken for a fee by the staff of the Coroner's office. In WA, the Coroner's office required the Project Director to personally visit in order to read and code the files in the office and ensure that no names were recorded on the coding form, in order to ensure confidentiality and privacy. In SA, where the study had already been completed and reported in a Transport SA research report (O'Connor, 2001), the files were coded in the Coroner's office. In Queensland and Tasmania, staff of the

[3] The reader is advised to consult the NMSC (1998) data standards in order to understand the scope of interest of the report and the definition of individual data items.

[4] The reader should consult the Phase 1 report (O'Connor 2002) in order to gain a fuller appreciation of the steps involved in the project.

marine authorities visited the Coroners' offices and photocopied the contents of the files and sent them on to the Project Director. Staff of the NMSC visited the Coroners' offices in New South Wales and the Northern Territory and photocopied the contents of the files and sent them on to the Project Director.

Step 2: Form and database design

The data collection form was developed on the basis of the NMSC data standards and other relevant national standards. The data entry and reporting facilities of the database were tested and verified.

Step 3: Data collection and data entry

A team of coders was trained in Adelaide and supervised throughout the data collection process. Each form was individually checked and quality assured by the Project Director prior to finalisation, to ensure reliability and validity. The finalised forms were then handed over to the data entry staff. Various crosschecks were undertaken to verify the data entry.

Step 4: Data analysis and reporting

The data was analysed using the SPSS statistical analysis software package (Norusis, 1998). The output was reported in a format that was consistent with the recent Phase 1 report (O'Connor, 2002) and other Australian boating studies.

The analysis focussed on national level aggregations of the data, presented as figures, tables and descriptive commentary.

Results

Assessment of Coroners' files

This assessment of the Coroners' files raised a number of issues associated with the reliability of the ABS data not previously identified in any other study of boating deaths in Australia.

In brief, the analysis showed that there were some coding errors in the ABS data, duplicate death registrations, deaths occurring prior to 1992, and deaths not registered by the ABS. It also showed that a number of boating deaths included in the ABS data were not within the scope of interest of the NMSC. Together, these findings indicate that the best possible data for NMSC purposes can only be obtained by ongoing in-depth assessment of Coroners' files.

ABS data revealed that 421 boating deaths were registered over the period 1992 to 1998. Although the Coroners' files were the source of both ABS published data and the data constructed for the present study, a number of anomalies were detected:

1. **Death wrongly coded as water transport related**
   Of the water transport related deaths reported by the ABS in its official publication, four deaths were wrongly coded as being water transport related.

2. **Duplicate death registration**
   One death registration was a duplicate registration.

3. **Death occurred prior to 1992[5]**
   Twenty-three deaths registered over the period 1992 to 1998 occurred prior to 1992. As the focus of the current investigation was fatal incidents occurring from 1992 to 1998, these deaths were excluded from the analysis.

4. **Deaths not registered by ABS**
   In the fatal incidents investigated on the basis of ABS death registrations, 18 additional deaths (i.e. multiple fatalities in a single incident) were identified in the files of the registered deaths that were not themselves registered by the ABS[6]. This was an unexpected but practically significant finding that demonstrated the need for the current study to be ongoing.

   When the unregistered deaths were examined, it was apparent that they were not evenly spread over time (Figure 1). This has important implications for the examination of trends based on ABS data. The ABS data has been used in recent regulatory impact

[5] Deaths occurring in any year may not be registered in the same year, especially where the investigation by the Coroner is delayed for any reason.

[6] The issue could not be readily examined any further in this study because the ABS does not include names on their source data files after publication of the annual cause of deaths statistics. In order to examine it further would require submission of the names of the unregistered deceased to the Registrar of Deaths in each jurisdiction, in order to obtain the death registration number, which could then be provided to the ABS for checking against their records. This was beyond the scope of the resources available in the present study.

statements and other evaluations of safety performance. It is now clear that this is not strictly appropriate. In order to ensure accuracy, trends need to be assessed on the basis of a direct and purpose specific examination of the Coroners' files rather than on the basis of ABS published data, particularly as a number of the deaths registered by the ABS as water transport related do not comply with NMSC criteria for boating incidents (8% of deaths investigated). The NMSC criteria are discussed on the next page and more completely in the NMSC (1998) data standards.

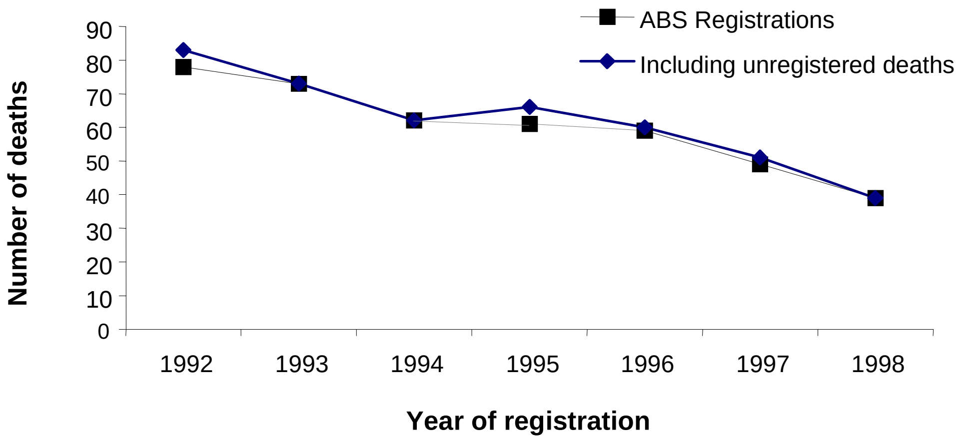

Figure 1—Boating fatalities. Number of deaths by year of death registration, Australia 1992 to 1998

Other issues with the Coroners' data

1. **Coroner's file not available or not found**
   For deaths occurring early in the 1990's some of the Coroners' files of the deceased could not be found (n=59); mainly in Queensland (n=36) which had only recently introduced a centralised filing and records management system within the Coroner's office. According to staff of the Coroners' offices this is no longer a problem. However, it was suggested that Coroners' files concerning boating deaths be reviewed within six months of registration on an ongoing basis in order to ensure that coding is completed before any file has a chance to go missing.

2. **Deaths not within the scope of interest of NMSC**
   The ABS statistics include deaths that reflect Australia's international obligations in respect to deaths involving trading and other vessels in international water, for example, where the closest port is in Australia, the vessel is en-route to an Australian port or the incident involves an Australian resident. However, these deaths are not within the scope of interest of the NMSC[7]. The NMSC data standards make it clear that "*The definition (of marine incident) applies exclusively to incidents involving small*

[7] The reader is advised to consult the NMSC (1998) data standards, and in order to better understand the scope of interest of the report.

commercial and recreational vessels – but not trading vessel incidents requiring investigation under the Commonwealth Navigation Act" (NMSC 1998, p.6).

Further, there are classes of activity that are not marine incidents according to the data standards and definitions of the NMSC, or do not involve vessels. For example, the death of a surfboard and surf-ski rider is specifically excluded as are incidents involving deliberate intent. Incidents involving rubber tubes from truck tyres and home-made rafts are also excluded as they are not vessels, but are included if towed along behind a vessel by rope. The rationale for these exclusions is covered in the NMSC data standards manual which states: "this manual is intended to reflect incidents which can actually be influenced by changes in legislation or policy, either on a national basis or, for cases specific to a particular location/condition, on a jurisdiction basis."

Of the 306 fatal incidents investigated, 36 were not within the scope of interest of NMSC. In the analysis that follows, the information presented applies only to incidents identified as fitting NMSC criteria that occurred from 1992 to 1998 (n=270 incidents, involving 333 deaths)[8].

3. **Absence of marine safety authority information on the Coroners' files**

   Very few of the Coroners' files contained a copy of a marine safety authority incident data form presenting statistical information about the fatal incident, or other investigative information gathered by those authorities. This could suggest that incidents are rarely investigated by marine authorities; that any investigations are withheld pending investigation by the Coroner; or that there is no necessity to provide the information to the Coroner. If there is no impediment to such information being provided to the Coroner, it is suggested that it be provided for every incident investigated. This would simplify the present data collection task and assist with cross-referencing to departmental databases.

   Although vessels are rarely lost and are generally impounded by Police until the finalisation of investigations, details of vessel construction are rarely recorded. This is an area where data collection can be improved, and implemented within a coordinated system of data collection based on Coroners' files, leading to more comprehensive and relevant data for safety analysis. To assist with this, a comprehensive assessment of standards for safety investigation is required. Some work has already been undertaken by the Project Director on the basis of contact with the IMO and consideration of the need to align the collected data items with those central to such policy debates as the Australian Builders Plate, involving such issues as excessive engine power and overloading. However this works needs to be extended as a component of a suggested Phase 3 study focussed on continuation of data collection based on Coroners' files.

Boating incidents meeting NMSC criteria

Incident details

The Coroners' files provided information on boating incidents that resulted in death. Incidents involving multiple deaths and more than one vessel can be distinguished. In addition, other non-fatal injuries in the event can be identified.

[8] The only exception is that the analysis of work-related incidents commencing on page 34 includes all fatalities.

There were 333 boating deaths that occurred in 270 separate incidents over the period 1992 to 1998 that met NMSC criteria. In these incidents, there were a further 24 people who were injured but survived: 6 had serious injuries and were admitted to hospital, 8 attended hospital for minor treatment and were released the same day, and 10 received other medical attention not serious enough to require hospital treatment. In total, 357 people were injured or killed in the 270 incidents. Of the people killed, 168 (50%) were vessel operators.

Most incidents involved only a single vessel: there were 288 vessels involved in total[9]. The trips involving these vessels were mainly for the purpose of fishing (48% of vessels) or a leisure cruise (26%; Figure 2).

Fifty seven percent of the incidents were the subject of a Coroners inquest, which is a detailed investigation involving substantial documentation. For other incidents, the documentation is usually less extensive but sufficient to enable the Coroner to decide the causes of death without the need for an inquest.

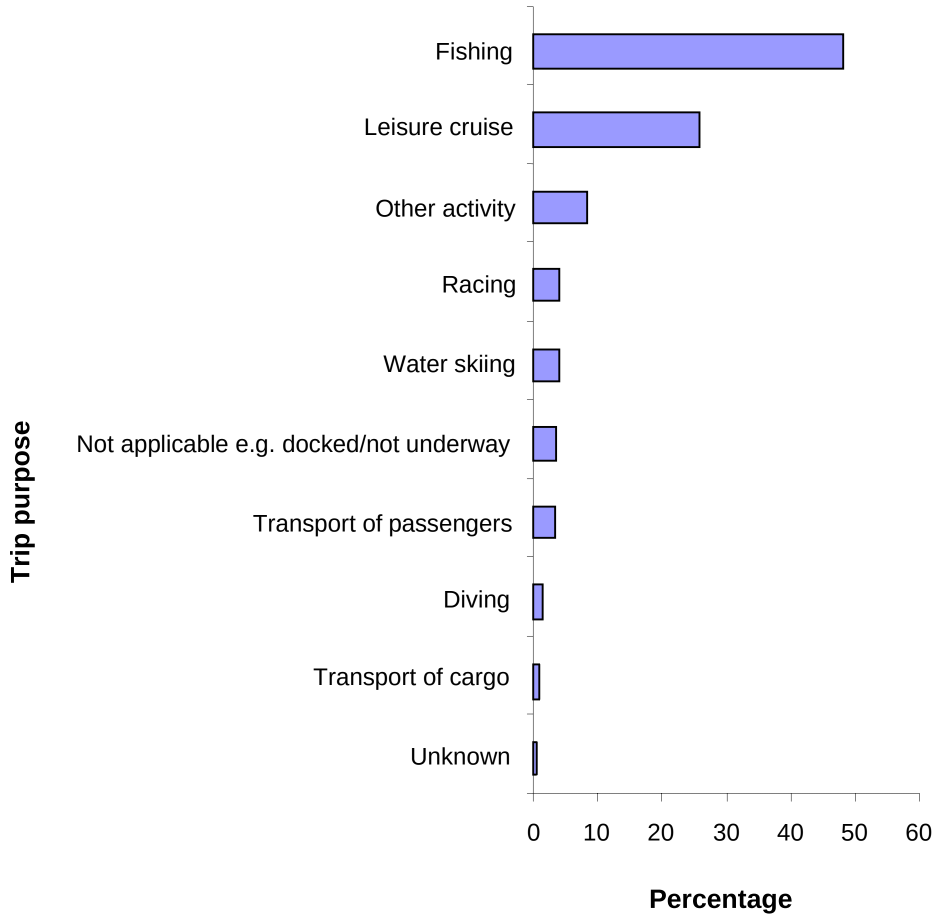

Figure 2—NMSC boating fatalities by trip purpose, Australia 1992 to 1998

[9] In one incident the number of vessels involved was unknown.

Cost of boating deaths in Australia

A recent report by the NMSC (2003, Table A.1, p. 31) presented an average cost per boating fatality of $1.5 million. Considering that there have been 333 deaths over the period 1992 to 1998, the total fatality cost was nearly $500 million over the period, and an annual average cost of $71 million; slightly higher than the cost estimate provided recently by the NMSC (2003). Added to this is the cost of non-fatal boating injury: an estimate of which is provided later in the report, on page 52.

Location

The NMSC data standard defines the location of the incident as follows:

1. **Inland Waters**
   Any navigable water that is not tidal eg. a river, dam, lake or creek. Where a river becomes tidal, only the non-tidal section will be classed as inland waters, while the tidal section of that river will be classed as enclosed waters.

2. **Enclosed Waters**
   Any navigable tidal water such as a harbour, coastal bay, estuary, tidal creek or tidal river, but does not include tidal waters identified in each State as being partially smooth.

3. **Inshore Waters**
   Any open stretch of water extending laterally along the coast up to and including 3 nautical miles offshore. It also includes bar entrances and tidal waters identified as being partially smooth.

4. **Offshore Waters**
   All open water more than 3 nautical miles seaward of the coast.

Thirty seven percent of the incidents occurred on inland waters, mainly rivers. Sixty three percent occurred elsewhere, mainly on inshore waters (Figure 3).

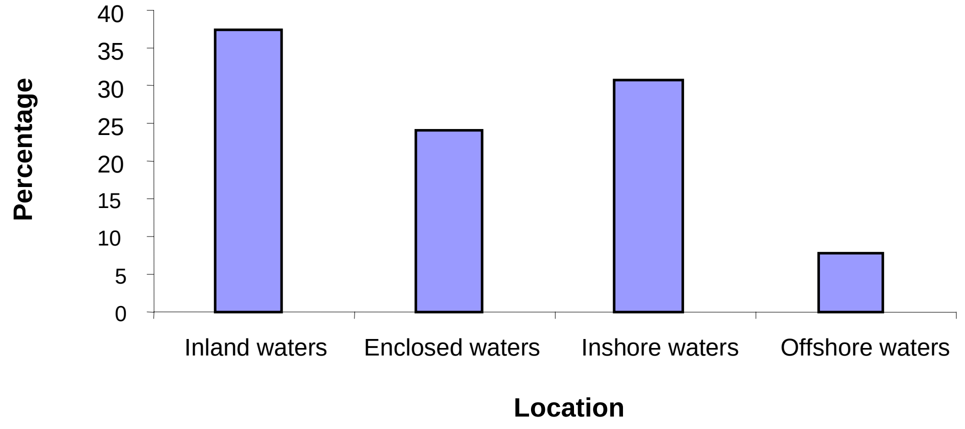

Figure 3—NMSC boating fatalities by location, Australia 1992 to 1998

Time of day

The most common time of incident was 12 mid-day to 4pm (32%)[10]. Twenty four percent occurred from 8pm to 8am (Figure 4).

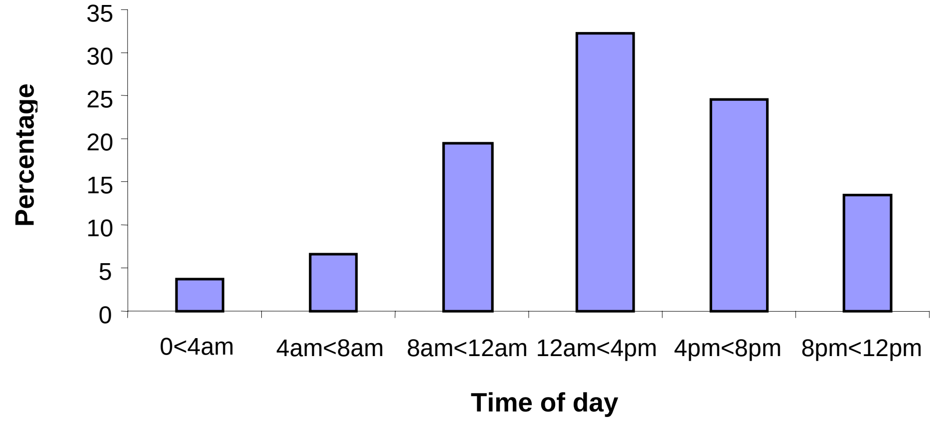

Figure 4—NMSC boating fatalities by time of day, Australia 1992 to 1998

Environmental conditions

Most of the incidents occurred in favourable environmental conditions (Figures 5 & 6)[11]. Seventy five percent occurred in wind conditions classified as none to moderate and 69% occurred in calm to moderate seas.

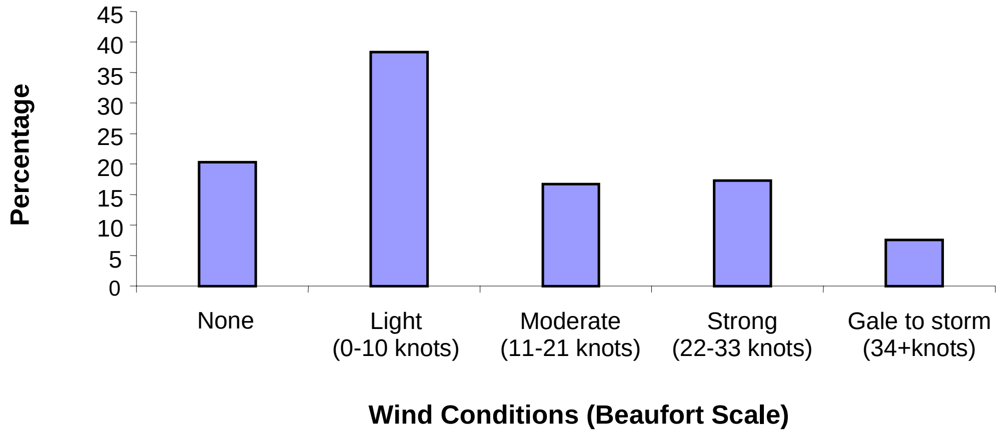

Figure 5—NMSC boating fatalities by wind conditions, Australia 1992 to 1998

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[10] In 28 incidents, the time of the incident was not precisely reported.

[11] In 85 incidents, the wind conditions were not precisely reported and in 76 incidents the water conditions were not precisely reported.

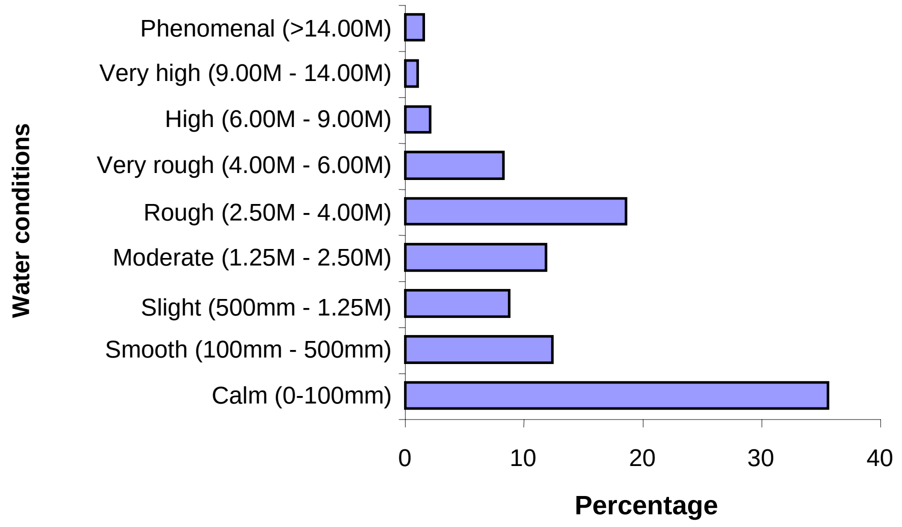

Figure 6—NMSC boating fatalities by water conditions, Australia 1992 to 1998

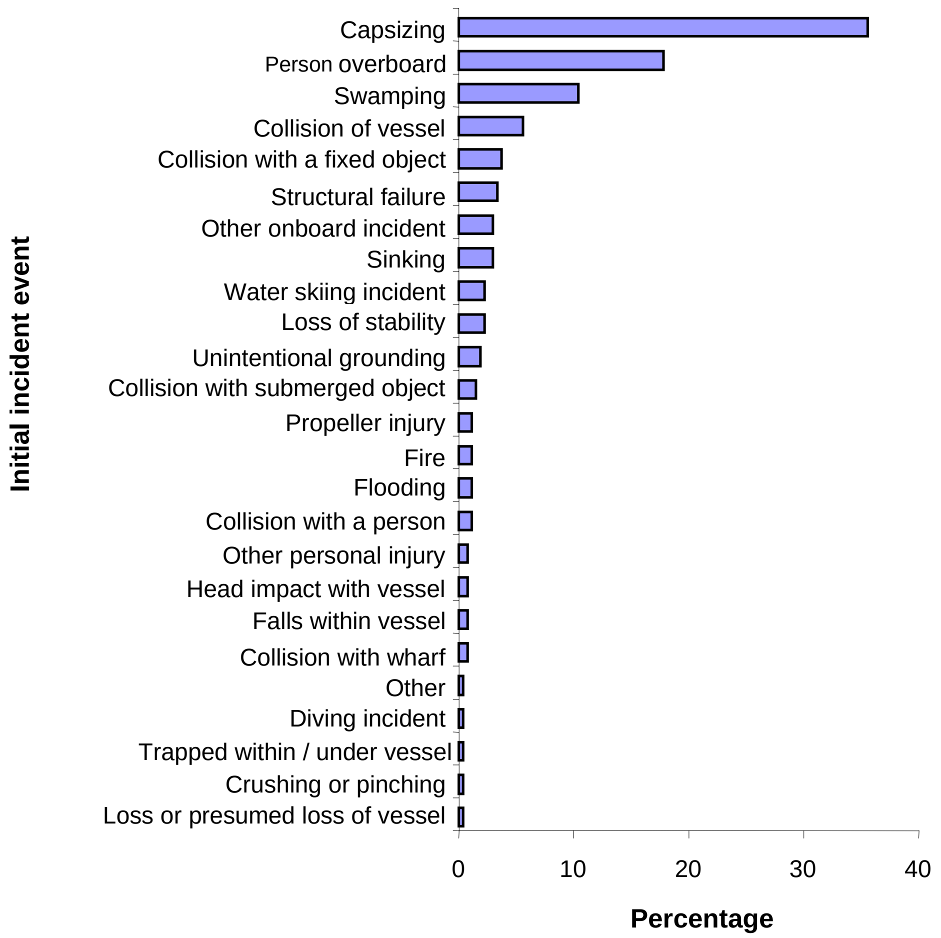

Figure 7—NMSC boating fatalities by initial incident event, Australia 1992 to 1998

Incident events

The sequence of events resulting in a boating death was initiated most often by capsize of the vessel (36%), a person falling overboard (18%) or swamping of the vessel (10%; Figure 7). Structural failure was rarely the initial event in a fatal incident (3%).

When all significant events were considered (a maximum of five were recorded for each incident; Figure 8), a fall overboard was the most common event (37% of the events noted). Capsize was responsible for 20% of all incident events.

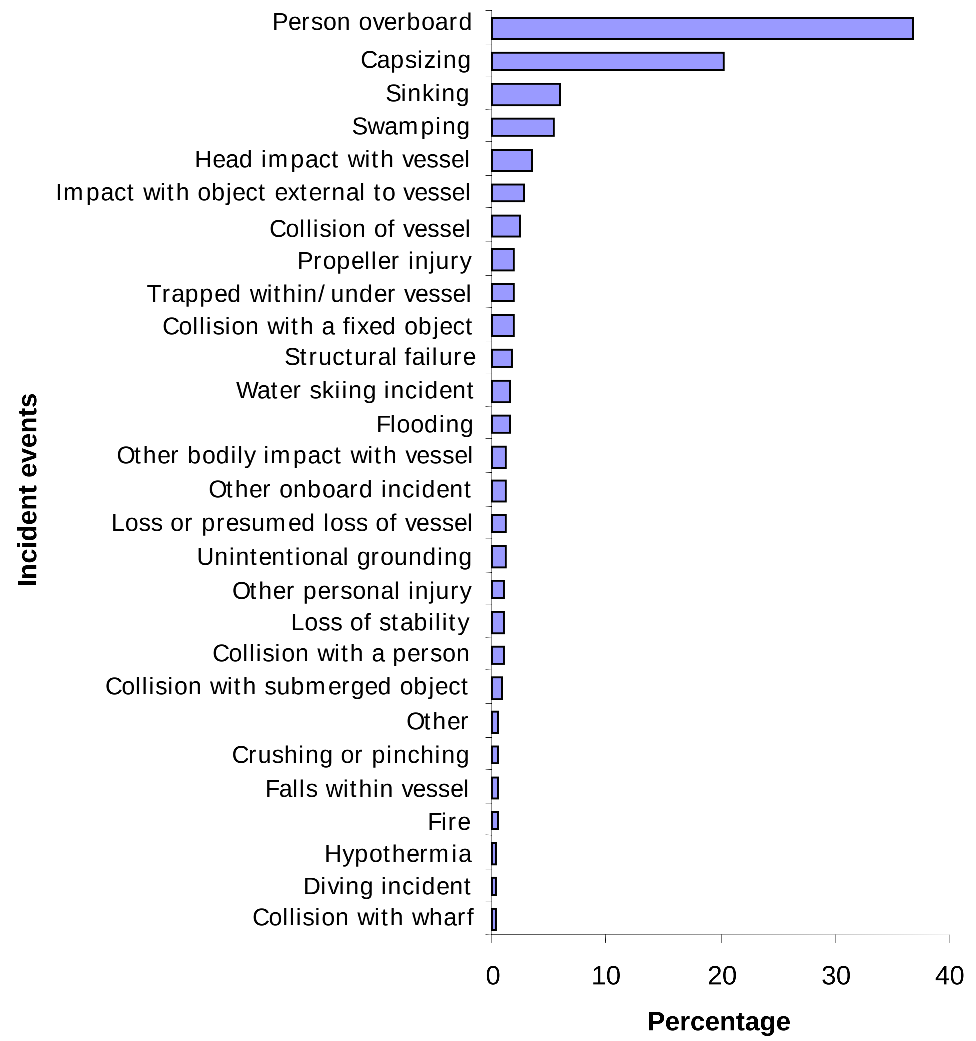

Figure 8—NMSC boating fatalities by incident events (multiple response), Australia 1992 to 1998

Contributing factors

The initial contributing factor in 63% of incidents was a human cause, mainly an error of judgement (16%) or alcohol or drugs (16%; Figure 9). The initial contributing factor was an environmental cause in 23% of incidents and a material factor in 13% of incidents. Hazardous wind and/or sea conditions were an initial contributing factor in 16% of incidents. Equipment failures were responsible for only 9% of initial contributing factors.

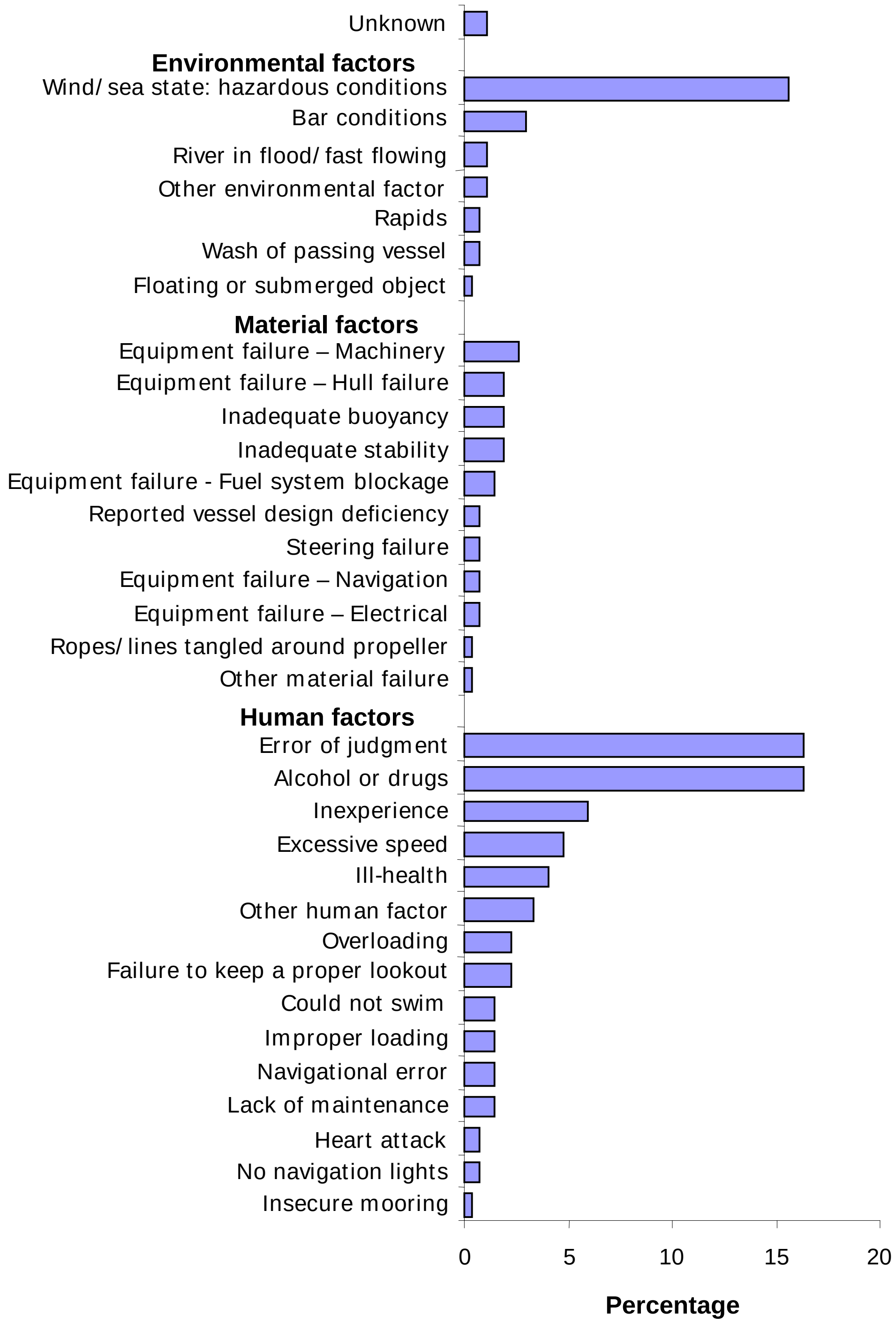

Figure 9—NMSC boating fatalities by initial contributing factor, Australia 1992 to 1998

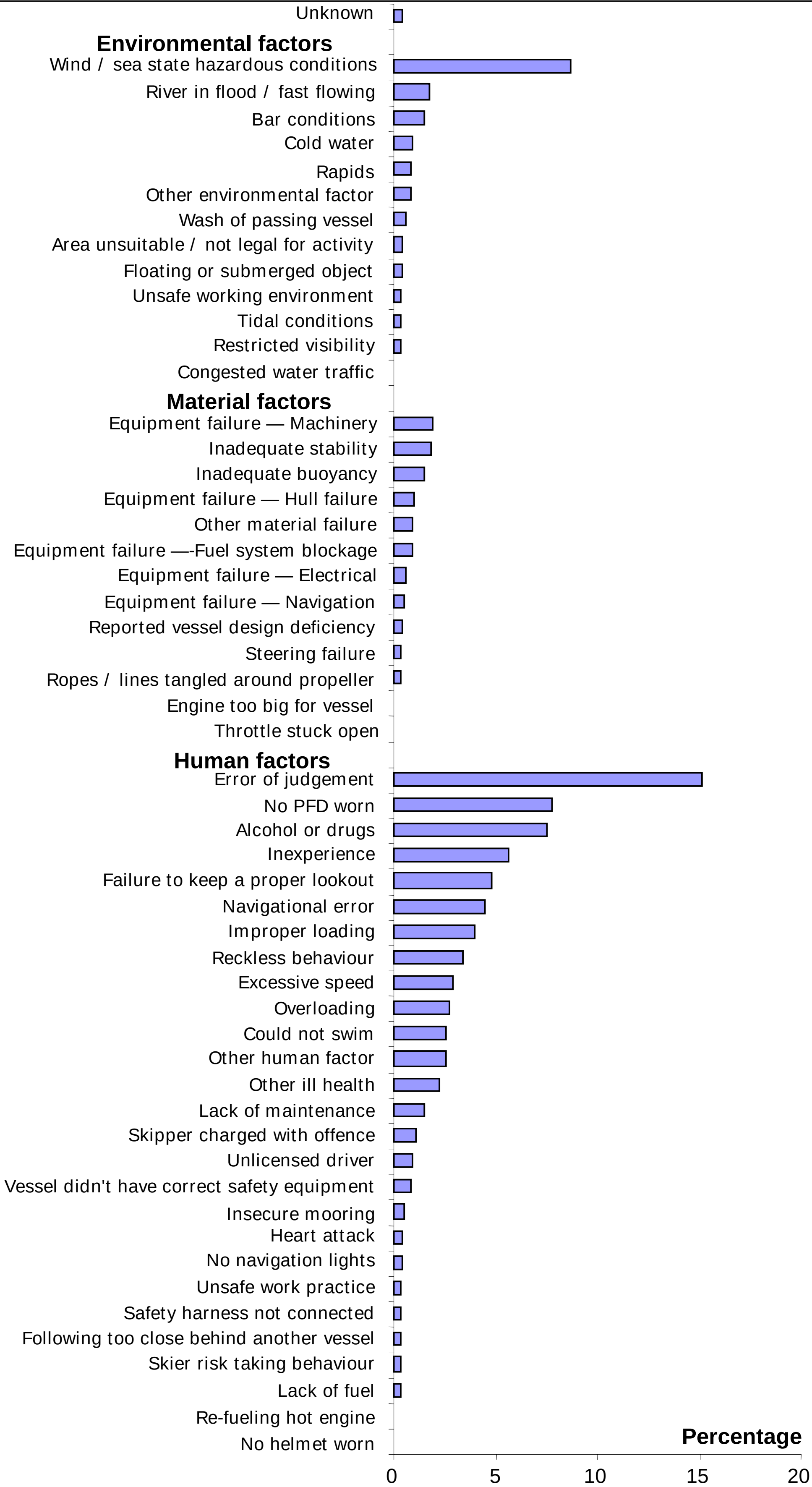

Figure 10—NMSC boating fatalities by contributing factors (multiple response), Australia 1992 to 1998

When all significant contributing factors were considered (a maximum of five were recorded for each incident; Figure 10), the top five were: an error of judgement, hazardous wind and/or sea conditions, failure to wear a PFD, alcohol and drugs, and inexperience.

Of all the significant contributing factors considered, human factors most often contributed to the incidents (73% versus 17% for environmental factors and 10% for material factors). The most common human factor was an error of judgement on behalf of the vessel operator or other occupant (15% of factors noted). The failure to wear a PFD was specifically noted by the Coroner's as a factor in death and comprised 8% of contributing factors. Alcohol or drugs comprised 8% of contributing factors. Inexperience was also a common factor in boating deaths (6%), and this result focuses attention on the issues of competency standards and training.

It was interesting to observe that fatigue was not identified as a contributing factor in any of the fatal boating incidents meeting NMSC criteria. However, this needs further assessment in a specialised study. An assessment and discussion of this factor among work-related incidents, including those not meeting NMSC criteria (eg. Trading vessel incidents), is covered later in the report.

Of all the significant contributing factors considered, the most common environmental factors noted were hazardous wind or sea conditions (9%), a river in flood or fast flowing (2%) and bar conditions (2%).

Of all the significant contributing factors considered, the most common material factors were machinery failure (2%), inadequate stability (2%) and inadequate buoyancy (2%).

Vessel details

Vessel type

Eighty five percent of the vessels were for recreational purposes and 14% were commercial vessels, mainly commercial fishing vessels[12]. Twenty five percent were dinghies, 19% were other open motorboats and 13% were half cabin motorboats (Figure 11). The hulls were mostly made from fibreglass/GRP (41%) and aluminium (32%; Figure 12).

Vessel length

Forty percent of the vessels were 2-4 metres in length, with 76% less than 6 metres (Figure 13)[13]. Average boat length was 5.6 metres.

In incidents involving inadequate stability or buoyancy[14], the vessels were not overall shorter than other vessels (t=-.664, df=246, p=.50). However, when the analysis was restricted to dinghies, other open motorboats and half cabin motorboats, which made up 57% of all vessels involved in fatal incidents, there was a relationship between absolute vessel length in metres and stability/buoyancy (t=-.239, df=149, p=.02). Inadequate stability or buoyancy was a contributing factor in 12% of the fatal incidents involving these

[12] Vessel purpose was unknown for 1 vessel and 'commercial hire' for 1 vessel. It needs to be considered that a vessel used for commercial purposes may not actually be designed to commercial vessel standards. Unfortunately, the vessel details recorded on the Coroner's files were not detailed enough for precise categorisation of vessel class for commercial vessels.

[13] Length was unknown for 45 vessels. In addition, the number of vessels involved was unknown in one incident.

[14] All significant contributing factors were considered with a maximum of five were recorded for each incident.

vessels when they were less than 6 metres in length compared to only 6% when these vessels were 6 metres or more. Inadequate stability or buoyancy was an even stronger feature of these vessels when they were less than 4 metres in length (Table 1).

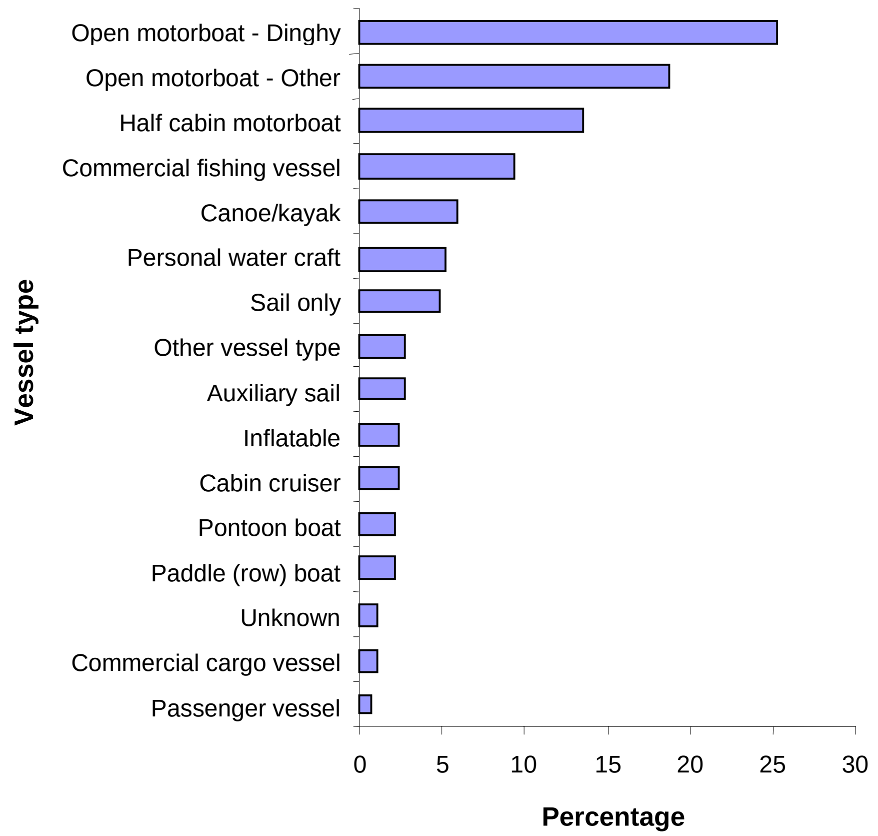

Figure 11—NMSC boating fatalities by vessel type, Australia 1992 to 1998

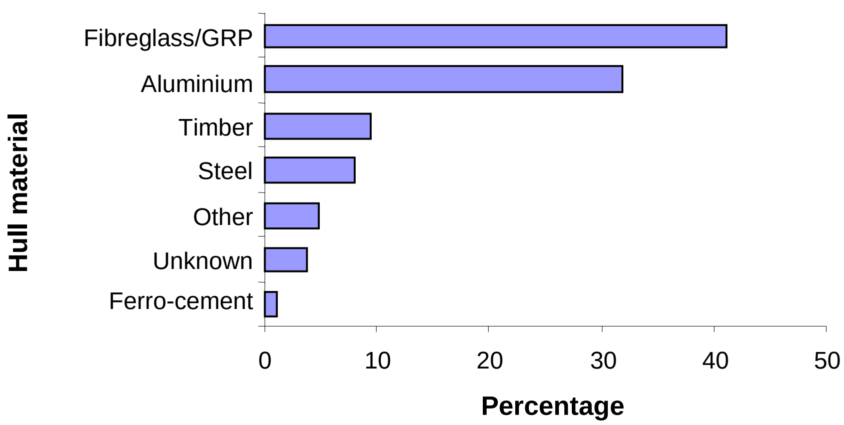

Figure 12—NMSC boating fatalities by hull material, Australia 1992 to 1998

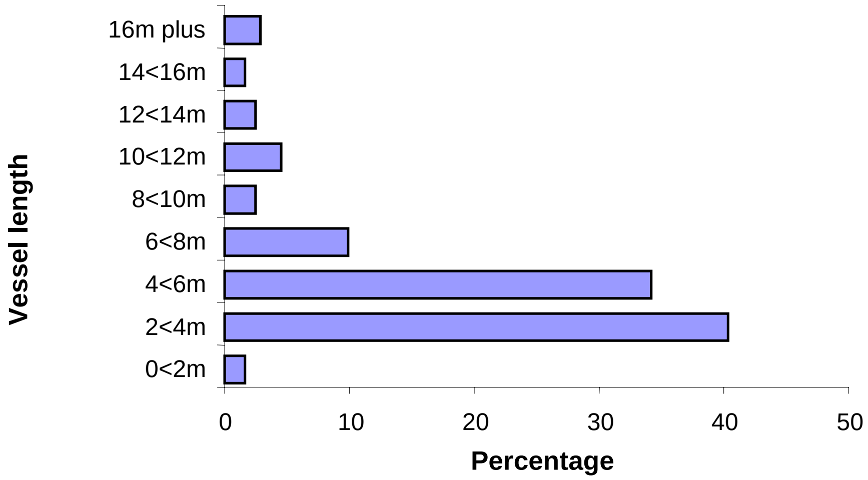

Figure 13—NMSC boating fatalities by vessel length, Australia 1992 to 1998

Table 1—NMSC boating fatalities by vessel length and stability/buoyancy for selected vessel types, Australia 1992 to 1998

	Inadequate stability or buoyancy		Not inadequate		
Vessel length (metres)	**n**	**%**	**n**	**%**	**Total**
0<2 m	0	0	2	100	2
2<4 m	12	20	48	80	60
4<6 m	4	6	66	94	70
6<8 m	1	6	16	94	17
8<10 m	0	0	1	100	1

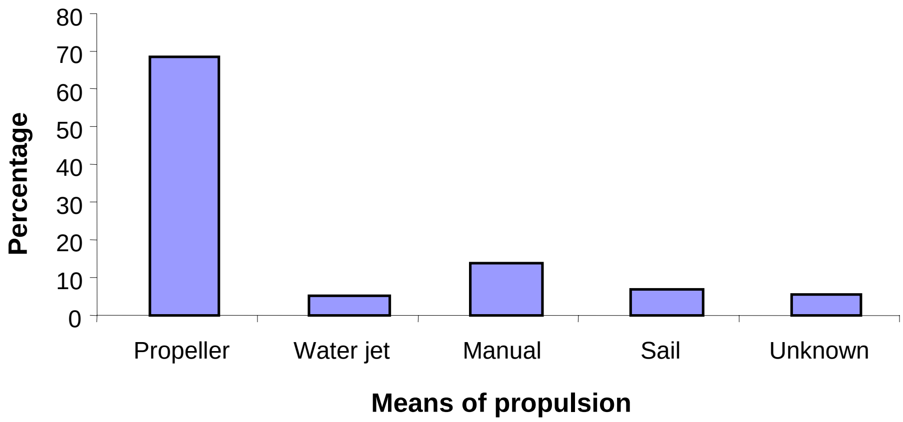

Figure 14—NMSC boating fatalities by means of propulsion, Australia 1992 to 1998

Vessel propulsion

A propeller was the means of propulsion for 69% of vessels, mainly using outboard engines fuelled by petrol (Figure 14). Fourteen percent were propelled manually using oars. The vessels propelled by water jet were all jet skis (n=15, 5% of vessels).

Vessel power

From Figures 15-17 it is evident that for dinghies and other open motorboats[15], there was a positive correlation between vessel length and power i.e. longer vessels had more powerful engines. The Pearson correlation coefficients were .6 and .7 respectively, and both were statistically significant at the 0.001 level. The relationship was not as clear for half cabin motorboats (Pearson correlation coefficient = .4, just statistically significant at the 0.05 level). There was, however, quite a lot of variation in engine power for any specific length and type of vessel.

While the appropriate engine horsepower for any vessel cannot be determined solely on the basis of its length, but needs to be considered in relation to other aspects of vessel design[16], the obvious outliers well above a line drawn through the middle of the data points shown in the figures suggest excessive power for some vessels involved in fatal incidents. Certainly, in a relative sense all vessels above the midline could be considered to be overpowered.

From Figures 15 and 16, it can be seen that a few vessels less than 4.5 metres in length had a 40-50 hp engine fitted. When considered in relation to AS 1799.1, an engine this powerful would be excessive where the transom width was less than or equal to 1.3 metres. In Figure 17, a half cabin motorboat just over 6 metres in length was fitted with a 245 hp engine, which would be excessive even if the transom width of the vessel was 2.5 metres[17]. Another half cabin motorboat, just over 4.5 metres in length was fitted with a 175 hp engine, which would be excessive even if the transom width was 2.6 metres.

Thirty one percent of dinghies, other open motorboats and half cabin motorboats were overpowered when considered against the AS 1799.1 method for calculating the maximum engine power for existing vessels.

A more precise assessment of vessel power would require better data on a range of vessel parameters, particularly transom width. In the case of fatal incidents this could be achieved through survey of the vessels impounded by police as a component of a coordinated and more comprehensive data collection linked into the present database created on the basis of Coroners' data[18].

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[15] A specialised speedboat having two 500hp engines has been excluded.

[16] See Australian Standard 1799.1.

[17] AS 1799.1 indicates that a 6 metre vessel having the transom width expected for such a vessel should have a maximum engine power rating of 170hp and a 4.5 metre vessel would have a maximum engine power rating of about 60hp.

[18] If this was undertaken by the police marine accident investigation staff as a routine process, there would be no cost. A basic survey by a private surveyor could cost less than $500 (NMSC, 2002).

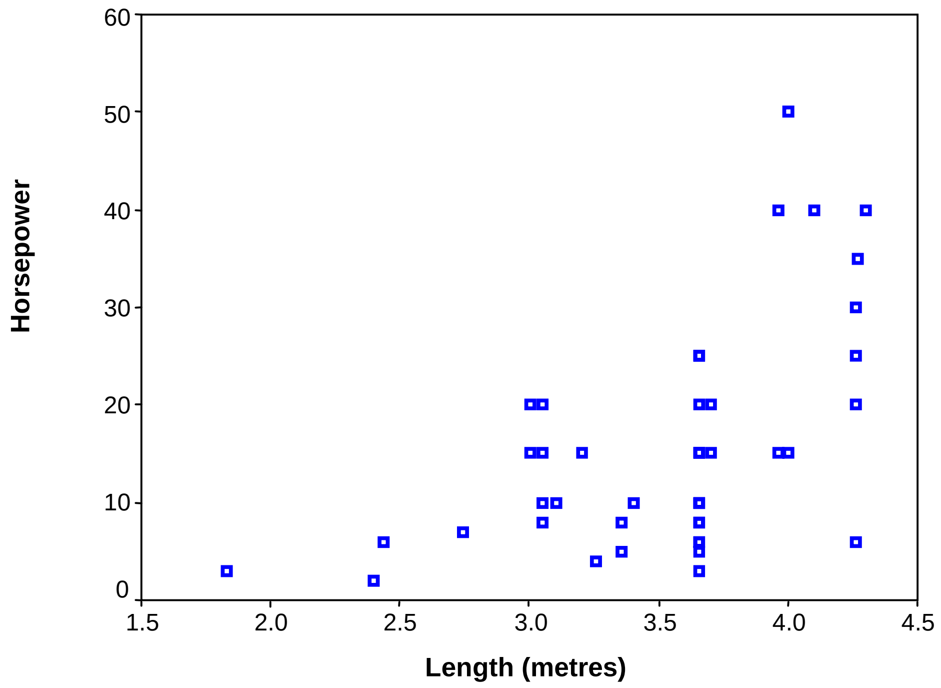

Figure 15—NMSC boating fatalities by engine power and vessel length for dinghies, Australia 1992 to 1998

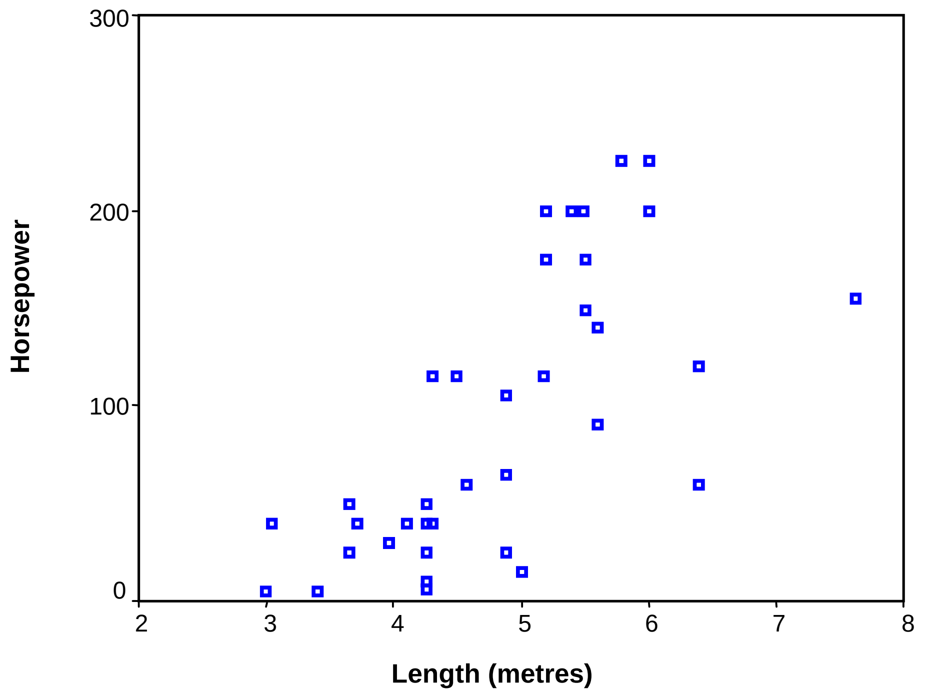

Figure 16—NMSC boating fatalities by engine power and vessel length for other open motorboats, Australia 1992 to 1998

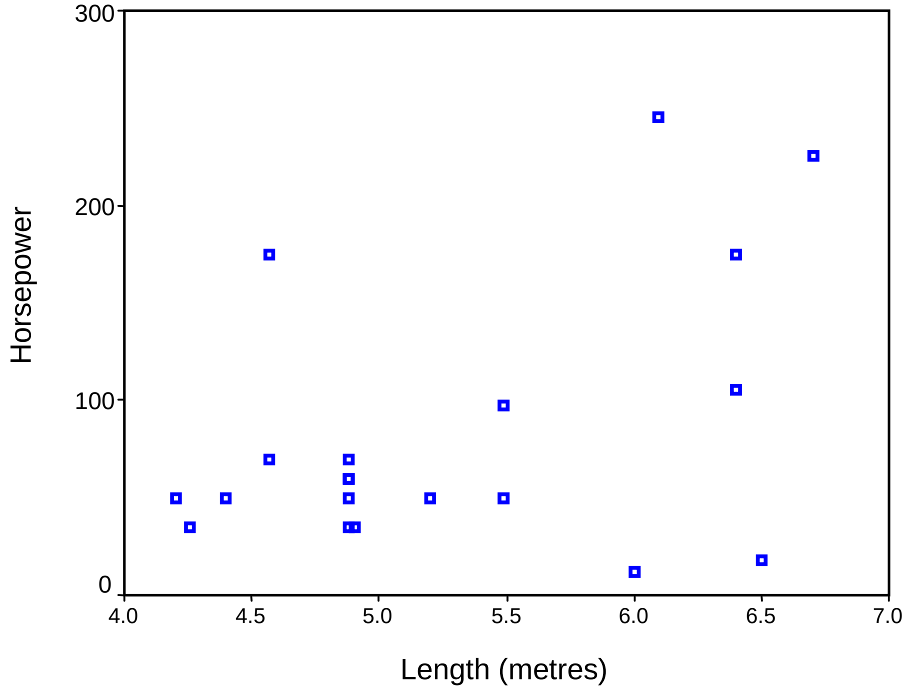

Figure 17—NMSC boating fatalities by engine power and vessel length for half cabin motorboats, Australia 1992 to 1998

Vessel occupancy - overloading and PFDs

It is generally considered as a rough 'rule of thumb', often mentioned in the Coroners' files, that there should be no more than one person per metre of vessel length for small boats. This is slightly less conservative than estimates provided by the rough method of estimation for existing vessel detailed in AS 1799.1. While neither of these methods is really a substitute for the full calculation of person capacity set out in the body of the Standard, they serve a useful analytical purpose in terms of hypothesising about possible causative factors in fatal incidents.

A simple index of overloading can be calculated for vessel types within the small vessel class by dividing the number of crew on board by the length of the vessel: a value greater than 1 indicating an absolute level of overloading. Alternatively the rough method of AS 1799.1 for existing vessels can be used.

When the rough method of AS 1799.1 was applied to dinghies, other open motorboats, half cabin motorboats and cabin cruisers, it was found that 24% of the vessels were overloaded (Table 2). Overloading was particularly a feature of dinghies (29% were overloaded).

Of the 191 fatalities for which the vessel occupancy and number of PFDs on board was known, 45% of the vessels had an insufficient number of PFDs for the number of people on board. This suggests that the availability of the required safety equipment may need to be more actively monitored.

Table 2—NMSC boating fatalities by vessel type and overloading, Australia 1992 to 1998 (row percentages)

Vessel type	Overloaded according to AS 1799.1		Not overloaded		
	n	%	n	%	Total
Open motorboat - Dinghy	21	29	52	71	73
Open motorboat - Other	9	17	45	83	54
Half cabin motorboat	3	8	36	92	39
Cabin cruiser		0	7	100	7
Total	33	24	140	81	173

Vessel operation

At the time of the incident, the vessels were cruising in 28% of cases (Figure 18). Seventeen percent were drifting and 15% were changing direction.

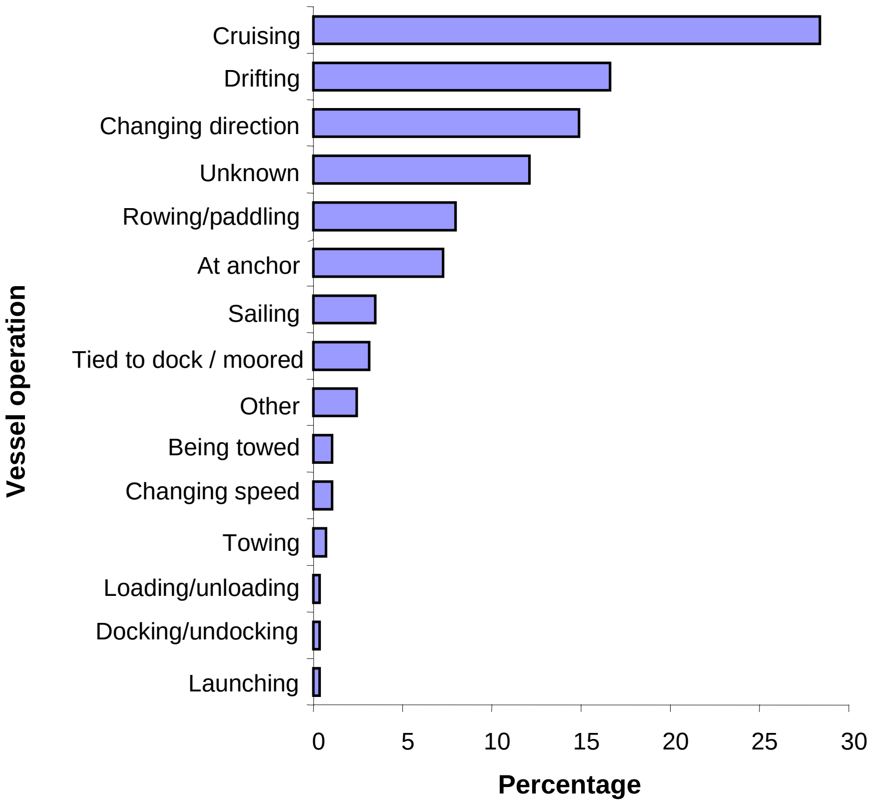

Figure 18—NMSC boating fatalities by vessel operation, Australia 1992 to 1998

Vessel damage

In the boating incidents investigated, nearly two thirds of the vessels (64%) suffered no damage and relatively few were lost (12%; Figure 19)[19]. In most cases, the recovered vessels were impounded by police until they had completed their investigations. Despite this, these vessels were often not subject to survey or detailed investigation. It is recommended that in the future impounded vessels be surveyed and the resulting information be provided for inclusion in the ABID:FI.

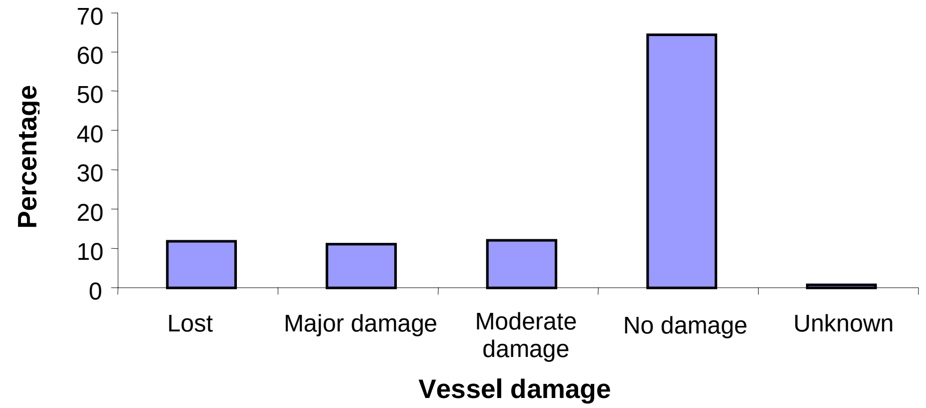

Figure 19—NMSC boating fatalities by vessel damage, Australia 1992 to 1998

Vessel operator details

Operator age and sex

Operators were most commonly in the age groups 25-29 years and 45-49 years (Figure 20),[20] and 97% were male[21].

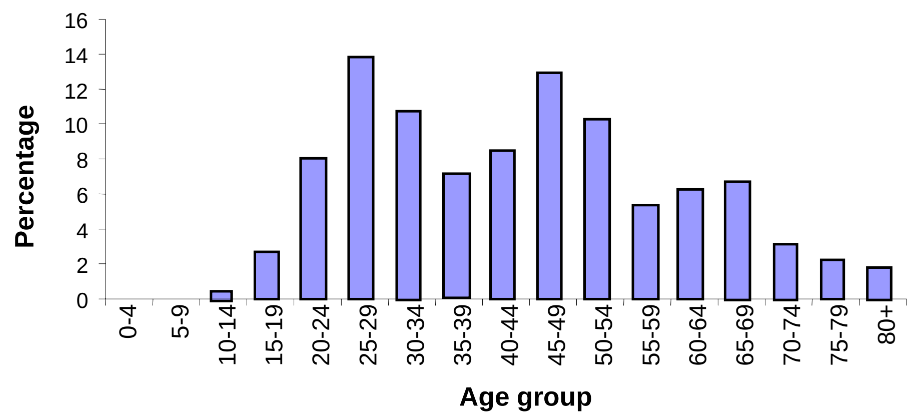

Figure 20—NMSC boating fatalities by age of operator, Australia 1992 to 1998

[19] Damage was unknown for 2 vessels. Percentages have been based on the total number of vessels including those with unknown damage.

[20] Excludes operators for whom age was unknown (n=65).

Operator testing for alcohol and drugs

One hundred and sixty eight vessel operators were killed in the 270 fatal incidents. Of the 288 vessel operators involved in the fatal incidents[22], 129 (45%) were blood or breath tested for alcohol and/or other drugs. Of the 129 operators tested for alcohol and/or drugs, 104 were operators killed and the other 25 were operators who survived. When the number of surviving operators tested (n=25) was considered in relation to the number of vessel operators who survived (n=120), it was evident that only 21% of the vessel operators who survived in fatal incidents were blood or breath tested. The low level of testing of the legally responsible surviving operator of a vessel involved in a fatal incident is very worrying indeed: a result that would not be acceptable in other areas of transport.

When all blood tested vessel operators[23] were considered (129 tested for alcohol and 102 tested for drugs), a positive blood test result was found for alcohol in 40% of cases: the highest level being near lethal in its own right at 0.352 gm/100ml. A positive drug test result was found in 9% of those tested.

Details of person killed and circumstances of death

Age and sex

Those killed were most often aged 25-29 years (14%; Figure 21). Ninety-five percent were male.

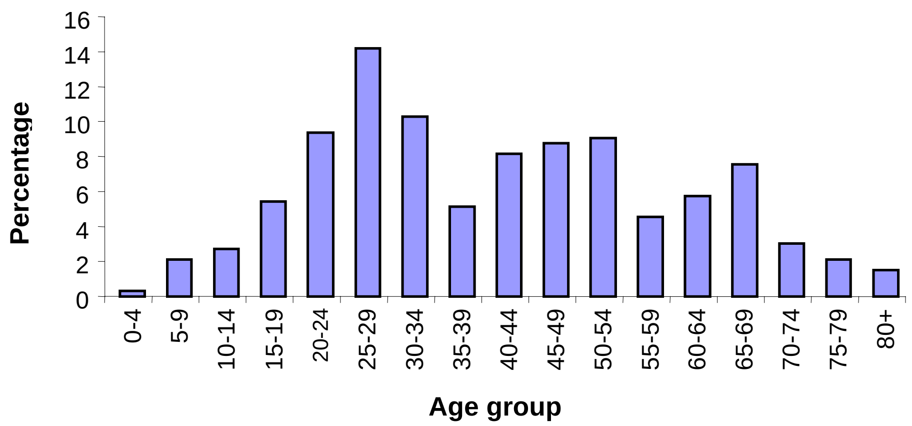

Figure 21—NMSC boating fatalities by age group of person killed, Australia 1992 to 1998

[21] Excludes operator for whom sex was unknown (n=11).

[22] Excludes one incident in which the number of vessels and operators involved was unknown.

[23] Includes those who died and those who survived.

Marital status

Forty seven percent of those killed were married (Figure 22).

Figure 22—NMSC boating fatalities by marital status of person killed, Australia 1992 to 1998

Employment status

Sixty four percent of people killed were employed and 17% were retired (Figure 23).

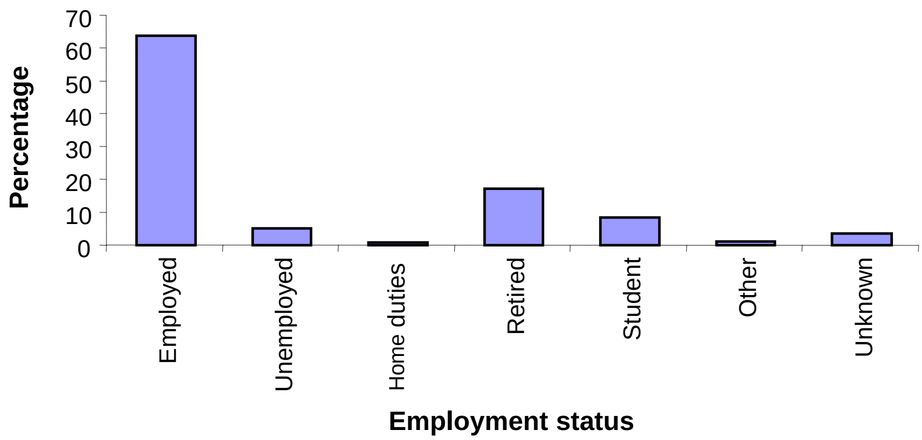

Figure 23—NMSC boating fatalities by employment status of person killed, Australia 1992 to 1998

Activity at the time of the incident

Eighty four percent of those killed were engaged in a sporting or recreational activity at the time of the incident; 15% were working for income; and 1% were engaged in other activities (Figure 24). Among those working for income, 88% were fishermen or other seamen. Half of those killed were vessel operators (n=168).

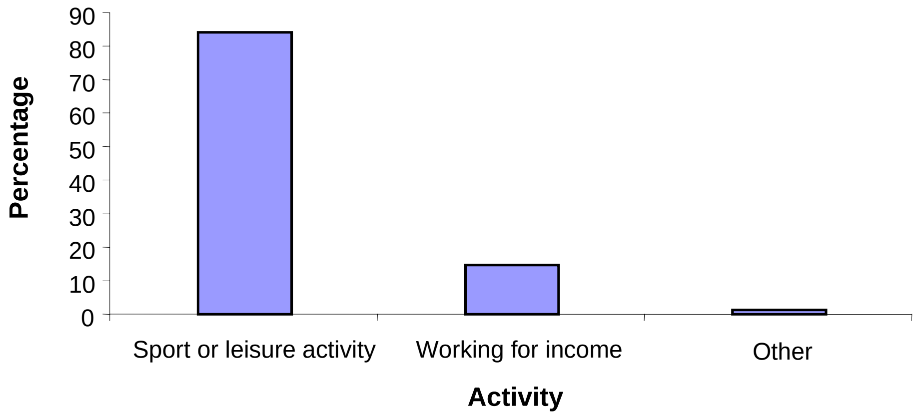

Figure 24—NMSC boating fatalities by activity of person killed, Australia 1992 to 1998

Results of blood testing for alcohol and drugs

Blood was taken for analysis for 67% of fatalities (n=224). The reason for failure to blood test was primarily because the body not found at all or only body parts were found (n=58). Therefore, the testing rate was 85% of the maximum possible rate.

Forty two percent (n=93) of the tested fatalities (n=224) were positive for alcohol: 26% (n=59/224) in excess of 0.05 gm/100ml. Even if deaths were excluded where putrefaction could explain the test result (n=15, with 14 below 0.05 gm/100ml and one at 0.05 gm/100ml), BAC was still positive for 35% (n=78/224) of those tested. When the results that could be explained by putrefaction were excluded, 28% were greater than 0.05 gm/100ml (n=58/[224-15]), demonstrating that alcohol is as much a factor in boating deaths as it is in road deaths (26%: ATSB, 2001).

There was no clear relationship between BAC level and age. The scatter plot shows that non-zero BACs were spread across the age range 20-80 years[24], suggesting that BAC testing of the boating population is required across this age range (Figure 25).

Among those killed and aged 18 years and over, there was a marked difference in alcohol involvement between those wearing a PFD (BAC average=.01 gm/100ml, n=29) compared to those not wearing a PFD (BAC average=.07 gm/100ml, n=176) and this difference was statistically significant (t=-2.81, df=203, p<.01). The result could reflect a pattern of safety mindedness, with those likely to wear a PFD also choosing to not drink alcohol or to drink very little while boating.

Statistical comparison shows that BAC levels were significantly higher among fatalities in inland waters compared to both inshore waters and offshore waters, and were also significantly higher among fatalities in enclosed waters compared to both inshore and offshore waters (Tables 3 & 4). This suggests that BAC testing of the boating population should be targeted at enclosed waters and inland waters.

[24] A small number of the positive results below .05 gm/100ml reflect putrification, notably in the case of a child.

Results for alcohol involvement by vessel type, reported later, emphasise the practical significance of the targeting of dinghy operators for BAC testing.

Of those tested for drugs (n=195), 9% were positive, with cannabinoid's detected in 85% of the positive samples and amphetamines in 20%[25].

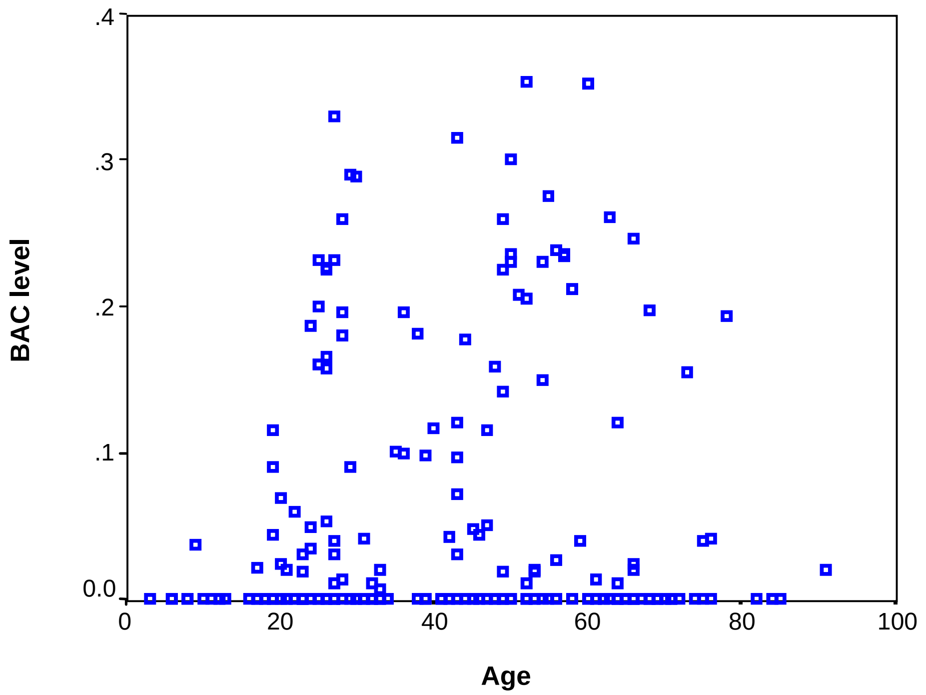

Figure 25—NMSC boating fatalities by BAC (gm/100ml) and age, Australia 1992 to 1998

Table 3—NMSC boating fatalities by location and BAC (gm/100ml), Australia 1992 to 1998

Location	Average BAC	n	Std. Deviation
Inland waters	0.063	87	0.094
Enclosed waters	0.075	62	0.107
Inshore waters	0.030	62	0.065
Offshore waters	0.004	13	0.013
Total	0.054	224	0.090

[25] Three samples had both cannabinoid's and amphetamines.

Table 4—NMSC boating fatalities by location and difference in BAC (gm/100ml), Australia 1992 to 1998

Location (I)	Location (J)	Mean Difference (I-J)	Std. Error	Sig.	Statistical significance
Inland waters	Enclosed waters	-0.012	0.015	0.42	Not significant
	Inshore waters	0.034	0.015	0.02	Significant
	Offshore waters	0.060	0.026	0.02	Significant
Enclosed waters	Inland waters	0.012	0.015	0.42	Not significant
	Inshore waters	0.046	0.016	<0.01	Significant
	Offshore waters	0.071	0.027	<0.01	Significant

Cause of death and contributing causes

Drowning was the stated cause of death in 82% of boating deaths, mainly salt water drowning (58%; Figure 26).

There were significant co-morbidities in 24% of deaths: such as cardiac arrest, asthma, chronic alcohol abuse, chronic alcoholic liver disease, diabetes, arthritis, enlarged heart, high blood pressure, emphysema, obesity, heart disease, and viral infection. Five percent of those killed were reported to be on medication for a disease. The co-morbidities and medication could have played a part in the deaths.

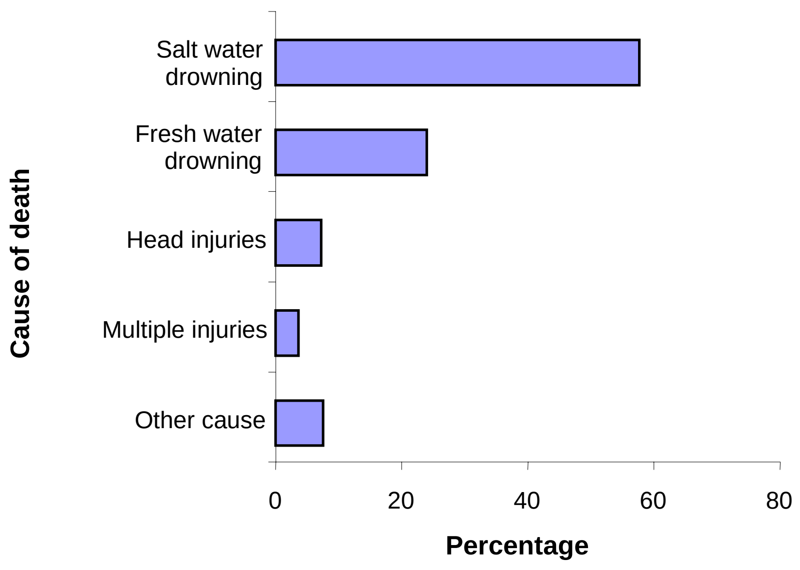

Figure 26—NMSC boating fatalities by cause of death, Australia 1992 to 1998

Topical issues

Personal flotation devices

Of all people killed in boating incidents, only 9% were wearing a PFD of any sort. This low percentage probably reflects a low prevalence of PFD use rather than in-effectiveness of the devices themselves. As there has not been a national exposure study of PFD use, it is difficult to know what to make of the result among those killed.

The existence of the Australian Boating Injury Database: Fatal Injury (ABID:NFI) in Australia has facilitated a unique study of PFDs, not undertaken before anywhere else in the world. In this study, some further insight into PFD effectiveness was able to be gained by comparing PFD use among those killed and those not killed in the same incidents. For this comparison, all boating incidents that fitted the following selection criteria were included:

1. Two or more people remained in the water until retrieved, whether dead or alive.

2. The deceased was not killed by an impact or trapped under water.

Incidents were excluded where the body of the deceased was not found and PFD status was unknown. Where the PFD was not fitted properly and came off, this was regarded as PFD not worn.

The comparison tabulated below (Table 5) effectively excludes environmental conditions as an independent factor in death, because those killed and those who survived were all exposed to the same conditions[26]. In addition, it has been assumed that those wearing a PFD had the same probability of death as other occupants in the absence of PFD use (ie. they were not more or less likely to die per se, whether on water or land or anywhere else)[27]. Comparison of the odds of PFD use among those killed with the odds among those not killed indicates the extent of the effect of PFDs for or against death. An odds ratio (OR) significantly above 1 would in this case indicate a protective effect of the PFD against death. An OR significantly below 1 would in this case indicate a facilitative effect of the PFD for death. An insignificant OR would indicate that there was no demonstrated protective or facilitative effect of the PFD on death.

From Table 5 it can be seen that the proportion wearing a PFD was higher among those who survived compared with those who died. The odds ratio was 2.1, indicating that people who were alive were more than two times more likely to have been wearing a PFD. The result was statistically significant, as indicated by the 95% confidence interval of the odds ratio (1.3 to 4.1).

The data in the table can be used to model the impact of an increase in PFD use. If PFD use increased to 50%, 2-3 lives could be saved nationally each year. If PFD use

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[26] This provides an assessment of PFD exposure in the source population superior to other methods involving, for example, PFD usage surveys of boaters, where environmental conditions could not be controlled with any degree of certainty relative to the deceased cases.

[27] If those wearing a PFD were otherwise more likely to die (eg. if they wore a PFD because they were ill or could not swim), then an apparent benefit of PFDs in the study would be deflated from its true level (ie. the benefit could be greater than shown in the study). On the other hand, if those not wearing a PFD were otherwise more likely to die, then an apparent benefit of PFDs in the study would be inflated from its true level (ie. the benefit could be less than shown in the study). As there is no compelling evidence suggesting that PFD users are otherwise more or less likely to die, the null hypothesis is that there is no difference in the probability of death in the two groups in the absence of PFD use.

increased to 75%, 5 lives could be saved, with a cost saving to the Australian community of nearly $8 million per year[28]. The saving of 5 lives per year would reduce the annual boating death toll by 13% based on the current annual toll: a very substantial reduction. The benefit of an increase in PFD use would accrue most substantially to recreational boaters who comprise the vast majority of those killed.

Table 5—NMSC boating fatalities by PFD status and survival status, Australia 1992 to 1998

	Survival status						
	Dead		Alive				
PFD Status	n	%	n	%	Total	OR	95% CI
Wearing PFD	16	11	34	21	50	1	Referent
Not wearing PFD	129	89	128	79	257	2.1	1.3-4.1
Total	145	100	162	100	307		

Jet-skis

Fifteen of the vessels involved in fatal incidents were jet skis. Collision was much more common among jet-ski incidents than incidents overall: 53% of jet-ski incidents versus 13% of initial events for all incidents. Six of the jet-ski incidents involved a collision with another jet ski and a further 2 involved a collision with other water craft.

The initial contributing factor was a human cause in all cases (Figure 27), with excessive speed for the conditions in 40% of cases: one travelling at 21-30 knots, two at 31-40 knots, two at 41-50 knots and one at 51-60 knots. When all significant contributing factors were considered (a maximum of five were recorded for each incident; Figure 29), it was found that 98% were human factors.

Just over half of the vessels (n=8) were being operated on inland waters (Figure 28).

Eight (53%) of the vessel operators were aged 20-25 years and 13 (87%) were male. Only 9 of the vessel operators were blood tested[29]: a poor level of testing considering the strong involvement of human factors such as speed and reckless or inattentive behaviours commonly associated with alcohol use. One of those tested returned a positive result for alcohol, but this result might have been unreliable due to putrefaction on decomposition resulting from a delay in finding the body. One of the operators tested returned a positive result for a drug: cannabis.

Of the jet-ski operators killed (n=11), 55% were not wearing a PFD despite legislation requiring that they be worn. While PFD use was more common among the jet-ski operators killed (45%) than among all persons killed (11%), the result indicates the need for further promotion and enforcement efforts directed at jet-ski operators.

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[28] Based on NMSC (2003, Table A.1, p. 31) information on average cost per fatality.

[29] Includes those operators who were killed and those who survived.

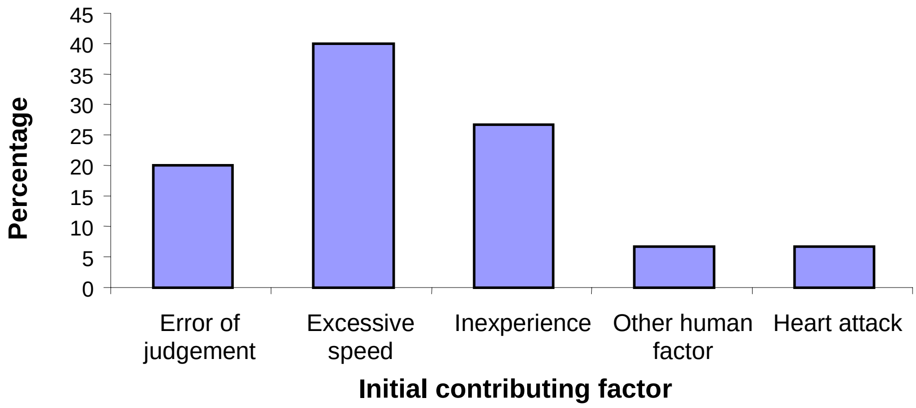

Figure 27—NMSC boating fatalities by initial contributing factor for jet-skis, Australia 1992 to 1998

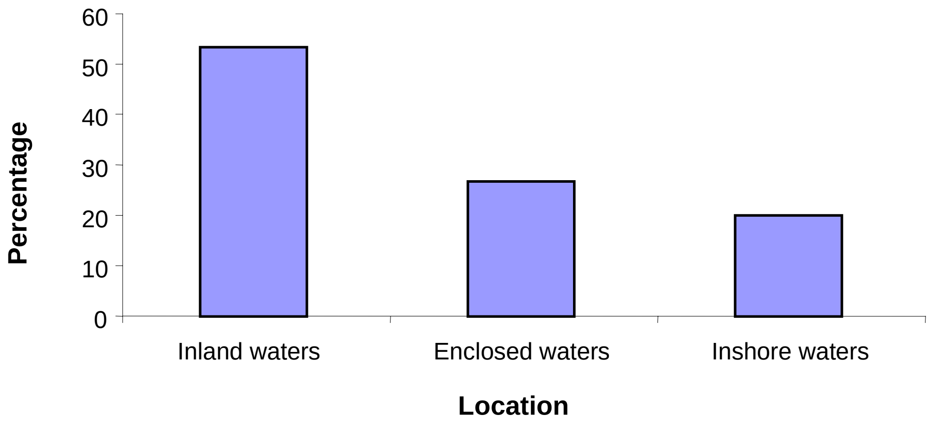

Figure 28—NMSC boating fatalities by location for jet-skis, Australia 1992 to 1998

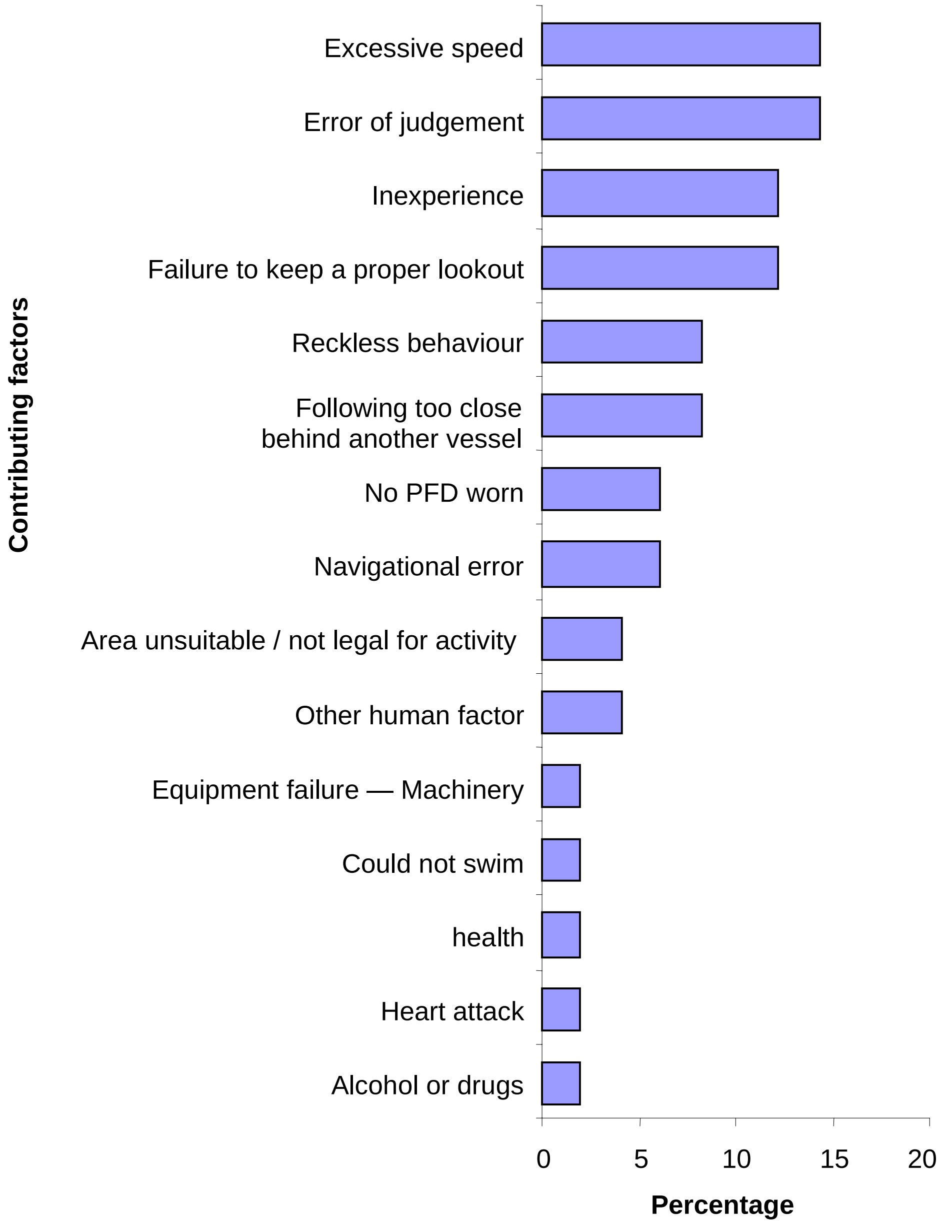

Figure 29—NMSC boating fatalities by contributing factors for jet-skis, Australia 1992 to 1998

Over-involvement of dinghies

Figure 11 showed that dinghies were the most common vessel involved in fatal incidents. The factors involved can be further assessed through a comparison of the features of incidents involving these and other vessels.

The involvement of dinghies in fatal incidents was not explained by differences in vessel length (in metres) relative to other comparables types of vessel (Table 6).

Another factor that can be studied to some extent is overloading. Using the simple index of overloading referred to earlier in the report (i.e. dividing the number of persons on board by the length of the vessel) it was found that dinghies were relatively more overloaded than cabin cruisers and sail only vessels, but less overloaded than inflatable vessels (Table 7)[30]. The difference in overloading of dinghies from other open motorboats and half cabin motorboats, which together made up 57% of all vessels involved in fatal incidents, was not quite statistically significant by this method of assessment of overloading (Table 7).

When the more conservative and rough method of calculating maximum occupancy for existing vessels detailed in AS 1799.1 was used to compare overloading of dinghies and other vessels, the difference was statistically significant (Table 8). The odds of overloading were more than two times higher for dinghies compared with open motorboats and half cabin motorboats.

Table 6—NMSC boating fatalities by vessel type and difference in vessel length, Australia 1992 to 1998

Vessel type (I)	Vessel type (J)	Mean Difference (I-J)	Std. Error	Sig.	Statistical significance
Dinghy	Other open motorboat	-3.542	2.326	0.13	Not significant
	Half cabin motorboat	-2.039	2.475	0.41	Not significant
	Cabin cruiser	-6.162	4.850	0.21	Not significant
	Auxiliary sail	-4.913	4.850	0.31	Not significant
	Sail only	-4.484	3.833	0.24	Not significant
	Paddle (row) boat	0.627	5.658	0.91	Not significant
	Inflatable	-0.133	4.850	0.98	Not significant
	Pontoon boat	0.209	5.658	0.97	Not significant

Table 7—NMSC boating fatalities by vessel type and difference in simple index of overloading, Australia 1992 to 1998

Vessel type (I)	Vessel type (J)	Mean Difference (I-J)	Std. Error	Sig.	Statistical significance
Dinghy	Other open motorboat	-0.005	0.063	0.93	Not significant
	Half cabin motorboat	0.080	0.066	0.22	Not significant
	Cabin cruiser	0.266	0.129	0.04	Significant
	Auxiliary sail	0.119	0.129	0.35	Not significant
	Sail only	0.297	0.102	0.00	Significant
	Paddle (row) boat	0.025	0.151	0.86	Not significant
	Inflatable	-0.513	0.129	0.00	Significant
	Pontoon boat	-0.266	0.151	0.07	Not significant

[30] Selected other vessels have been excluded from the comparison as the index is considered to be less likely to be the basis of a valid comparison ie. jet skis, kyaks, passenger vessels, commercial fishing vessels and other unspecified vessels.

On the basis of this assessment, it seems that overloading is more a factor in dinghy incidents compared with incidents involving some other types of vessels.

Dinghies were more likely to involve capsize as the initial incident event compared with selected other vessels in fatal incidents (Table 9)[31]. Assessment using the odds ratio, indicates that the odds of dinghy involvement was more than two times greater among those capsized compared with not capsized and this was statistically significant.

Dinghies were more likely to involve alcohol as a contributing factor in fatal incidents (Table 10).[31] Assessment using the odds ratio, indicates that odds of dinghy involvement was nearly four times greater among those involving alcohol compared with not involving alcohol and this was statistically significant.

Dinghies were also more likely to involve failure to wear a PFD among those killed (Table 11).[31,32] Assessment using the odds ratio, indicates that odds of dinghy involvement was more than six times higher among those not wearing a PFD compared with those wearing a PFD and this was statistically significant.

In summary, dinghies were implicated in boating deaths through associated risk factors such as overloading, capsize, alcohol involvement and failure to wear a PFD. Increased attention to this vessel type and the associated risk factors is warranted.

Table 8—NMSC boating fatalities by vessel type and overloading according to AS 1799.1, Australia 1992 to 1998.

	Assessment of overloading according to AS 1799.1						
	Overloaded		Not overloaded				
Vessel type	**n**	**%**	**n**	**%**	**Total**	**OR**	**95% CI**
Other open motorboats & half cabin motorboats	12	36	81	61	93	1	Referent
Dinghy	21	63	52	39	73	2.7	1.2-6.0
Total	33	100	133	100	166		

Table 9—NMSC boating fatalities by selected vessel type and capsize, Australia 1992 to 1998.

	Capsized		Not capsized				
Vessel type	**n**	**%**	**n**	**%**	**Total**	**OR**	**95% CI**
Not a dinghy	37	51	98	72	135	1	Referent
Dinghy	35	49	38	28	73	2.4	1.3-4.4
Total	72	100	136	100	208		

[31] Only the vessel types included in Table 7 have been included in the comparison as the index and other variables tabulated were not considered to form the basis of a valid comparison if the other vessel types (ie. jet skis, kyaks, passenger vessels, commercial fishing vessels and other unspecified vessels) were included. Note: Tables 9 & 10 are based on the number of selected vessels (total=208) whereas Table 11 is based on the number of fatalities for the selected vessels (total=224), which explains why the table totals are not the same.

[32] PFD status was unknown for 17 fatalities.

Table 10—NMSC boating fatalities by selected vessel type and alcohol involvement, Australia 1992 to 1998

Vessel type	Alcohol was a factor		Alcohol was not a factor				
	n	%	n	%	Total	OR	95% CI
Not a dinghy	19	40	116	72	135	1	Referent
Dinghy	28	60	45	28	73	3.8	1.9-7.5
Total	47	100	161	100	208		

Table 11—NMSC boating fatalities by selected vessel type and PFD status, Australia 1992 to 1998

Vessel type	PFD status						
	Worn		Not worn				
	n	%	n	%	Total	OR	95% CI
Not a dinghy	24	89	109	55	133	1	Referent
Dinghy	3	11	88	45	91	6.5	1.9-22.2
Total	27	100	197	100	224		

Capsize

Of the initial incident events, capsize was most common: 36% of initial events in the 270 fatal incidents investigated (Figure 7) and comprising 34% of initial incident events for the 288 vessels involved. It is therefore appropriate to further consider the factors involved in these initial events.

Human factors (OR=1.7) and environmental factors (OR=1.8) were more implicated in capsize as the initial event than with other initial events (Tables 12 & 13). Overloading/ improper loading and alcohol involvement were considered as potentiating human factors (Tables 14 & 15).

It was found that overloading/improper loading was a strong factor in capsize (Table 14). Twenty six percent of the vessels involved that has capsize as the initial event, had overloading/improper loading as a contributing factor in the incident[33] compared with 8% for those not involving capsize. The odds of an overloaded or improperly loaded vessel are more than three times higher among capsized vessels compared with those not capsized.

Twenty five percent of the capsized vessels involved alcohol as a contributing factor in the incident compared with 19% for other vessels (Table 15). However, the odds ratio was not statistically significant, suggesting that alcohol may not be a strong factor in capsize as the initial event in a fatal incident.

Twenty percent of capsized vessels (vs. 12% of vessels not capsized), were incidents in which the initial contributing factor was hazardous wind/sea conditions (Table 16). The

[33] All significant contributing factors were considered with a maximum of five were recorded for each incident.

odds of hazardous conditions was nearly two times higher for capsized vessels than those not involving capsize.

The assessment of other human and environmental factors involved could not be assessed further due to small numbers and other considerations.

The coded material factors, which were mainly equipment failures, were not overall more implicated in capsize (Table 17). However, it has already been shown that vessel type (dinghies) is a risk factor for capsize (Table 9). Assessment of capsize in relation to overloading calculated according to the rough method specified in AS 1799.1 (Table 18)[34], failed to demonstrate any significant effect. Therefore, contrary to popular assumption, capsize was not shown to be a more common outcome in small vessels as such or in relatively more overloaded vessels, but rather in specific vessel types (Table 9) and where improper loading was also considered along with overloading (Table 14).

On the basis of this analysis it is clear that vessel type, overloading/improper loading and hazardous conditions contribute to capsize in the absence of some prior event such as a collision, loss of stability or swamping. The causes need to be further investigated because capsize is the most common initial event in boating deaths.

Table 12—NMSC boating fatalities by initial event (human factors) and capsize, Australia 1992 to 1998

Initial event	Capsize						
	Yes		No				
	n	%	n	%	Total	OR	95% CI
Not a human factor	55	56	131	69	186	1	Referent
Human factor	43	44	59	31	102	1.7	1.0-2.9
Total	98	100	190	100	288		

Table 13—NMSC boating fatalities by initial event (environmental factors) and capsize, Australia 1992 to 1998

Initial event	Capsize						
	Yes		No				
	n	%	n	%	Total	OR	95% CI
Not environmental factor	70	71	156	82	226	1	Referent
Environmental factor	28	29	34	18	62	1.8	1.0-3.3
Total	98	100	190	100	288		

[34] Vessel length was unknown for 45 vessels. In addition, the number of vessels involved was unknown in 1 fatal incident.

Table 14—NMSC boating fatalities by vessel loading and capsize, Australia 1992 to 1998

Vessel loading	Capsize						
	Yes		No				
	n	%	n	%	Total	OR	95% CI
Not overloaded/ improperly loaded	73	74	174	92	247	1	Referent
Overloaded/ improperly loaded	25	26	16	8	41	3.7	1.9-7.4
Total	98	100	190	100	288		

Table 15—NMSC boating fatalities by alcohol involvement and capsize, Australia 1992 to 1998

Alcohol involvement	Capsize						
	Yes		No				
	n	%	n	%	Total	OR	95% CI
Not a contributing factor	74	76	153	81	227	1	Referent
A contributing factor	24	25	37	19	61	1.3	0.7-2.4
Total	98	100	190	100	288		

Table 16—NMSC boating fatalities by wind/sea conditions and capsize, Australia 1992 to 1998

Wind/sea conditions	Capsize						
	Yes		No				
	n	%	n	%	Total	OR	95% CI
Not hazardous	78	80	167	88	245	1	Referent
Hazardous	20	20	23	12	43	1.9	1.0-3.6
Total	98	100	190	100	288		

Table 17—NMSC boating fatalities by initial event (material factors) and capsize, Australia 1992 to 1998

Initial event	Capsize						
	Yes		No				
	n	%	n	%	Total	OR	95% CI
Not material factor	83	85	168	88	251	1	Referent
Material factor	15	15	22	12	37	1.4	0.7-2.8
Total	98	100	190	100	288		

Table 18—NMSC boating fatalities by overloading according to AS 1799.1 and capsize, Australia 1992 to 1998

Assessment of overloading according to AS 1799.1	Capsize						
	Yes		No				
	n	%	n	%	Total	OR	95% CI
Not overloaded	57	70	128	80	185	1	Referent
Overloaded	25	30	33	20	58	1.7	0.9-3.1
Total	82	100	161	100	243		

Person overboard

A fall overboard was second only to capsize in terms of importance as an initial incident event: 18% of initial events in the 270 fatal incidents investigated (Figure 7) and comprising 17% of initial incident events for the 288 vessels involved. It is therefore appropriate to further consider the factors involved in these initial events.

Human factors were more implicated in the falls overboard compared with other initial events: the odds of involvement of a human factor was more than three times higher for falls overboard (Table 19). Twenty nine percent of these involved alcohol as a contributing factor in the incident compared with 20% for other initial events (Table 20). However, the odds of alcohol involvement was not significantly higher, statistically, for falls overboard, suggesting that alcohol may not be a strong factor in such initial events. Overloading/improper loading was not more often involved in vessels having falls overboard as the initial event, whether assessed on the basis of contributing factors (Table 21) or the rough method of AS 1799.1 (Table 22). The assessment of other human factors involved could not be assessed further due to small numbers and other considerations.

Material factors were not more implicated in the falls overboard compared with other initial events (Table 23). When vessel type was considered, it was found that dinghies were not more likely to involve a person overboard as the initial event (Table 24)[35].

Also, environmental factors were not more implicated in the falls overboard compared with other initial events (Table 25).

On the basis of this analysis it is not entirely clear what specific human factors cause a person to fall overboard in the absence of some prior event such as a collision, capsize or loss of stability. The causes need to be further investigated because falls overboard is an important initial event in boating deaths. It is possible that the risk is associated with inappropriate movement within the vessel, a factor not separately coded in the database. Further data items may need to be added to the Australian Boating Injury Database: Fatal Injury (ABID:FI) in the future in order to further explore the factors involved in falls overboard.

[35] Only the vessel types included in Table 7 have been included in the comparison. It was not considered to be valid if the other vessel types (ie. jet skis, kyaks, passenger vessels, commercial fishing vessels and other unspecified vessels) were included.

Table 19—NMSC boating fatalities by initial event (human factors) and person overboard, Australia 1992 to 1998

Initial event	Person overboard						
	Yes		No				
	n	%	N	%	Total	OR	95% CI
Not a human factor	8	17	94	39	102	1	Referent
Human factor	40	83	146	61	186	3.2	1.4-7.2
Total	48	100	240	100	288		

Table 20—NMSC boating fatalities by alcohol involvement and person overboard, Australia 1992 to 1998

Alcohol involvement	Person overboard						
	Yes		No				
	n	%	N	%	Total	OR	95% CI
Alcohol was not a contributing factor	34	71	193	80	227	1	Referent
Alcohol was a contributing factor	14	29	47	20	61	1.7	0.8-3.4
Total	48	100	240	100	288		

Table 21—NMSC boating fatalities by vessel loading and person overboard, Australia 1992 to 1998

Vessel loading	Person overboard						
	Yes		No				
	n	%	N	%	Total	OR	95% CI
Not overloaded/ improperly loaded	45	94	202	84	247	1	Referent
Overloaded/ improperly loaded	3	6	38	16	41	0.4	0.1-1.2
Total	48	100	240	100	288		

Table 22—NMSC boating fatalities by overloading according to AS 1799.1 and person overboard, Australia 1992 to 1998

Assessment of overloading according to AS 1799.1	Person overboard						
	Yes		No				
	n	%	n	%	Total	OR	95% CI
Not overloaded	34	83	151	75	185	1	Referent
Overloaded	7	17	51	25	58	0.6	0.3-1.5
Total	41	100	202	100	243		

* Excludes vessels with unknown length

Table 23—NMSC boating fatalities by initial event (material factors) and person overboard, Australia 1992 to 1998

Initial event	Person overboard						
	Yes		No				
	n	%	n	%	Total	OR	95% CI
Not material factor	46	96	205	85	251	1	Referent
Material factor	2	4	35	15	37	0.3	0.1-1.1
Total	48	100	240	100	288		

Table 24—NMSC boating fatalities by selected vessel type and person overboard, Australia 1992 to 1998

Vessel type	Person overboard						
	Yes		No				
	n	%	n	%	Total	OR	95% CI
Not a dinghy	18	55	117	67	135	1	Referent
Dinghy	15	45	58	33	73	1.7	0.8-3.6
Total	33	100	175	100	208		

Table 25—NMSC boating fatalities by initial event (environmental factors) and person overboard, Australia 1992 to 1998

Initial event	Person overboard						
	Yes		No				
	n	%	n	%	Total	OR	95% CI
Not environmental factor	42	88	184	77	226	1	Referent
Environmental factor	6	13	56	23	62	0.5	0.2-1.2
Total	48	100	240	100	288		

Work-related fatal incidents

The two previous Australian work-related fatalities studies, conducted by the National Occupational Health and Safety Commission (NOHSC 1999a,b; Driscoll et al., 1994), have demonstrated the high fatality risk of commercial fishermen and others involved in maritime activities. The fishing industry had one of the highest rates of fatal injury (143 per 100,000 workers in 1982-84 and 89.2 deaths per 100,000 workers in 1989-92) of any working group in Australia.

The present study found that over the period 1992 to 1998 there were 49 fatalities that fitted the NMSC criteria and involved people working for income; 41 of whom were fishermen, one was a seamen involved in the transport of cargo and the remainder were miscellaneous workers. There were a further 25 work-related fatalities that did not fit the

NMSC criteria[36], 11 of whom were merchant seamen involved in the transport of cargo, 5 were fishermen on board large overseas commercial fishing vessels and the remainder were miscellaneous workers. In the analysis that follows deaths not fitting NMSC criteria have been included in order to enable a comparison with previous studies that have included them (NOHSC, 1999a,b; Driscoll et al. 1994).

The annual average number of fisherman deaths was 6-7 per annum, compared with 13-14 per annum over the period 1989-1992 (NOHSC 1999a). Therefore, the total number of fisherman deaths has been halved over recent years. It is important to consider these numbers relative to the number of people employed as fishermen, because a reduction in the number of deaths could just reflect a decline in the number employed in the industry. With reference to the ABS labour force data for the period 1992 to 1998, it can be calculated that the death rate of fishermen was 56/100,000 fishermen, a substantial reduction from earlier years (Figure 30). The decrease in the rate represents an enormous achievement for an industry reported by NOHSC as having one of the worst safety records.

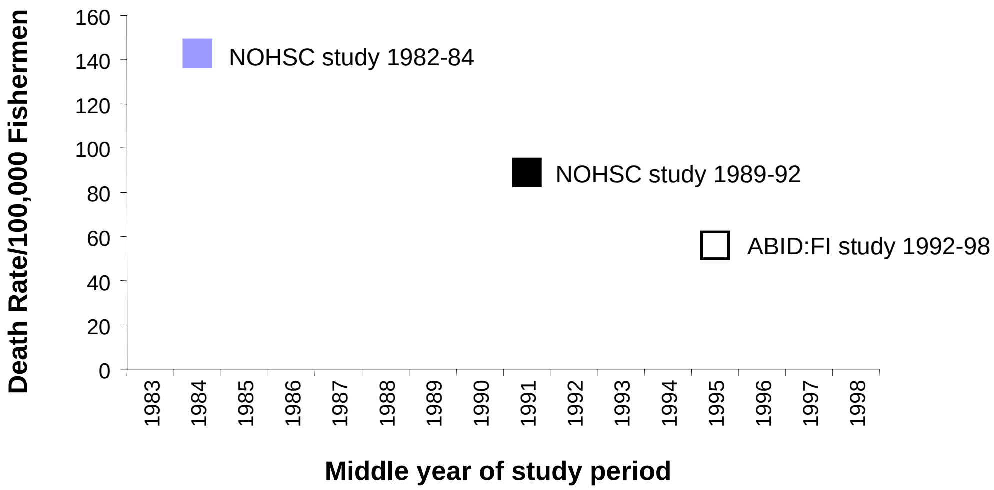

Figure 30—Time series trend in the death rate of fishermen, Australia 1982 to 1998

The main incident events in the deaths of fishermen were: person overboard, sinking of the vessel, capsize and being trapped within/under the vessel (Figure 31). The main contributing factors were: hazardous conditions, an error of judgement, unsafe work practices and failure to wear a PFD in circumstances where, in the opinion of the Coroners, it would have saved life (Figure 32).

When all contributing factors were considered[37], hazardous conditions were much more of a factor in the incidents involving the deaths of fishermen (72%) than in other incidents (27%), suggesting a much higher level of risk and/or risk taking/acceptance with respect to environmental conditions (Table 26).

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[36] See discussion on page 7.

[37] Conditions were tabulated as hazardous if any of the five contributing factors was coded as 'Wind/sea state-hazardous conditions'. Note: the total number of fatalities (n=379) includes those fitting NMSC criteria (n=333) and other investigated deaths not fitting the criteria..

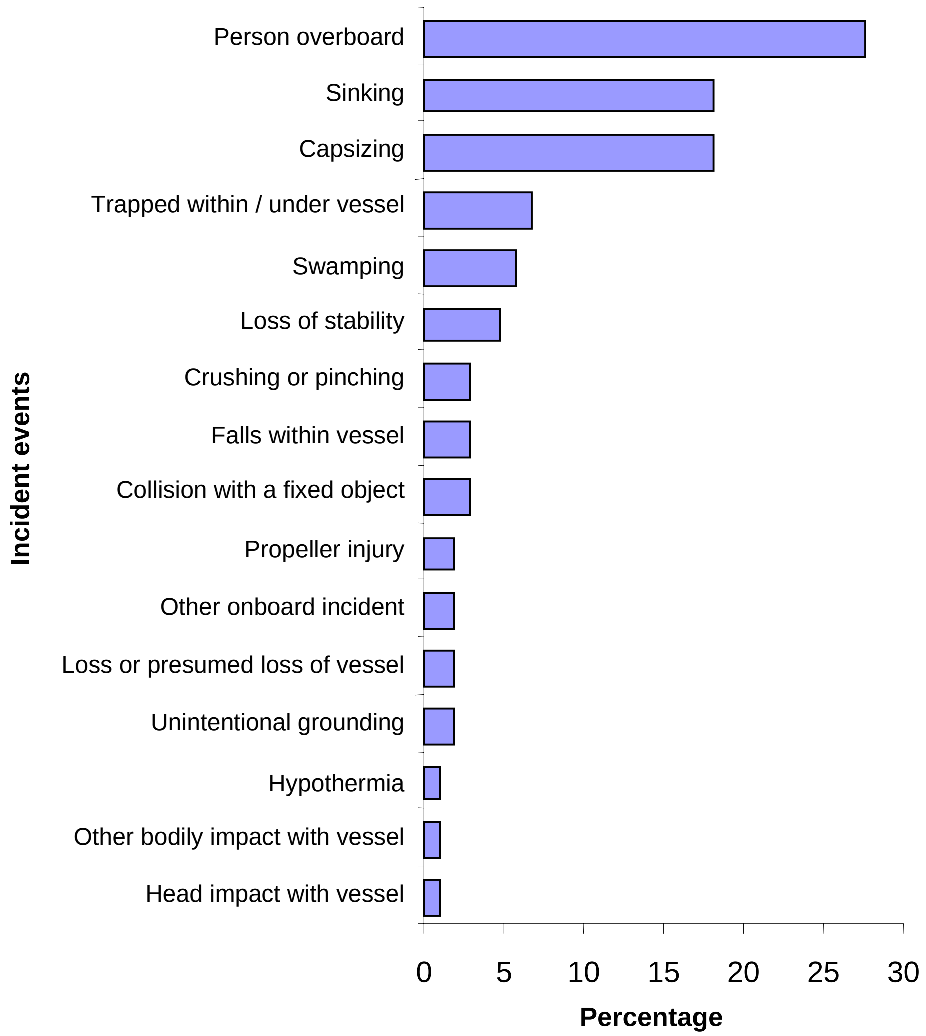

Figure 31—Incident events in fishermen deaths, Australia 1992 to 1998.

Information on BAC was available for half (n=23) of the deceased fishermen and 22% of these tested positive. Twenty percent (n=5) of those tested for drugs (n=20) showed positive results, mainly involving cannabis. In 15% (n=7) of fatal incidents where the person at the helm was blood tested for alcohol (n=44 tested), the test proved positive. Therefore, alcohol and drugs is a factor in the deaths of fishermen and this exposure factor warrants more active surveillance.

Drowning was the cause of death for 82% of fishermen, similar to the results of the earlier NOHSC study of such deaths (NOHSC, 1999a). Among the commercial fishermen who drowned, only 5% were wearing a PFD compared to 12% for all others that drowned in boating incidents (Table 27)[38]. The odds of not wearing a PFD were not higher among fishermen who drowned compared with others who drowned.

[38] PFD status was unknown for 44 of those killed.

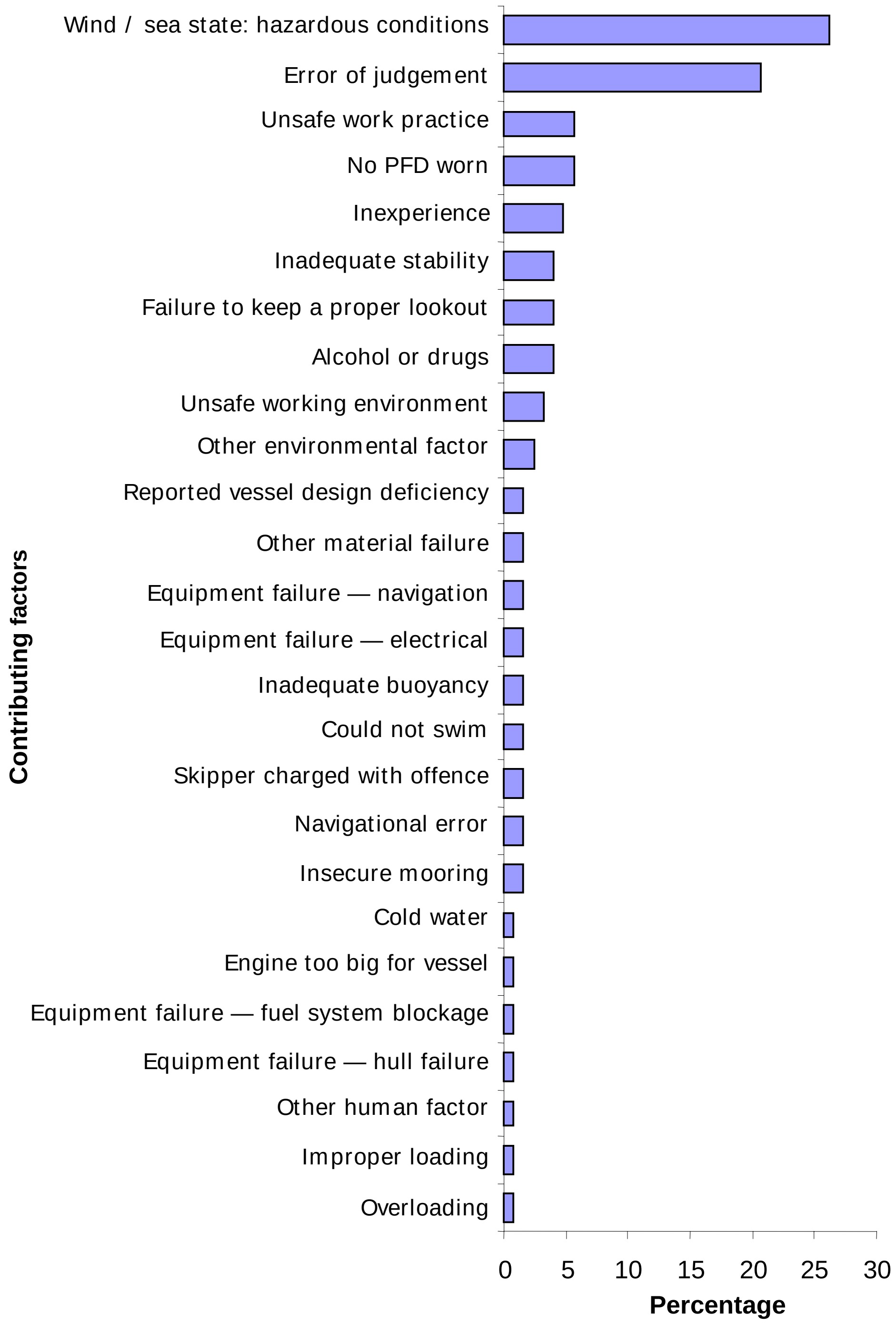

Figure 32—Contributing factors in fishermen deaths, Australia 1992 to 1998

Where vessel occupancy and number of PFDs on board was known (n=17), 29% of the vessels involved in fisherman deaths did not have a sufficient number of PFDs for all occupants on board. The safety equipment on board commercial vessels clearly needs to be more closely monitored. In addition, the wearing of PFDs should be further promoted, having due regard to the practicalities of the hard physical labour often required of fishermen.

The potential for entrapment in the vessel when wearing a PFD has not been studied and may need to be considered as a possible competing risk.

This analysis suggests a higher level of risk, risk-taking or risk-acceptance by fishermen compared with all people killed in boating incidents. Presumably, in order to make a living they must often be prepared to work in less than ideal conditions.

Of the people killed that were seamen involved in the transport of cargo (n=12), two thirds died as a result of crush- and striking-related injuries, often associated with unsafe work practices and conditions, and in confined spaces as identified in an earlier NOHSC study (NOHSC, 1999b).

When all work-related deaths were assessed, fatigue was not reported by the Coroners to be a factor in any of the deaths. This is perplexing as there are anecdotal reports that excessive working hours and poor roster arrangements are widespread throughout the industry. As the Coroners would have an interest in the contribution of fatigue to fatal incidents and the files of their investigations reveal that information in relation to working hours and rest periods is often sought, but negated as a cause, the fatigue factor remains elusive. It is probably the case that the assessment has not been formal enough and that further in-depth study is required. A study method is being planned to make use of the latest in fatigue measurement technology and expertise in the field.

Table 26—NMSC boating fatalities by wind/sea conditions and activity type, Australia 1992 to 1998

Wind/sea conditions	Activity type						
	Work-related fisherman deaths		Not work-related fisherman deaths				
	n	%	n	%	Total	OR	95% CI
Not hazardous	13	28	244	73	257	1	Referent
Hazardous	33	72	89	27	122	7.0	3.5-13.8
Total	46	100	333	100	379		

Table 27—NMSC boating fatalities by PFD status and activity type for drowning deaths, Australia 1992 to 1998

	Activity type for drowning deaths						
	Work-related fisherman deaths		Not work-related fisherman deaths				
PFD Status*	n	%	n	%	Total	OR	95% CI
Wearing PFD	2	5	37	12	39	1	Referent
Not wearing PFD	35	95	261	88	296	2.5	0.6-10.7
Total	37	100	298	100	335		

* PFD status was unknown for 44 of those killed

A more extensive and detailed analysis of the deaths of fisherman, seamen, and other work-related cases, could be undertaken with the assistance of NOHSC through access to their data from the earlier national fatality studies. Along with the data compiled for the present study, this would provide for the first time a comprehensive database of work-related deaths covering seventeen years from 1982 to 1998. The extended database would provide a more substantial underpinning of safety analysis and prevention efforts. The changing patterns over time could reflect changes in policy in the areas of occupational health and safety and national and international maritime safety and it would be important to overlay these changes onto the annualised time series trend.

Ongoing maintenance of the Australian Boating Injury Database: Fatal Injury (ABID:FI)

Given the ABS data coverage problems detected in the present study[39], ongoing access is required to the Coroners' files for the specific purpose of identifying boating fatalities that fit NMSC criteria and for assessing and coding these fatalities according to the NMSC data standards. The ongoing data collection should be framed as Phase 3 of the present study.

The benefits of an ongoing collection are considerable when compared to periodic study, for the following reasons:

1. The Coroners' files are more likely to go missing with the passage of time and off-site archiving.
2. The contacts within the Coroners' offices have already been established and if they lapse, considerable effort and expense will be required in the future to re-establish positive working relationships.
3. The expertise and infrastructure for data coding and analysis has already been established and can be applied to future data collection at little marginal cost.
4. The annual number of boating deaths is now relatively low (approx. 40 p.a.), and the files could be coded six-monthly or annually over a period of two weeks, at very low cost, in order to provide an ongoing annual statistical report and extended database on boating fatalities.
5. An ongoing collection has the capacity to detect new events and emerging trends quickly, leading to better prevention and control.
6. The capabilities of the database for relevant analysis would be improved through the increasing size of the case series, continual enhancement of the relevance of the data collected and its ready availability to provide information and intelligence relevant to the new and emerging issues of the day.

Gaining access to Coroners' files for 1999 and beyond would require an application to be made to the National Coroners Information System (NCIS). An application for continuation of the existing national database is more likely to receive a positive response than a one-off future study, because the benefits of the work have already been clearly shown and the arguments for continuation are compelling. However, the application should specifically request access to the individual Coroners files rather than to NCIS coded data. In addition, it will be less costly and enable NMSC to preserve greater autonomy and control over the data, to continue the present arrangements for data coding rather than to incorporate this

[39] It is likely that NCIS coded data also suffers from this (Driscoll et al., 2003). In addition, NCIS data is not coded to the NMSC data standard.

as a component of NCIS coding work[40]. The ABS does its own coding. In addition, in the road sector the Australian Transport Safety Bureau have an external consultant that undertakes the coding specifically for them. This is the type of arrangement that NMSC has at present and should maintain.

The Australian Boating Injury Database: Non-Fatal Injury (ABID:NFI)

The Phase 1 report showed that over the period 1993/94 to 1997/98 there were nearly 5,000 new cases of serious non-fatal injury due to boating, with an average of 2-3 new cases per week over the period and showing no hint of a decline over time. The average annual cost of these injuries can be estimated at more than $300 million, calculated on the basis of unit cost estimates for injuries provided by the NMSC (2003, Table A.1, p. 31). Over a recent five year period boating caused more serious injuries than rail accidents and air crashes combined and was second only to road transport as a cause of transport-related injury. However, the information routinely available on serious non-fatal boating injury is by comparison inadequate and it needs to be brought up to the level of that available in the other transport sectors.

The best available information on serious non-fatal boating injury comes from Australian hospitals. The advantages of data from this source over other sources are that:

1. It is readily available, but requires expert assessment as there are many technical issues that need to be understood in order for the data to be properly used
2. It is compiled according to national and international standards, enabling fair comparisons between jurisdictions and countries over time
3. It is coded by well-trained staff in the hospitals who have a national coding centre to refer to, ensuring consistent and reliable data
4. It is based on a reliable medical diagnosis of the nature and extent of the injury and its causes; a feature not available in marine authority incident reporting systems
5. It is collected separately from the marine authorities, providing the necessary separation of interests for propriety of use in evaluations. However, until recently a very significant impediment with the data source has been timeliness. This is readily illustrated in the hospital data used in the Phase 1 report. The 1997/98 hospital data was the most recent available at the time that the report was prepared in 2001. This was unacceptable.

Through a separate funded project from the current one, designed to improve the timeliness of hospital data on road injury, the Project Director also set out without any specific funding to work to improve the timeliness of information on serious non-fatal boating injury in Australia. The result of these efforts has been the creation of a national database of serious transport injury, a component of which is the Australian Boating Injury Database: Non-Fatal Injury (ABID:NFI). The ATSB is funding the component of the database focussing on serious non-fatal road injury: the National Road Injury Database (NRID), funded initially for five years in order to establish and maintain the national database, publish a bi-annual statistical report and to provide associated data analysis on

[40] The lack of progress of an NCIS (2000) feasibility study of data needs for water-related deaths demonstrated that it was not possible to satisfy the interests of all potential stakeholders through centralised NCIS coding. In contrast, the demonstrated success of the present study argues for a very specific purpose built assessment that fully satisfies the needs of an individual stakeholder: the marine authorities, including NMSC. This is demonstrably the most effective model.

request. The ABID:NFI also needs to be funded in order to ensure that a comparable level of information is available on boating as it is for road injury. As the national database of serious transport injury has already been created and includes ABID:NFI at no cost, the only funds required are those to initiate and maintain the production of the bi-annual statistical report based on ABID:NFI. The funds required are small.

With the ABID:NFI statistical report it will be possible to monitor trends in boating injury within 3 months of the end of each six-month period. The trends can be broken down by a large number of variables, including: demographics such as age, sex, country of birth, and indigenous status; insurance items such as the source of compensation for the boating injury; medical diagnosis of the nature and extent of injury; classification of the events leading to the boating related injury and the activity of the person at the time; classification of the place of occurrence of the boating event and including the location of hospital treating the person and the location of residence of the injured person.

A highlight of the database will be the capacity to monitor, for the first time, regional trends in injury as a measure of the impact of local safety initiatives on communities. In addition, with approval from the state health departments it could be used to link up with the marine authority incident reports in order to provide a more complete picture of the causes as well as the injury outcomes of boating incidents.

As the number of cases of serious non-fatal injury each year is about 25 times higher than the number of deaths, analysis of trends using this data will not suffer from the ‘small numbers problem’ inherent in boating fatality data which can lead to large fluctuations in the number of fatalities from year to year purely due to chance[41]. Data from the ABID:NFI will be inherently more reliable as a measure of change, albeit within a severity stratum that excludes death.

The opportunity to initiate bi-annual reporting of serious non-fatal boating injury is a significant one when assessed in terms of the promotion value that it provides for boating safety. Publication of statistics twice a year will enable the magnitude of the issues and the importance of the sector to be put in front of the public, leading to better acceptance of the need for new policies, better compliance and, ultimately, improved safety performance of the sector. Data enables the successes to be highlighted.

[41] The Poisson errors are large for case numbers under 100 and very large under 50.

Discussion

Boating fatalities and serious injuries cost the Australian community in excess of $370 million per year. Over a recent five-year period, boating caused more harm than rail accidents and air crashes combined and was second only to road transport as a cause of transport-related injury.

With an improved information base, boating is now able to benefit from the developments that have been possible in other areas of transport, such as in road transport and air safety, where the national fatality studies and the routine monitoring of other serious injury have been well established for some considerable time.

This report and the earlier Phase 1 report show what can be done with data sourced from the Coroners' files on boating deaths and hospital data on serious non-fatal injury. However, the value of the report could be quickly diminished with the passage of time if the work is not ongoing, as new causal factors and prevention initiatives come into play. The NMSC has recently introduced many new initiatives and they will need to be evaluated with the best possible data. In addition, further analysis of the existing ABID:FI and ABID:NFI data will be required in order to inform and target new initiatives and assess the regulatory impact of proposals. The information needs indicate that routine and ongoing surveillance is required.

The report has shown that ABS statistics on boating deaths cannot be used directly for NMSC surveillance purposes as some of the deaths included in their statistics do not fit within the scope the interests of the NMSC. In addition, much of the interest in boating deaths relates to the characteristics of the incident, and this cannot be effectively determined without the analysis of Coroners' data and the specialised coding undertaken in the present study. The need for routine and ongoing surveillance indicates that the present study should proceed to Phase 3: ongoing data collection based on Coroners' files, incorporated into, and reported from, the Australian Boating Injury Database: Fatal Injury (ABID:FI). In addition, recent developments in information on serious non-fatal boating injury have provided the opportunity to include non-fatal injury within the scope of reporting through the Australian Boating Injury Database: Non-Fatal Injury (ABID:NFI). Together, these information initiatives, which are readily achievable, will serve to enhance and underpin the vision of the NMSC to establish and sustain a harmonised national system to protect life in Australian waters.

This report presents new information, much of it unique even in world terms. For the first time, the benefit of PFDs has been shown statistically through a case-control study and the impact of a future increase in PFD use has been quantified in terms of lives saved. In addition, the hazards of excessive engine power and overloading have been quantified for the first time in a national study utilising the methods detailed in the Australian Standard AS 1799.1. Another key outcome of the study is the identification of risk factors. The features of different incidents and outcomes have been compared and contrasted in order to provide information on risk factors and some substantial risk factors have been identified, many providing direct support for elements of the new initiatives of the NMSC.

Over-powered vessels

Thirty one percent of dinghies, other open motorboats and half cabin motorboats were overpowered when considered against the Australian Standard (AS 1799.1) method for calculating the maximum engine power for existing vessels.

Vessel stability and buoyancy

The study found that there was a relationship between absolute vessel length in metres and stability/buoyancy, for dinghies, other open motorboats and half cabin motorboats, which together made up 57% of all vessels involved in fatal incidents. Inadequate stability or buoyancy was a contributing factor in 12% of the fatal incidents involving these vessels when they were less than 6 metres in length compared to only 6% when these vessels were 6 metres or more. Inadequate stability or buoyancy was an even stronger feature of these vessels when they were less than 4 metres in length.

Overloading of vessels

When considered against the method described in AS 1799.1, it was found that 24% of common vessel types (dinghies, other open motorboats, half cabin motorboats and cabin cruisers) were overloaded. Overloading was particularly a feature of dinghies.

Alcohol and drugs

Among the risk factors studied, alcohol and drugs was one of the most important. Other limited studies have pointed to the importance of alcohol and drugs in contributing to boating deaths (O'Connor, 2001; Waterways, 1999; MaST, 2000). However, until the present study there had been no truly national analysis of the problem. It was found that alcohol was involved in at least 35% of those killed and other drugs in 9%. The contribution of alcohol to boating deaths (28% in excess of 0.05 gm/100ml) was the similar to its contribution to road deaths (26% in excess of 0.05 gm/100ml: ATSB, 2001), demonstrating the need for strengthened legislation and enforcement in conjunction with high profile media and public education activities. In the road safety field, the on-road BAC is monitored by researchers as a continuing measure of exposure in the driving population in order to assess the relative risk of death and injury and to monitor the changing level of risk over time in response to safety initiatives[42]. This information was critical in determining the appropriate BAC cut-off point for national drink-driving legislation. The same sort of exposure testing should be implemented for boating. It is suspected that the risk-curve for alcohol in boating rises more sharply than it does for driving, indicating the possibility that a lower BAC limit should apply to boating than driving. A pilot study has been implemented to target boat ramps and should be further developed with the NMSC. Enforcement activities should target enclosed waters and inland waters as these are the types of location where alcohol involvement is greatest among fatalities. Targeting of dinghies is also warranted on the basis of the results reported herein.

Relatively few vessel operators were tested for alcohol and drugs, particularly in the case of jet-ski operators. This situation would not be tolerated in other areas of transport. This glaring anomaly suggests the need for strengthened legislation and enforcement. In the

[42] In South Australia, this involves voluntary compliance by drivers who stop at traffic lights. The level of compliance is very high and the data is highly reliable as a measure of BAC in the driving population. Police enforcement data, on the other hand, is not reliable as it reflects targeting and legal compliance issues.

case of road crashes, any injured person (including vehicle operators but also all others) attending hospital is required to be blood tested for alcohol. These results and Police breath test results are matched to the road crash incident report. A similar system should be implemented for boating.

Personal flotation devices

Personal flotation devices (PFDs) are an important safety measure and it needs to be considered how they might further improve the safety of boating. The present study showed that if PFD use increased to 50%, 2-3 lives could be saved nationally each year. If PFD use increased to 75%, 5 lives could be saved, with a cost saving to the Australian community of nearly $8 million per year[43]. The saving of 5 lives per year would reduce the annual boating death toll by 13% based on the current annual toll: a very substantial reduction. The benefit of such an increase would be most substantially to the recreational boater as they comprise the vast majority of those killed. The need to consider regulatory changes was highlighted by the US Department of Transport (DOT, 1999), based on evidence that despite national campaigns to encourage the wearing of life jackets “nonregulatory methods of modifying behaviour have not been successful enough.”

Work-related boating fatalities

The assessment of work-related boating fatalities indicated that there has been a substantial drop in the death rate of fishermen, representing an enormous achievement for an industry reported by the National Occupational Health and Safety Commission as having one of the worst safety records. The results indicated that fishermen have a higher level of risk and/or risk taking/acceptance with respect to environmental conditions. Presumably, in order to make a living they must often be prepared to work in less than ideal conditions. Alcohol and drugs was a factor in the deaths of fishermen and this exposure factor warrants more active surveillance. PFD use was not significantly lower among fishermen than other boating fatalities. However, nearly a third of the vessels involved did not have sufficient PFDs for all occupants, suggesting that the safety equipment on board commercial vessels needs to be more closely monitored. The wearing of PFDs should be further promoted, having due regard to the practicalities of the hard physical labour often required of fishermen. The potential for entrapment in the vessel when wearing a PFD has not been studied and may need to be considered as a possible competing risk. Different considerations may apply to recreational boaters and commercial fishermen. Unsafe work practices and conditions were implicated in a number of the deaths of merchant seaman.

When all work-related deaths were assessed, fatigue was not reported by the Coroners to be a factor in any of the deaths. This was perplexing as there are anecdotal reports that excessive working hours and poor roster arrangements were widespread throughout the industry. As the Coroners would have an interest in the contribution of fatigue to fatal incidents and the files of their investigations reveal that information in relation to working hours and rest periods was often sought, but negated as a cause, the fatigue factor remains elusive. It is probably the case that the assessment has not been formal enough and that further in-depth study is required. A study is being planned to make use of the latest in fatigue measurement technology and expertise in the field.

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[43] Based on NMSC (2003, Table A.1, p. 31) information on average cost per fatality.

Co-morbidities

Nearly a quarter of those killed in boating incidents had co-morbidities that may have contributed to death. The boating public, particularly the elderly, should be better informed of the implications of their existing health conditions in reducing their chances of survival in the water, particularly if struggling to stay afloat without a PFD fitted. In road transport, specified health conditions prevent re-licensing. While the public impact of impaired boating may not be as extensive as impaired driving, there may be an educational role for licensing authorities.

Jet-skis

The poor safety record of personal watercraft has been the focus of considerable recent attention in the international literature (MSA, 2000; NTSB, 1998; Shatz et al, 1998; Barach and Baum, 1998; Branche et al, 1997; Jones 2000; Garri et al, 1999). The present study has shown that human factors were overwhelmingly responsible for the deaths of jet-ski operators in Australia. Collisions and excessive speed were common and despite mandated PFD usage, more than half of those killed on jet-skis were not wearing one. The results highlight the need for continuing surveillance of this relatively new and potentially lethal threat.

Analysis of other risk factors

As a vessel type, dinghies are over-represented with respect to overloading, capsize, alcohol involvement, and failure to wear a PFD. Increased attention to this vessel type and the associated risk factors is clearly warranted. If a range of measures focussing on these known risk factors achieved a halving of the level of involvement of dinghies, the overall number of fatal incidents would reduce by 5-6 per annum which is about 14% of all fatal incidents. The number of fatalities saved would be even higher as dinghies have a higher relative occupancy. There could be a strong argument on the basis of the results of this study for special measures to be directed at dinghies. For example, PFD use could be compulsory for this vessel type and enforcement efforts could more heavily target overloading and alcohol use. In other areas of transport, the necessity of insurance for injury risk, action by insurers to prove liability and the award of damages has been a strong force in changing safety culture. Perhaps the time has come to consider a targeted or universal third party insurance scheme.

Capsize was the most common initial event in fatal incidents. Among the potentiating factors considered, overloading/improper loading, environmental conditions and specific risk of dinghies, were shown to be important. The involvement of capsize did not appear to have a strong relationship to any of the other factors considered, such as alcohol.

In contrast to capsize, the analysis did not indicate what factors were involved in incidents where the initial event was a person falling overboard, and this needs to be studied further. Further data items targeting potential factors, improper movement within the vessel, need to be added to ABID:FI in the future.

Recommendations

There are a number of recommendations that should be considered in order to improve the monitoring and surveillance of boating deaths and injury in Australia. These are:

6. The national collection, analysis and reporting of data on fatal and non-fatal boating injury should be ongoing. The foundation for this is provided by the Australian Boating Injury Database: Fatal Injury (ABID:FI) and Australian Boating Injury Database: Non-Fatal Injury (ABID:NFI) developed by the Author. The ABID:NFI has been developed as a component of the National Transport Injury Database for ATSB based on hospitalisations.

7. Alcohol usage among the boating public should be assessed in the circumstances in which it can provide a valid indicator of exposure, but also considering practicalities eg. at boat ramps when the vessel is still on the water. This information is essential for determining relative-risk.

8. Consideration should be given to modifying the NMSC data standards in order to capture new information relevant to current and emerging risk factors.

9. Consideration should be given to the surveying of vessels involved in fatal incidents with a view to including this data in the ABID:FI so that reliable information on such factors as maximum power and occupancy can be considered relative to actual levels and more detailed information on other vessel factors can be analysed and reported.

10. The level of breath and blood testing for alcohol of vessel operators and other injured survivors in fatal incidents should be substantially increased. The results should then be incorporated into the ABID:FI for each incident.

This report makes no specific policy recommendations. As it is not possible to anticipate all information needs, the results presented are only a sample of those that could be made available from the database created. Requests for further analysis of the available data should be forwarded to the CEO, National Marine Safety Committee Inc, PO Box 1773, Rozelle NSW 2039.

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