MARITIME INJURY STATISTICS

VICTORIA 2005/06 TO 2014/15

Report prepared by the Victorian Injury Surveillance Unit (VISU, Accident Research Centre) for Transport Safety Victoria (TSV)

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Summary of Key Findings

Maritime transport related injury hospital admissions

- There were 1094 admissions to Victorian hospitals as a result of maritime-related injuries in the ten-year period from 2005/6 to 2014/15: an average of 109 admissions per year
- Almost three-quarters (72.1%, n=789) of maritime transport related injury admissions were male
- Those aged 15-29 years were most commonly represented among those injured in maritime transport related incidents and admitted to hospital (29.1%, n=318)
- Almost two-thirds (64%, n=700) of maritime injury admissions were by residents of the Melbourne metropolitan region
- Maritime-related injury rates increased by an average 5.3% per year over the study period

Maritime transport injury cause and injury type

- Incidents aboard watercraft, that did not cause damage to the watercraft and did not result in drowning or submersion, were responsible for the greatest proportion of maritime related injury admissions (36.7%, n=402)
- 'Other powered watercraft' (e.g., jet skis) (30.5%, n=334) were the most commonly observed vessel designation involved in maritime-related injuries resulting in admission to hospital
- Almost half (47.9%, n=524) of all maritime-related injury admissions involved bone fractures
- The lower extremities was the most commonly injured body region (31.7%, n=347), and the most commonly injured specific body site was the knee/lower leg (21.6%, n=197)

Maritime transport injury burden: admission bed days, discharge destination and cost

- Maritime transport injury related hospital bed days per population increased by an average of 5.5% per year over the study period
- Almost half (49.9%, n=546) of maritime-related injury admissions resulted in hospital stays of fewer than two days
- In 86.7% of cases (n=949) the patient was discharged to a private residence/accommodation
- Over the two-year period 2011/12-2012/13 the direct cost of maritime-related injury admissions was $2.54 million

Maritime transport injury narrative information, from ED presentations that resulted in admission

- Vessels (defined as any type of boat or ship, based on descriptors) were involved in 47% (n=393) of ED presentations subsequently admitted
- Over three-quarters (76.1%, n=636) of maritime-related ED presentations did not involve a collision or were unspecified as to their status
- Rivers were the location/body of water most commonly mentioned in descriptions of ED presentations (6.9%, n=58) but in almost 90% of cases, the body of water was not recorded

Maritime transport injury deaths

- Over the six-year period from 2007 to 2012, 29 deaths were recorded as a result of maritime-related accidents; cases coded as due to intentional self-harm by drowning and submersion were not included in this.
- More than half of these deaths (n=16, 55.2%) occurred in accidents involving vessels designated as 'other powered watercraft'

Maritime Incident Database (MID) compared with VISU maritime transport injury data

- There were 691 cases (affected persons) in the MID for the period 2008/09 to 2015/16, ranging from no injury to fatality
- In 2008/09 to 2015/16, MID recorded fatalities increased by 0.9 cases per year and serious injuries increased by 0.8 cases per year. Incidents overall increased by 2.4 per year
- Maritime transport fatalities were comparable in the two sources, with 21 cases (MID) vs. 19 cases (VISU held Cause of Death data) in 2009 to 2012
- In 2008/09 to 2014/15, the annual number of ED presentations for maritime transport injury (n=587) **was approximately 10-fold** the annual number of MID recorded injury cases (n=55)
- In the MID, 28% of cases were attributable to jet ski/PWC, water ski or wake boarding incidents; in the ED presentations, these were mentioned in 44% of cases
- Reporting requirement for TSV (death or injury to a person **on board a vessel**) could explain some of the difference in number of injury cases captured in the MID vs. VEMD: injuries incurred while knee boarding, wake boarding and water skiing do not involve a person on board.

Introduction

Water transport, whilst much less common and less frequently used by the majority of the population, is subject to no less strict regulations regarding ownership and safe use compared with other modes of transport. However, with regard to knowledge of water vessel use and understanding of factors involved in maritime accidents and injuries, less resources are invested. For example, whilst the Australian Bureau of Statistics (ABS) conducts a regular motor vehicle census in order to maintain knowledge of the number and types of motor vehicles registered for use on roads, no equivalent government census is regularly conducted for maritime vessels*. Little published research has been conducted in this area with almost all available local information coming through Transport Safety Victoria or the Victorian Water Police. However, more work needs to be done investigating maritime accidents and injuries. Over the 2008/09 summer period, the Water Police performed a crackdown on boat and jet ski users in Victoria, issuing 1,286 fines for violations of safety equipment regulations, speed offences, and licensing offences, and responded to 441 incidents across the state (Victoria Police, 2009). Maritime related accidents and injuries continue to be an issue. On February 4 2017, The Age reported on a number of jet ski related incidents including collisions, some of which result in fatalities to the rider or another water user. This has led to calls for stricter licensing requirements, not just for operators of personal watercraft such as jet skis but for all watercraft.

Recent numbers provided by Transport Safety Victoria (2016) show that for the financial year 2015/16 almost 400,000 current marine licenses were held and 190,428 vessels were registered for use in Victorian waterways. However, this does not take into account commercial vessels or human powered vessels such as kayaks or canoes, the latter of which are estimated to be anywhere between 350,000 and 400,000 in number in Victoria in 2016. This is just a small indication of the complexities faced by investigators of maritime related accidents and injuries. To attempt to provide further insight into maritime-related injuries, the report that follows utilises the Victorian Admitted Episodes Dataset (VAED) and Victorian Emergency Minimum Dataset (VEMD) to investigate maritime-related injury admissions over the period 2005/6-2014/15. Cause of Death Unit Record Files (COD URF) were also analysed to provide insight into deaths resulting from maritime-related injury over the period 2007-2012. This report aims to:

- investigate the nature, cause, and mechanism of maritime transport related injuries and deaths
- determine demographic risk factors relating to maritime transport-related injuries
- determine the burden of maritime-related injuries in terms of hospital bed days and direct hospital costs
- compare data from VEMD cases to those held in the Maritime Incident Database (MID)
- integrate the findings and propose a number of recommendations to reduce the impact of maritime transport-related injuries in Victoria

**A boat census was conducted by Roy Morgan on behalf of The Boating Industry Association of Victoria in 2014*

Maritime transport injury hospital admissions, 2005/6 to 2014/15

Over the period 2005/6 to 2014/15 there were a total of 1094 admissions to Victorian hospitals as a result of maritime transport-related injuries. Males were more commonly represented, comprising 72.1% (n=789) of observed cases (Table 1). A geographic breakdown of admissions revealed that almost two-thirds (64%, n=700) of admissions for maritime-related injuries were residents of the Melbourne Metropolitan Area and a further 28.5% (n=312) were residents of regional and rural Victoria. Younger persons were most frequently observed in the admissions data; 17-29 year olds accounted for 25.9% (n=283) of admissions. However, 30-44 year olds (24.7%, n=270) and 45-59 year olds (23.9%, n=262) also accounted for sizeable proportions of maritime-related injury admissions.

Table 1. Demographic data for 2005/6-2014/15

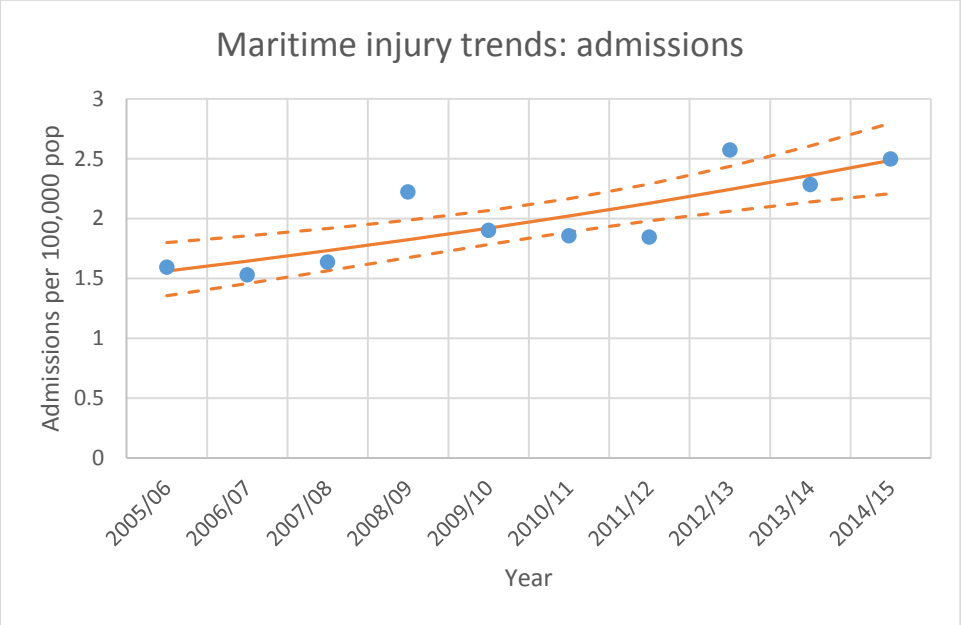
Characteristics	N	%
Sex		
Male	789	72.1
Female	305	27.9
Geographic Region		
Melbourne Metropolitan Area	700	64.0
Regional/Rural Victoria	312	28.5
Interstate	78	7.1
Overseas	*	*
Unknown	*	*
Age		
0-16 years	113	10.3
17-29 years	283	25.9
30-44 years	270	24.7
45-59 years	262	23.9
60-74 years	124	11.3
75+ years	42	3.8

Admissions per year for the ten-year period revealed that maritime-related hospital admissions peaked in 2014/15 with 147 cases (13.4%) and were at their lowest in 2006/7 with 78 cases (7.1%) (Table 2). The raw numbers suggest an increase in maritime-related injury admissions over the ten-year period. However, to accurately assess if an increase in injury rates occurred, a trend analysis was conducted using these data and population data for Victoria at a given time point in each year over the study period. The trend analysis revealed that maritime-related injury admissions per 100,000 population increased by 5.3% each year; a statistically significant trend ($p<0.0001$) (Figure 1). This analysis did not account for trends in maritime transport use (i.e., exposure).

Table 2. Number of injury admissions per financial year, 2005/06-2014/15

Financial Year	N	%
2005/06	80	7.3
2006/07	78	7.1
2007/08	85	7.8
2008/09	118	10.8
2009/10	103	9.4
2010/11	102	9.3
2011/12	103	9.4
2012/13	146	13.3
2013/14	132	12.1
2014/15	147	13.4

Figure 1. Trends for admissions for maritime-related injuries (per 100,000 population), 2005/06-2014/15



An analysis of the cause of injury revealed that accidents occurring *aboard a watercraft*, not causing drowning or submersion, were the most common scenario leading to admission (36.7%, n=402) followed by accidents to watercraft, not causing drowning or submersion (13.8%, n=151) (Table 3). However, a large proportion of incidents (34.6%, n=378) were classified as 'other or unspecified'.

Table 3. Cause of injury, 2005/06-2014/15

Cause	N	%
Accident on board watercraft without accident to watercraft, not causing drowning and submersion	402	36.7
Other and unspecified water transport accidents	378	34.6
Accident to watercraft causing other injury	151	13.8
Water-transport-related drowning and submersion without accident to watercraft	130	11.9
Accident to watercraft causing drowning and submersion	33	3.0

Vessels classified as 'other powered watercraft' (e.g. jet skis) were those most commonly involved in maritime-related injuries (30.5%, n=334) followed by 'other unpowered watercraft' (15.8%, n=173) (Table 4). A large proportion of vessels were unspecified (23.6%, n=258); this category includes cases where the vessel type was recorded broadly (e.g. boat, ship etc.).

Table 4. Vessel involved in accident, 2005/06-2014/15

Vessel Type	N	%
Other powered watercraft (i.e., jet ski)	334	30.5
Unspecified watercraft, boat, ship, watercraft NOS	258	23.6
Other unpowered watercraft, i.e. windsurfing	173	15.8
Water skis	88	8.0
Fishing Boat	72	6.6
Sailboat	60	5.5
Passenger Ship	49	4.5
Inflatable craft, non-powered	34	3.1
Merchant Ship	13	1.2
Canoe or kayak	13	1.2

With regard to the nature of the injury, almost half (47.9%, n=524) of all maritime-related injury admissions involved fractures (Table 5). The next most commonly observed injury was open wounds (8.7%, n=95) although 10.2% of injuries were classified as 'other or unspecified'. The body region most commonly injured was the lower extremities (31.7%, n=347) but each of the other three major regions were also prominently represented, indicating a diversity with regard to maritime injuries. Injuries to the knee and lower leg were most common among specific body sites (19.7%, n=216) followed by head injuries (13.6%, n=149).

Table 5. Nature and location of injury, 2015/06-2014/15

	N	%
Nature of Injury		
Fracture	524	47.9
Other & unspecified injury	112	10.2
Open wound	95	8.7
Dislocation, sprain & strain	67	6.1
Intracranial injury	59	5.4
Injury to muscle & tendon	47	4.3
Injury to internal organs	44	4.0
Other effects of external cause/complications/late effects	38	3.5
Superficial injury	37	3.4
Burns	24	2.2
Traumatic amputation	17	1.6
Injury to nerves & spinal cord	16	1.5
Injury to blood vessels	*	*
Eye injury - excluding foreign body	*	*
Crushing injury	*	*
Body Region		
Lower extremity	347	31.7
Trunk	254	23.2
Head/face/neck	228	20.8
Upper extremity	221	20.2
Body region not relevant	38	3.5
Unspecified body region	6	0.5
Body Location		
Knee & lower leg	216	19.7
Head	149	13.6
Abdomen, lower back, lumbar spine & pelvis	141	12.9
Thorax	111	10.1
Elbow & forearm	78	7.1
Neck	77	7.0
Wrist & hand	70	6.4
Shoulder & upper arm	67	6.1
Hip & thigh	67	6.1
Ankle & foot	50	4.6
Body region not relevant	38	3.5
Burn - lower limb	14	1.3
Unspecified body region	*	*
Burn - upper limb	*	*
Burn - head & neck	*	*
Burn - trunk	*	*
Burn - respiratory tract	*	*

Maritime transport related injuries resulted in a total of 4,620 utilised bed days over the ten-year period at an average of 3.73 days per admission. Over the ten-year period, bed days utilised as a

result of maritime-related injury experienced a peak of 797 in 2012/13 and a trough of 291 in 2006/07 (Table 6). Overall, almost half (49.9%, n=546) of maritime-related injury admissions were due to injuries requiring fewer than two bed days, and another 38.6% (n=422) of injuries required an admission period of between two and seven days (Table 7). A trend analysis was conducted to determine how bed day usage had changed over the ten-year period, using the data below and Victorian population data for a specific time point for each year. The trend analysis showed that hospital days per 100,000 population increased by 5.5% per year, a marginally statistically significant result (p=0.03) (Figure 2). This analysis did not account for trends in maritime transport use (i.e., exposure).

Table 6. Number of hospital bed days per financial year, 2005/06-2014/15

Financial Year	N	%
2005/06	325	7.03
2006/07	291	6.30
2007/08	392	8.48
2008/09	466	10.09
2009/10	411	8.90
2010/11	397	8.59
2011/12	541	11.71
2012/13	797	17.25
2013/14	439	9.50
2014/15	561	12.14

Figure 2. Trends for hospital bed days per admission (per 100,000 population), 2005/06-2014/15

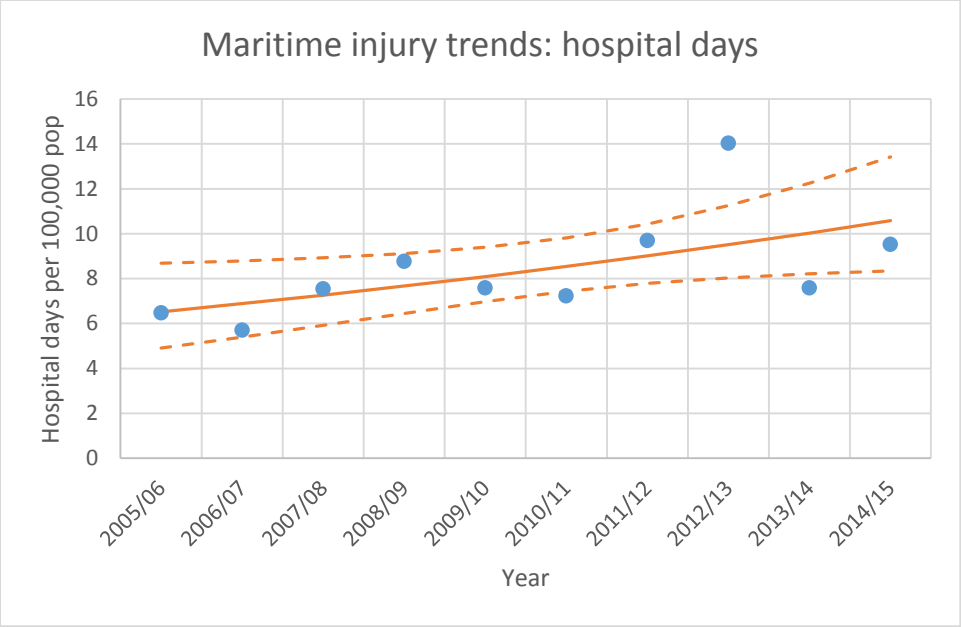


Table 7. Hospital bed days (grouped), 2005/06-2014/15

Grouped Bed Days	N	%
< 2 days	546	49.9
2-7 days	422	38.6
8-30 days	115	10.5
31+ days	11	1.0

Inspection of separation type revealed that in 86.7% of cases (n=949) the patient was discharged to a private residence/accommodation, followed by separations and transfers to acute hospital/extended care (11.2%, n=122); seven cases (<1%) died in hospital in the ten year period (Table 8). Cost calculations revealed that hospital admission costs of maritime transport-related injury admissions over the two years 2011/12-2012/13 was $2.54 million.

Table 8. Type of separation from hospital, 2005/06-2014/15

Separation Destination	N	%
Separation to private residence/accommodation	949	86.7
Separation and transfer to acute hospital/extended care	122	11.2
Left against medical advice	8	0.7
Death	7	0.6
Statistical Separation	*	*
Separation and transfer to Transition Care bed based program	*	*

Emergency Department Presentations Subsequently Admitted, 2005/06-2014/15

To provide further insight into the nature and circumstances of maritime-related injuries, the VEMD text narrative was inspected using commonly occurring descriptors. The VAED (hospital admissions) could not be used as these do not contain narrative text. Only ED cases that were subsequently admitted were included in this analysis, for better matching with the admissions data on which the rest of the report is based. An iterative approach was used to gradually improve the accuracy of the analysis as much as possible. However, the analysis conducted is subject to the accuracy and completeness of the narrative data. Therefore, it is not always possible to extract information for all parameters.

Table 9. Circumstances of accident resulting in ED presentation, 2005/06-2014/15

Transport Type	N	%
Vessel	393	47.0
Other	176	21.1
Water ski	110	13.2
Jet ski	102	12.2
Wakeboard	55	6.6
Collision Status		
Non-collision or unspecified	636	76.1
Collision	200	23.9
Body of Water		
Unspecified	748	89.5
River or channel	58	6.9
Ocean	20	2.4
Lake or dam	10	1.2

A total of 836 ED presentations subsequently admitted for maritime related injuries were observed in the ten-year period. Most frequently, patients presented for injuries involving a vessel described broadly as a boat, ship, or yacht (47%, n=393) (Table 9). Descriptors of the vessel involved were often not more precise than this when it came to these types of vessel. Injuries involving water-skiing (13.2%, n=110) and jet skiing (12.2%, n=102) were not uncommon.

In over three-quarters of cases (76.1%, n=636) there was no collision involved or the nature of the accident was not specified, leaving 200 (23.9%) cases in which a collision preceded, or directly caused, the injury.

Lastly the body of water in which injury occurred was analysed. The results for this analysis are tenuous, given the relative lack of information regarding the type of body of water in which the injury occurred; 10.5% (n=88) of descriptions contained this information. Of those cases, 58 (6.9% of the total) occurred in a river or channel (Table 9).

Maritime injury deaths, 2007-2012

Over the six-year period, 29 deaths were recorded as a result of maritime-related accidents. Intentional self-harm (ICD-10-AM code X71: Intentional self-harm by drowning and submersion) was not included in the data selection, because these codes do not specify maritime transport. Because intentional self-harm codes were not included, these 29 deaths are unlikely to include suicide deaths.

Due to privacy concerns surrounding low cell counts, VISU is unable to provide detail regarding many aspects of the accidents and resulting injuries which led to these fatalities. Therefore, a brief summary of the information which can be provided is found below:

- 16 (55.2%) deaths occurred in accidents involving vessels designated as 'other powered watercraft' (i.e., jet skis, hovercraft)
- 19 (65.5%) involved an accident to a watercraft
- 11 (37.9%) of the deceased were aged 30-44 years

All other information including sex, age, residence, year, and the specifics of the accident and injuries sustained resulting in death cannot be provided by VISU.

Maritime Incident Data compared with VISU Emergency Department records and death data

This section of the report provides an overview of the Maritime Incident Data (MID) provided by TSV, and a comparison with maritime injury deaths and Emergency Department presentations in VISU-held data sources.

The case selection and methods used to describe the Maritime Incident Database in this report are designed specifically for comparison of the MID with the VISU-held ED presentations relating to maritime incidents. Namely, the data are presented in terms of *injured persons*; not incidents. **As a results, the MID data summaries might not align with other outputs and overviews of Transport Safety Victoria's Maritime Incident Database published elsewhere.**

For this section, ED presentations and not hospital admissions data are used, as injury case definition in the TSV data relates to ambulance call-out, which is likely to match better with ED presentation than with admission. Therefore, the Emergency Department cases relating to maritime injury presented in this section of the report are not limited to cases subsequently admitted: for the purposes of the data comparison, both admitted and non-admitted presentations are considered. 'Maritime' in this case refers to waterways in Victoria, not limited to coastal waters. The data selection for the VISU held data sources is provided elsewhere in the report [see Appendix A].

Maritime Incident Database summary

An overall summary of incidents recorded in the Maritime Incident Database is given in Table 10. Between 2008/09 and 2015/16, there were an average of:

- 6.4 incidents per year involving a fatality
- 21.1 incidents per year involving a serious injury
- 2.1 incidents per year of a vessel lost
- 4.0 incidents per year of damage to property incidents
- 5.6 other vessel damage incidents per year
- 12.8 reported incidents without any damage, per year

recorded in the Maritime Incident Data. Most of the incidents took place in waterways that were classified as 'Enclosed' (53%), followed by 'Inland' (26%), 'Coastal Inshore' (14%), 'Coastal Offshore (5%), and 'Unnavigable' (3%). The total number of recorded incidents increased during this time period by approximately 2.4 incidents per year (R^2=0.46) (Figure 3).

Table 10. Maritime incident database: incident summary, 2008/09 to 2015/16

	Incidents, by incident status*			
	Fatal incident	Serious injury	Vessel lost	Total
Year				
2008/09	4	17	21	42
2009/10	3	19	18	40
2010/11	7	21	26	54
2011/12	5	25	30	60
2012/13	4	24	16	44
2013/14	11	17	33	61
2014/15	9	26	23	58
2015/16	8	20	29	57
Total	51	169	196	416

*Every incident is counted only once, regardless of the number of persons involved. Severity of the incident is based on the most serious.

Table 11. Marine incident database: summary of persons affected, 2008/09 to 2015/16

	Persons affected, by incident severity*				
Year	Fatality	Serious injury	Minor injury	No injury	Total
2008/09	4	21	27	10	62
2009/10	4	19	24	15	62
2010/11	7	25	31	17	80
2011/12	6	27	56	25	114
2012/13	5	26	27	25	83
2013/14	11	22	49	13	95
2014/15	11	28	29	29	97
2015/16	8	25	41	24	98
Total	56	193	284	158	691

*Every person is counted once, even if multiple persons were involved in the same incident

A summary of affected persons recorded in the Maritime Incident Database is given in Table 11. The number of fatalities increased by 0.9 cases per year (R^2=0.58) and the number of serious injuries increased by 0.8 cases per year (R^2=0.34) (Figure 4, Figure 5). These increases could be due to an underlying increased accident and injury risk associated with maritime activity and transport. However, this increase could also be attributable to improved incident reporting and recording in the Maritime Incident Database. Furthermore, to fully understand the trends in risk associated with maritime transport, exposure must be taken into account. Exposure could be captured as the number of registered vessels, the number of persons engaging in maritime transport and activity, and the hours spent. Data on exposure over time will clarify if the observed increasing injury and incident trend is (partly) attributable to increased participation in maritime transport and activity.

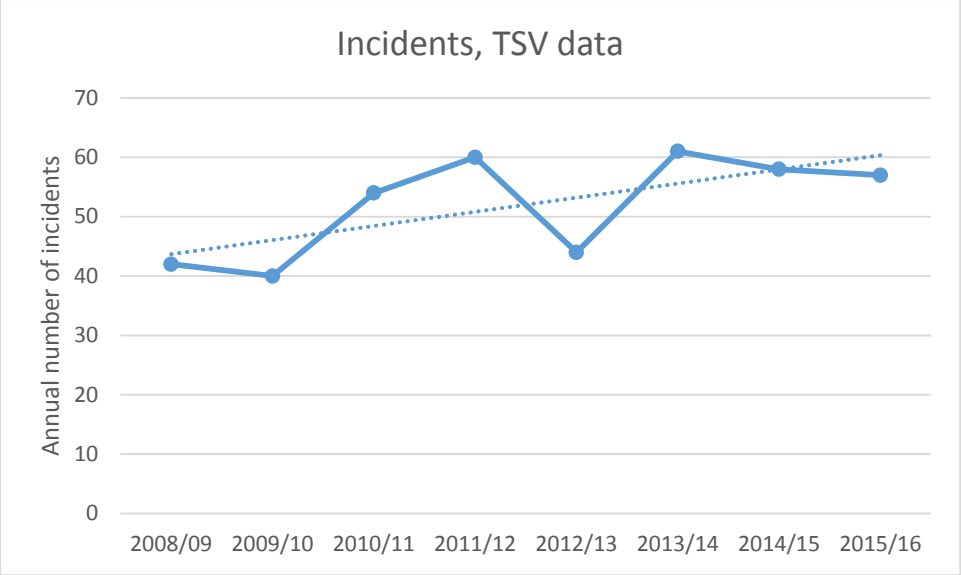


Figure 3 Marine incident database: the number of reported incidents per year in Victoria, 2008/09 to 2015/16

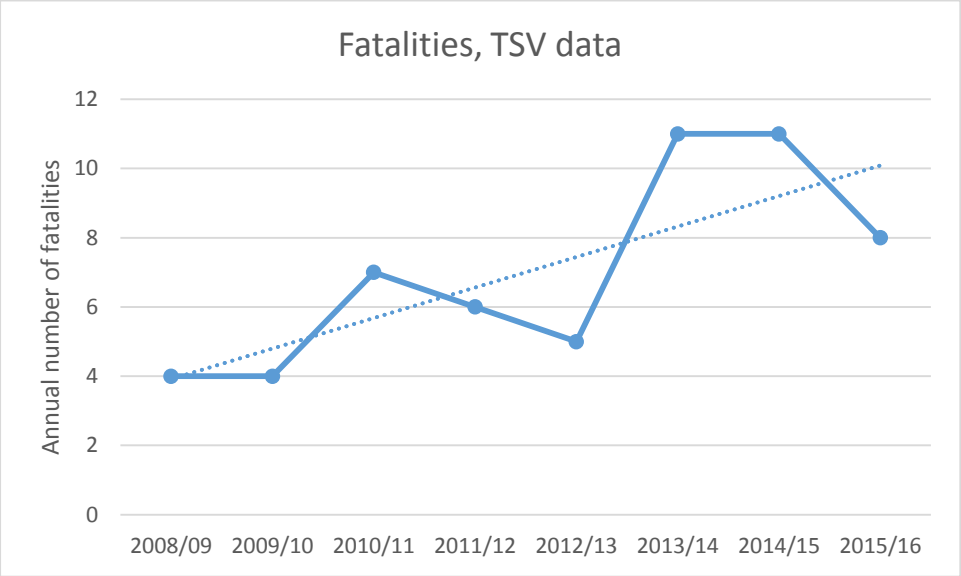


Figure 4 Marine incident database: the number of reported fatalities per year in Victoria, 2008/09 to 2015/16

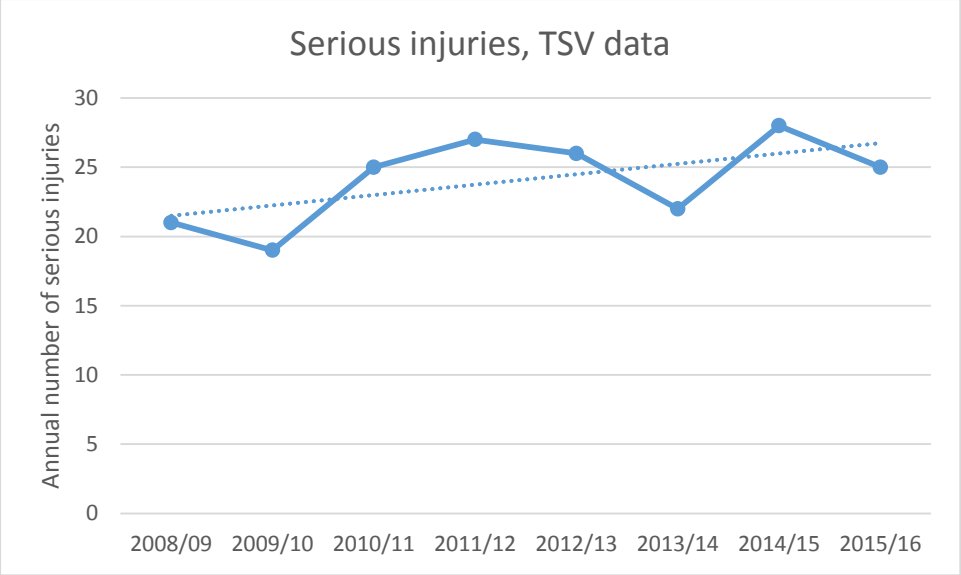


Figure 5 Marine incident database: the number of reported serious injuries per year in Victoria, 2008/09 to 2015/16

Comparison of maritime injury fatalities in the Maritime Incident Database vs. VISU-held death data

Summarised maritime fatalities recorded in the TSV-provided Maritime Incident Data files are compared with those recorded in the Cause of Death (COD) data (VISU, sourced from the Australian Co-ordinating Registry) (Table 12). Only four years were included: 2009-2012, as VISU-held death data were only available up to 2012 and Maritime Incident Data were only available from 2008/9 onwards. Selecting maritime deaths (please see Appendix A for ICD-10 codes) registered in Victoria in 2009-2012 (reference year), there were 19 fatalities recorded in the COD data. This is slightly lower than the Maritime Incident Data which contained 21 fatalities, selected using the 'injury_status' variable.

Table 12. Maritime fatalities: summary of maritime incident database records compared with COD data (VISU), 2009 to 2012 (4 years)

	Maritime Fatalities	
	Maritime Incident Data N=21	Cause of Death data from the ACR N=19
Year*		
2009-2010	10	8
2011-2012	11	11
Age group		
<49 years†	8	11
≥50 years	11	8
Unknown	2	0
Sex		
Male	≥14	≥14
Female	≤5	≤5

**Reference year* is used as reported in the Cause of Death data. ARC=Australian co-ordinating registry. †In the Maritime Incident Database, age=0 is considered to be age= missing.

Two factors could contribute to this slight discrepancy. First, MID incident descriptions revealed that one of the deaths recorded in the MID was a recreational swimmer; therefore only twenty fatalities from the MID could be expected in the cases selected in the COD data based on maritime transport (a swimmer struck by a vessel is not captured). Second, the MID incident descriptions revealed that in the case of three of the recorded fatalities, the body was not found. These cases, which were presumed deceased, would only have been recorded in the COD data if they were reported to the coroner: whether this was the case or not was not explicitly mentioned in the MID incident description.

The age distributions of the deceased do not match well between the two databases. This could either be due to poor matching of cases, i.e. cases recorded in the maritime incident database were not the same as the cases extracted from the COD data, or due to incorrect recording of ages in the Maritime Incident Data.

Comparison of maritime injuries in the Maritime Incident Database vs. VISU-held Emergency Department presentation data

Summarised maritime injuries (serious injury or minor injury) recorded in the TSV-provided Maritime Incident Data are compared with those recorded in the Emergency Department data (VEMD) held by VISU (Table 13). The ED cases were selected as described elsewhere in the report [see Appendix A]. Only seven years were included, 2008/09 to 2014/15, as VISU-held VEMD data for 2015/16 were not available at the time of this report. Summaries of the datasets are shown in **Error! Not a valid bookmark self-reference.**. There were 387 injury cases recorded in the MID during the 7-year period, compared with 4108 Emergency Department (ED) presentations; 609 of those cases were subsequently admitted. The number of ED presentations that resulted in admission increased by 6 cases per year during the 7-year period (R^2=0.81); the annual number of non-admitted ED presentations remained approximately the same.

Table 13 Summary of the Maritime Incident Database compared with Emergency Department presentations data (VISU) 2008/09 to 2014/15 (7 years)

	Maritime Incident Database Injuries	Emergency Department Presentations, not admitted	Emergency Department Presentations, admitted
Year			
2008/09	43 (11%)	485 (14%)	74 (12%)
2009/10	42 (11%)	523 (15%)	73 (12%)
2010/11	53 (14%)	403 (11%)	70 (11%)
2011/12	81 (21%)	531 (15%)	93 (15%)
2012/13	52 (13%)	520 (15%)	93 (15%)
2013/14	64 (17%)	520 (15%)	105 (17%)
2014/15	52 (13%)	516 (15%)	101 (17%)
Age group			
0-24 years	92 (24%)	1403 (40%)	215 (35%)
25-44 years	101 (26%)	1313 (38%)	234 (38%)
45-64 years	102 (26%)	646 (18%)	126 (21%)
≥65 years	35 (9%)	136 (4%)	34 (6%)
missing	57 (15%)	0 (0%)	0 (0%)
Sex			
Male	292 (75%)	2569 (73%)	452 (74%)
Female	68 (18%)	929 (27%)	157 (26%)
missing	27 (7%)	0 (0%)	0 (0%)

The annual number of ED presentations for maritime injury **was approximately 10-fold** the annual number of MID recorded injury cases. The discrepancy between the number of MID recorded injury cases and the number of ED presentations related to maritime injury could be due to several factors. First, the case selection used to identify VEMD cases is imperfect. However, closer analysis of included cases show a remarkable number of water ski, jet ski and wake or knee boarding cases in the ED presentations data. These cases were flagged using a word search in the narrative; a similar method was applied to flag these cases in the MID data: the results are presented in Table 14. In the

MID, 28% of cases were attributable to jet ski/PWC, water ski or wake boarding incidents; in the Emergency Department presentations, these were mentioned in 44% of cases. Reportable maritime incidents include death or injury to a person on board a vessel; loss of vessel; collision; grounding; sinking; fire etc. Injuries sustained while wake boarding, knee boarding, and water skiing are therefore not routinely reported to TSV. In the MID injury cases, the incident description frequently mentioned causes such as capsizing (18%), collision (19%), on-board incidents (18%), person overboard (10%) and even explosion (7%). Involvement of the water police was frequently mentioned. A personal injury sustained while water skiing or wake boarding might not be perceived as requiring TSV involvement or notification, unless ambulance, police or fire brigade services were required, or collision with another vessel took place.

Table 14. Cause of the incident: jet ski, water ski and wake boarding. Comparison of the Maritime Incident Database with Emergency Department presentations (VISU) 2008/09 to 2014/15 (7 years)

	Maritime Incident Database Injuries	Emergency Department Presentations, not admitted	Emergency Department Presentations, admitted
Cause*			
Jet ski/Personal water craft	67 (17%)	248 (7%)	74 (12%)
Water ski (or ski boat)	39 (10%)	796 (22%)	143 (23%)
Knee board	0 (0%)	161 (5%)	6 (1%)
Wake board	2 (0.5%)	343 (10%)	33 (5%)
Other	279 (72%)	1950 (56%)	353 (58%)

*The ED presentation narrative and the Maritime Incident Database incident descriptions were searched for terms related to jet ski/PWC, knee/wake boarding or water ski. In the Maritime Incident Database, cases coded as Personalised Water Craft were included with Jet ski and cases coded as Ski Boat were included with water ski.

This could also explain the difference in demographics summarised in Table 13: although males predominated in all datasets, younger persons were overrepresented in the ED data, with 35-40% of cases aged under 25 years: in the MID records, only 24% were under 25 years. Similarly, persons aged 45 years or over constituted 35% of injured persons in the MID database and only 22-26% of cases presenting to the ED. This could be related to the demographics associated with water sports such as water skiing and wake boarding vs. the demographic associated with operating or travelling on other types of vessels such as cabin cruisers and fishing boats.

Discussion and Recommendations

Overall, the data suggests that being male, aged 15-29, and a resident of metropolitan Melbourne are the demographic risk factors for maritime-related injury. Males outnumbered females 4:1 and this findings is consistent with figures previously reported by TSV (2016). Injuries were more common in the 17-29 year age group but those aged 30-44 and 45-59 years still accounted for a comparable proportion of maritime-related injuries. It may be the case that older individuals are more likely to be injured on boats whereas injuries to younger individuals may result more frequently from use of jet skis; ownership/use figures would be required to verify this. A large proportion of the Victorian population having access to Port Phillip Bay may explain the increased likelihood of injury with regard to area of residence; rates of water vessel use are likely to be higher in metropolitan Melbourne than regional/rural Victoria due to population density.

Maritime-related injury rates have increased significantly over the ten-year study period. A possible explanation for this is that use or ownership of modes of maritime transport have increased over time at a rate faster than the state population (used to calculate the trends). This would be difficult to gauge precisely however, given that a number of vessel/transport types, including kayaks, canoes, rafts are not subject to registration. However, the vessels that are subject to registration and licensing, and that are more likely to be involved in maritime-related injuries, namely jet skis and various boats, certainly are. Furthermore, the rates of hospital bed days per population have also increased significantly over the study period. What this suggests is that not only are maritime-related injuries becoming more common but they are also increasing in severity as judged by time spent in hospital. This is supported by the fact that over a third of maritime-related injuries resulted in a hospital stay of between two and seven days with an average of 3.73 days per admission.

Accidents aboard watercraft, without damage to the watercraft, and not causing drowning or submersion were the most frequently observed general cause of injury. Such accidents include fires, explosions, machinery malfunctions, fume inhalation, and falls caused by various means (where water transport is a relevant factor). Considering this in combination with the vessel types most likely to be involved in maritime-related injuries begins to clarify the picture. Vessels such as jet skis, and those generally described as boats account for over half of all maritime-related injuries, the most commonly observed injuries involved fractures, and the most commonly injured areas were the knee and lower leg, head, abdomen, and thorax (i.e., a wide range of injury sites). Presumably, injuries resulting from jet skis would involve submersion so this would indicate that incidents such as falls or other mechanical injuries aboard boats are accounting for a large proportion of maritime-related injuries. This suggests that jet ski accidents are accounted for by other categories of cause such as ‘other and unspecified’. The text narrative data from the VEMD supports the notion that falls and mechanical injuries occurring on boats or ships are the cause of a significant proportion of the maritime-related injury burden. Collisions were not often involved in maritime-related injuries and forms of transport broadly categorised as ‘vessels’ comprised almost half of the observed cases.

Between 2008/9 and 2015/16, there were annually 52 TSV-reported incidents in the Maritime Incident Data; during this period, there was an overall increase of 2.4 incidents per year. The number of fatalities reported in the MID was approximated the number recorded in the Cause of Death data: 21 vs. 19 in total in 2009 to 2012 (four years). Between 2008/9 and 2014/15, the annual number of maritime injuries recorded in the Emergency Department presentations data was over 10-fold the number of injured cases recorded in the MID; even ED presentations that were subsequently admitted outnumbered MID injury records. Water skiing, wake boarding and knee boarding were

frequently identified as the cause of injury in the ED presentations (37%) and subsequent admissions (29%); these were less commonly reported in the MID (11%). Differences in the number of maritime injury cases captured in the MID vs. ED records could be (partly) explained by the TSV reporting requirement: injuries incurred while knee boarding, wake boarding and water skiing do not involve a person on board. Speculatively, if the injury is not caused by a collision, and if there is no involvement of police, ambulance or other emergency services, there may not be a perceived incentive to report the incident to the TSV.

To address the issues raised and insights provided by this report, specifically, the increases in admission rates and injury severity, the Victorian Injury Surveillance Unit recommends that stricter licensing requirements be implemented, especially with regard to personal watercraft; greater education be provided for all users of waterways about the dangers involved and sharing waterways responsibly, and that regulations regarding activities such as jet skiing, wakeboarding and water skiing be policed more heavily. A more complete capture of all maritime transport related injuries in the Maritime Incident Database could be obtained by improving recording of water ski, wake board and jet ski related injuries. This could be facilitated by expanding the definition of a *reportable injury* to include all death or injury to a person caused by the operation or navigation of a vessel (regardless of whether the person was on board the vessel).

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Appendix A: Data sources & case selection

Deaths

Data have been extracted from the VISU-held Cause of Death (COD) dataset supplied by the Australian Coordinating Registry (ACR) and based on the Australian Bureau of Statistics (ABS) cause of death data.

Cases were selected according to the following criteria:

- Victorian cases (closed cases only)
- Deaths recorded with a reference year of 2007-2012
- Death was coded as due to external cause on completion of coronial process
- The type of activity being undertaken by the person when injured was coded within the coding range V900-V949, which pertain to water transportation, and codes U530-U539, U5460-U5480, and U644-U645, which pertain to relevant water activity related injuries

Hospital admissions

Hospital admission data were extracted from the Victorian Admitted Episodes Dataset (VAED) for the years 2005/6 to 2014/5. The VAED records all hospital admissions in public and private hospitals in the state of Victoria.

Injury incident cases were selected if the admission was for a community injury (principle diagnosis code in range of S00-T75 or T79) and included a water transport accident code (V900-V949) or a relevant water activity code (U530-U539, U5460-U5480, and U644-U645). Those who were admitted via a statistical separation within the same hospital or transferred inward from another hospital were excluded to prevent over-counting of incident injuries.

When calculating estimates of direct hospital costs and number of hospital bed days, all cases with a principal diagnosis as an injury in the ICD-10-AM code range S00-T75.9, T79-T79.9, T89-T98.99 (these codes exclude medical injury) or one of two relevant rehabilitation codes - Z094 (follow-up examination after treatment of a fracture) or Z509 (care involving use of rehabilitation procedure, unspecified) with an injury code (any of the diagnosis codes in the range of S00-T98) were included, to provide a more accurate estimate of the burden of injury.

Note: Frequencies less than 5 and rates based on frequencies less than 10 are suppressed and appear with an "" in the tables provided.*

Emergency department (ED) presentations

ED presentations data were extracted from the Victorian Emergency Minimum Dataset (VEMD) for the years 2005/6 to 2014/15. The VEMD records all presentations to Victorian public hospitals with 24-hour emergency departments (currently 39 hospitals – 100% state-wide coverage of these hospitals applies from 2004). ED presentations were selected if the presentation was for a community injury (primary diagnosis code in the range of S00-T75 or T79) with a relevant maritime activity code (U530-U539, U5460-U5480, and U644-U645) or the text description contained one of a number of keywords indicating that the injury was maritime-related (see syntax files for complete list). Pre-arranged admissions (through the ED) and return visits were excluded to avoid over-counting of incident injury presentations.

Note: Frequencies less than 5 and rates based on frequencies less than 10 are suppressed and appear with an "" in the tables provided.*

Intent

Intentionally caused injuries (assault and self-harm) were not included in this report as ICD-10-AM coding contains no reference to intentionally caused maritime-related injuries.

Appendix B: Analysis methods

Rates

Maritime-related injury rates and bed day rates (per 100,000) were calculated using ABS population data for Victorians in the corresponding years of injury. Population data was sourced from Employment data were sourced from Australian Demographic Statistics, September 2016, copyright © Commonwealth of Australia 2017 (ABS, 2017). Crude rate and 95% confidence interval of the crude rates are shown, for ED presentation rates and hospital admission rates. Confidence intervals were calculated as:

$$\frac{100{,}000}{Population} \times \left(events \pm \left[1.96 \times \sqrt{events}\right]\right)$$

Trend analysis

Trends in the rates of maritime-related injuries and bed days (per 100,000) were modelled using Poisson models, as trends in the annual number of events, with the log of the Victorian population as offset. The results are shown in figures as the observed rates over time as well as the fitted rates with 95% confidence intervals. The results are presented in a table as the modelled annual % change in rate, calculated as:

$$percentage\ change = [e^{\alpha} - 1] \times 100\%$$

where α is the estimated value from the Poisson model. The analyses were conducted using the PROC GENMOD procedure in SAS V9.4.