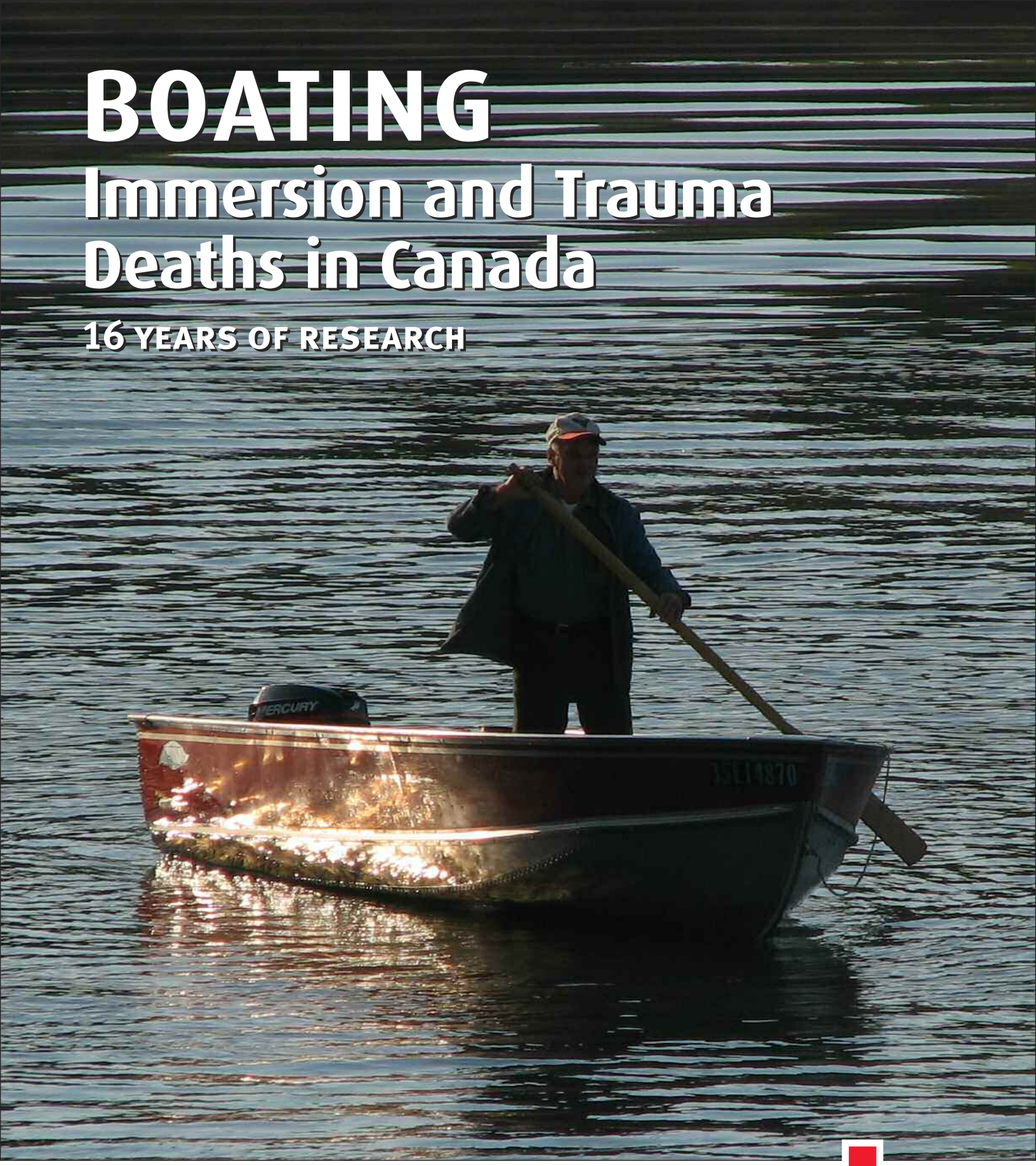
BOATING
Immersion and Trauma Deaths in Canada
16 YEARS OF RESEARCH



Transport Canada
Transports Canada

OFFICE OF BOATING SAFETY
BUREAU DE LA SÉCURITÉ NAUTIQUE

Canadian Red Cross
Croix-Rouge canadienne

Boating Immersion and Trauma Deaths in Canada: 16 Years of Research

This recreational boating surveillance report was developed and written by Dr. Peter Barss in collaboration with the Canadian Red Cross. Jane Hamilton, MSc. Epidemiology, carried out the data analysis and tables, Sophie Lapointe data management, Cait Beattie design, charts and figures, and review of data. Peter Barss reviewed, coded, verified, and corrected data for each death and coordinated the research.

Data collectors included volunteers and staff of the Canadian Red Cross and the Lifesaving Society. Data collection was made possible through the assistance and co-operation of provincial coroners, medical examiners, their statistical staff, and the National Association of Coroners. Financing of the work was done collaboratively by sharing resources and staff. Data collection mainly involved the Canadian Red Cross, the Lifesaving Society, and provincial coroners. The Canadian Red Cross translation department supervised translation with the assistance of Cait Beattie.

Transport Canada sponsored and helped monitor progress of the current report and research for 2005-2006 data, together with reformulation and reanalysis of 1991-2004 data. Shelley Dalke of the Canadian Red Cross managed this project in collaboration with Myke Dwyer of Transport Canada's Office of Boating Safety.

The National Search and Rescue Secretariat and the Canadian Red Cross funded data analysis and writing, as well as editing, design, and layout for the earlier 10-year modular report on which this 16-year report is based. Rosemary Hong, former coordinator for drowning research at the Canadian Red Cross, initiated the 10-year modular project that was a foundation for this report. Data management was supported in earlier years by the Canadian Red Cross and the Lifesaving Society, and Isabelle Masson made an important contribution to that process.

The Research Institute of the McGill University Health Centre provided administrative support for data management during the initial 15 years of the research. For the first six years, the National Drowning Report and related special interest reports were supported by The Injury Prevention Module of the Régie régionale de la santé et des services sociaux de Montréal-Centre, a member of the World Health Organization's Collaborating Centre for Injury Prevention and Safety Promotion.

This report has drawn upon the Canadian Red Cross 10-year research modules on boating and cold immersion deaths, which received the Canadian Marine Safety Award from Transport Canada in 2009. Many recommendations are the same, but there are additions based upon the current research, which incorporates an additional six years of national data and reanalyses of the entire database.

Design, layout, and cover photo: Cait Beattie and Jean Louis Martin, Résolutique globale
Translation: Monique Edwards (text), Résolutique globale (figures)

Ce rapport est aussi publié en français.

Boating Immersion and Trauma Deaths in Canada: 16 Years of Research (1991-2006)

While canoes, kayaks and sailing vessels were all necessary for various environments and activities, and continue to be popular with many Canadians, at present powered boats are more numerous. Powerboats are used for three main purpose: recreation, occupation, and activities of daily life, including travel and subsistence fishing and hunting. At present recreational activities, including fishing and powerboating, predominate.

The marine environment can be harsh to the unprepared boater, and so year after year about 40% of drowning deaths from immersion in Canada involve boaters, and boating is the leading cause of fatalities from immersion and other water-related injuries.

This report includes an overview of 16 years of research data on all deaths involving boats in Canada, with the main emphasis on recreational incidents. For the purposes of this report recreational and activities of daily life have been combined as recreational. This is justifiable in terms of international injury coding practices of the World Health Organisation and since the distinction between these categories is often unclear. The report focuses on activities and incidents associated with deaths, and on personal, equipment, and environmental risk factors. Readers with an interest in details of deaths associated with specific types of boats should also consult the 10-year modules on which this report was based, at the Canadian Red Cross website.

In the 10-year modules, according to files from all provincial and territorial coroners' and medical examiners' offices, there were 1,952 boating fatalities in Canada during 1991-2000, including 1,803 drownings, and 149 water-related non-drowning deaths resulting primarily from trauma (98) and hypothermia (51) (Canadian Red Cross 2009). After verification with coroners in several provinces, the data for this period were believed to include greater than 95% of all boating deaths. Boating accounted for 33% of drownings and 41% of non-drowning deaths. When land and air transport were excluded, boating represented 39% of drownings and 50% of other water-related fatalities.

Sadly, year after year boaters continue to remain unaware of or ignore fundamental yet simple principles of boating safety, and many die. Canadians who faithfully fasten their safety belts and avoid alcohol in the much less dangerous traffic environment embark onto the water without the protection of a properly worn flotation device, often in boats that are unsafe except in ideal conditions. Many boaters are weak swimmers or cannot swim at all. Although alcohol is ill advised while boating for both operators and passengers, purchasing and loading supplies of alcohol into the boat frequently takes priority over a visit to a reputable boating shop to ensure that the operator and all passengers are fitted with a safe and comfortable flotation device, appropriate to the nature of the boating activity.

Similarly, while many drivers assess weather and road conditions prior to travel by road, few verify marine weather and water temperatures before setting off in their boats. Boaters are also unable to easily access safety reviews of boats and flotation devices prior to purchase, including performance under adverse weather conditions such as wind, waves, and cold. Safety performance data for motor vehicles and for related safety equipment such as seat belts, airbags, and child restraints are available at various sources such as Transport Canada and the U.S. Insurance Institute for Highway Safety.

From the results of detailed epidemiologic studies, including this and earlier reports, it is evident that injuries such as drowning do not strike randomly as thunderbolts from the sky. While the exact moment of a tragic incident is not always predictable, usual combinations of circumstances are generally predictable and preventable.

In the belief that knowledge of the circumstances of water-related deaths offers a source of prevention for all boaters, this report on the circumstances of death for nearly 3,000 Canadian boaters is provided as a guide to survival for decision makers, as well as future boaters, operators and passengers, since we all carry at least partial responsibility for our own security when we choose to step into a boat, be it at anchor, wharf or underway.

It is hoped that the wearing of an appropriate flotation device supplemented when necessary by protection against cold immersion, together with careful assessment of prevailing and predicted water temperatures, wind, waves, and darkness, will become a routine for all users of boats. No boater should embark on the waters without the specific training, safety equipment, safe boat, and swimming ability, all of which are essential for their chosen activity.

Decision makers carry a heavy burden of responsibility for the survival of boating populations, especially in Canada with so many vulnerable people at risk. Political leaders and their civil servants have a duty to act, ensuring that legislation and enforcement are ready and effective for the universal protection of all Canadians, including the naive, from their own folly during boating, with special attention to the need for all boaters to wear an appropriate flotation device.

It is astounding to note that in exposure to boating, where the most frequent injury incidents involve capsizing and falling overboard, non-swimmers and weak swimmers continue to boat without a flotation device, and drown as a result. No one should receive the death penalty for ignorance. Special attention should also be given to regulations governing the manufacture of small open boats to ensure that they are safe to operate even when sudden changes of wind and waves pose a threat to survival, and that they provide a reasonable safety platform and the possibility of self-rescue even when swamped or overturned.

This report has been prepared to provide an epidemiologic profile for prevention. Injury incidents are often multifactorial. Nevertheless, a favourable change in a single factor can be sufficient to tip the balance sufficiently away from danger in favour of safety to prevent an incident from occurring. This is pre-emptive action in the pre-event phase. The use of appropriate safety equipment or action can prevent injury even if an incident does occur; in this case, injury is aborted or reduced in the event phase. Finally, post-event phase activities such as rapid intervention with lifesaving, first aid, appropriate methods of rewarming, CPR, and so forth after an injury has occurred can minimize, stop, or reverse the progression of damage from any injuries sustained during the event phase.

The results are based upon annual data abstraction of information about each incident collected by thousands of coroners and police, and recorded in provincial and territorial coroners' files across Canada. The data required nearly 20 years of dedicated work by voluntary Red Cross and other data collectors, guided by project managers and research professionals. Details of each incident were recorded in 15-page structured questionnaires and converted into electronic format for analysis. Each year's data collection, transformation into electronic format, and analysis require about two years' work. The analysis of 16 years of data has been much more complex than for a single year. Our hope is that this report will help to prevent fatalities and reduce economic losses due to immersion and trauma during recreational boating, an important activity for many Canadians.

STUDY POPULATION AND TIME PERIOD All drownings and other water-related injury deaths in Canada were monitored between 1 January 1991 and 31 December 2006. In the 2001 census, the total population of Canada was 30 million. Thus, boating deaths in 1991-2006 occurred on the background of about 50 million person years of exposure to risk for all ages.

DEFINITIONS

IMMERSION DEATHS: DROWNING & IMMERSION HYPOTHERMIA For the purposes of this report, ***immersion death*** includes death by drowning and/or immersion hypothermia. An immersion death was classified as a drowning if drowning was included in the coroner's report, based upon the autopsy or other findings. The death was classified as hypothermia without drowning only if the coroner's report excluded drowning as among the causes of death based on lack of autopsy findings of drowning, and contained other supporting factors that exclude drowning, such as wearing of a flotation device. Reporting was done on all immersions as a single category because, as evident from the Canadian Red Cross 10-year module on cold immersion, cold is a factor in at least 38% of boating immersion deaths, and hypothermia is reported inconsistently due to lack of clear criteria for such a diagnosis, as well as lack of training in immersion death on the part of some coroners and police. Risk factors for both types of immersion death tend to be similar.

TRAUMA DEATHS As in the World Health Organisation's International Classification of Diseases, trauma deaths are reported as a separate category. Causes of death include blunt and penetrating trauma, mainly from external causes such as various types of collisions and falls. Types of injury include head and spinal injury, fractures, severe lacerations, and multiple injuries.

TYPES OF BOATS For the purposes of this report, ***powerboats*** are boats that are mainly propelled by a motor. ***Unpowered boats*** are not really unpowered, just not mainly powered by a motor. They are generally propelled by human or wind power, although larger sailboats do have a motor. The cut-off between ***small and large powerboats*** was 5.5 metres when surveillance reporting began in 1991. This has changed recently with some organizations, but the original classification has been retained. It is seldom that police or coroners record the exact length of boats. Hence the most frequent category of powerboat generally specified is small open fishing type boats, most of which are mass produced in aluminum for ease of transport, which is not necessarily conducive to safety in adverse conditions. Most of the powerboats reported only as unknown probably also fall into this category. Boats designated as ***personal watercraft (PWCs)*** by Transport Canada are referred to as jet skis in the World Health Organisation's International Classification of Diseases, 10th edition. Unpowered paddle boats or pedalos (French), also known as water cycles, are referred to as pedal boats in this report.

OTHER DEFINITIONS ***Boating*** refers to being in a boat, boarding or leaving a boat, falling from or jumping from a boat (to retrieve a person, animal, or object), and being towed by a boat (e.g. water-skier, tuber). Swimmers and waders struck by a boat or propeller are also included in the report. In accord with the World Health Organisation's 10th edition of the International Classification of Diseases (World Health Organisation, 2007), persons voluntarily swimming or diving from a boat are excluded from boating, as these are aquatic activities. For the purposes of this report, ***recreational boating*** includes activities of daily life, such as boat travel and subsistence fishing. ***Occupational boating*** refers to boating as part of professional life. ***Rescue*** refers to an attempt to rescue another person or an animal such as a dog. The term ***fishing*** was used when fishing was the main objective of the activity; fishing includes travelling to and from the fishing site. ***Powerboating*** refers to operating a powerboat, including a PWC, as an end in itself. ***Sailing, canoeing, kayaking, rafting, rowing,*** etc. refer to the activity rather than the type of boat (i.e. fishing from a canoe is categorized as fishing rather than canoeing.) ***Capsized*** means that the boat overturned. ***Swamped*** indicates that the boat took on water. ***Collision*** means that the boat struck or was struck by another boat, or struck a fixed object (e.g. a rock, stump, or dock) or a person (e.g. swimmer, water-skier, tuber). ***Fell or thrown overboard (or was ejected)*** refers to an incident in which the person ended up in the water but the boat remained upright and intact (i.e. without capsizing, swamping or collision).

ETHNICITY Because of greater exposure among aboriginal peoples to boat travel, and communities or homes near the water, the proportion of victims among First Nations and Inuit peoples is provided. Aboriginal status was considered definite if the victim was classified as such in the coroner, police, or autopsy files by coroner, police, or pathologist. Probable aboriginal status was assigned if the address corresponded to a known reserve and if the family name was known to be aboriginal. The definition of aboriginal varies, but they probably represent at least three to four percent of the Canadian population. Since Ontario has not consistently facilitated reporting on aboriginal status, data are incomplete for the largest province for several years, affecting overall reporting. Hence the true proportion of aboriginal drowning is undoubtedly substantially greater than reported.

NATIONAL SURVEILLANCE DATABASE In the early 1990's, the Canadian Red Cross implemented a national drowning surveillance database. This was developed with the collaboration of public health injury prevention professionals, all provincial coroners, and other water-safety organizations including the Coast Guard and Lifesaving Society. The database was funded to provide a sound research basis for national water-safety programs, by monitoring the incidence and circumstances of all water-related injury deaths in Canada on an annual basis. It includes annual information from 1991 onwards (Canadian Red Cross, 2001). An epidemiologic profile of all water-related injury deaths is available (Red Cross 2003, 2005). The completeness of the database was affected during 2005 and 2006 as discussed below.

DATA COLLECTION The surveillance database relies upon annual structured reviews of the mandatory coroner and police reports for all water-related deaths. A questionnaire with 48 questions is used to obtain data on cause of death, activity and purpose of activity, along with personal, equipment, and environment risk factors. Project managers supervised volunteer data collectors in each province with the collaboration and joint management of the Red Cross and Lifesaving Society between 1991-2004. During 2005 and 2006, data collection was carried out and/or supervised by a for-profit group known as the Water-Related Injury Alliance. We believe this group closed out data collection earlier than in previous years, and they did shorten the data questionnaire. During 2001-2005 and especially during 2006, the proportion of estimated missing deaths rose significantly, as reported in the results section of this report. Missing data for available 2005-2006 death files for questions relating to alcohol and other key issues were collected by the Canadian Red Cross from coroners so validity of blood alcohol could be assessed when recovery of the body was delayed. However, access to retrospectively collected death files missing from the surveillance database was not possible for most provinces. Hence while population-based incidence rates were calculated for the Canadian Red Cross 10-year modular reports for 1999-2000, this has not been done for the current report and the number of deaths for 2005 and 2006 should be considered incomplete.

DATA VERIFICATION AND ANALYSIS All completed questionnaires are verified and corrected at the national level by a medically trained injury epidemiologist. Verification is highly structured and includes such issues as admissibility, completeness, internal consistency of responses, and consistency from year to year. Data entry is done with appropriate quality control, including double entry and compare. Data are analyzed annually, but for this report 16 years of data were used. Since coroners take a year or more to finalize all cases, and data collection and analysis nearly another year, reporting tends to lag behind the incidents by about two years. This is not of major consequence for prevention, since major trends usually occur slowly. Due to concern about missing deaths under new data collection policies during 2005-2006, each province and territory's coroner/medical examiner statistical staff were surveyed using a one-page structured questionnaire to assess the number of boating deaths in each jurisdiction. This was done to provide an estimate of incomplete data collection by year from 1991-2006.

In the early development years, the analytical work was considered research. In later years, it became a mix of surveillance and research. Detailed reports on new topics, such as the present report on recreational boating deaths, fall into this category. Hence it is possible to provide a sound basis for new programming. Recommendations have also been supported by periodic monitoring of the scientific literature on injury prevention in international databases.

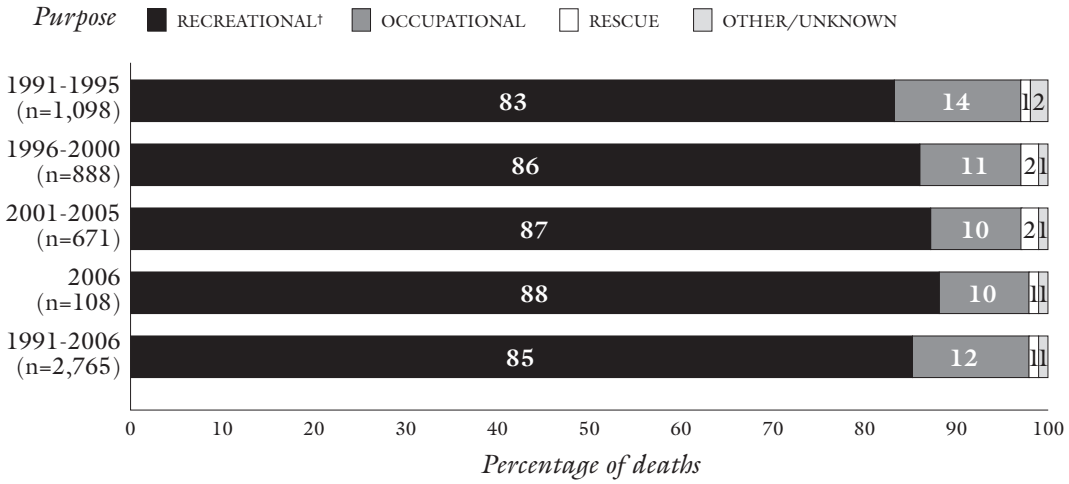
RESULTS

OVERVIEW OF ALL BOATING FATALITIES

PURPOSE During 1991-2006, recreational activities, including activities of daily life, accounted for 85% of all boating fatalities, occupational activities for 12%, attempted rescue for 1%, and other or unknown activities for 1% (Table 3a).*

TRENDS Between 1991-1995 and 2006, the proportion of recreational fatalities increased from 83% to 88%, occupational fell from 14% to 10%, and attempted rescue remained constant at about 1% (Figure 1, Table 3a). Recreational boating accounted for 85% of immersion deaths, including drowning and immersion hypothermia (Table 3b) and 91% of boating trauma deaths (Table 3c).

Figure 1 **TRENDS IN BOATING FATALITIES* BY PURPOSE OF ACTIVITY, CANADA 1991-2006 (n=2,765)**



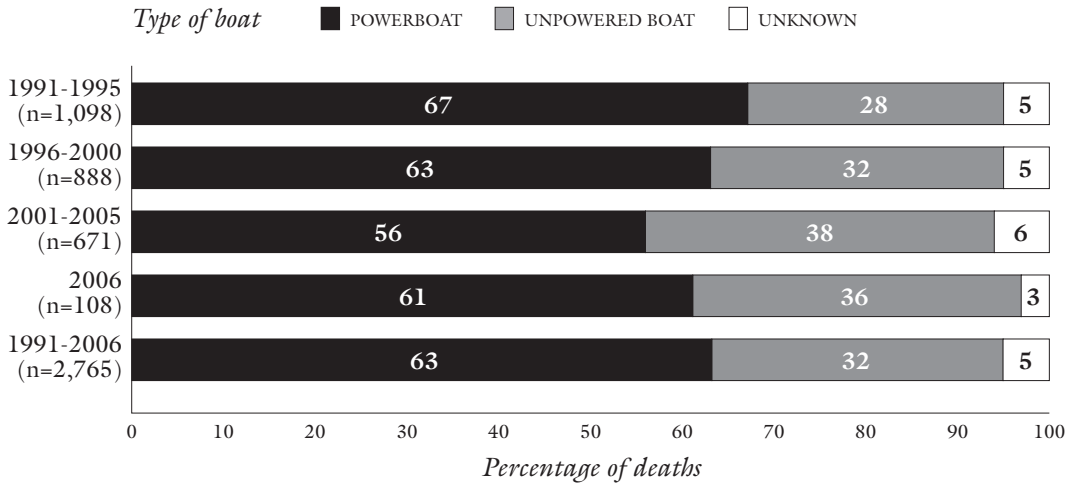
** Includes death from all causes: drowning, immersion hypothermia, and trauma † Includes boating during recreation and daily life*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

ESTIMATED TRENDS Using the method described in the methods section, the proportion of deaths estimated to be missing from the database was 5% for 1991-95, 0% for 1996-2000, 17% for 2001-2005, and 33% for 2006. When the numbers of deaths were corrected by these factors, there was an estimated 27% decline between 1991-1995 and 1996-2000, 15% between 1996-2000 and 2001-2005, and 14% between 2001-2005 and 2006 (Table 1). These are estimates only, and for 2001-2006 the possibility of error is considerable since not all coroners were able to report the annual numbers of boating deaths in their province or territory.

** All tables can be found at the end of the Results section.*

TYPE OF BOAT 63% of boating fatalities involved powerboats and 32% unpowered boats; for the remaining 5% it was unknown whether the boat was powered or unpowered (Table 3a). The trend showed a decreasing proportion of powerboats and an increasing proportion of unpowered boats (Figure 2).

Figure 2 **TRENDS IN BOATING FATALITIES* BY TYPE OF BOAT, CANADA 1991-2006 (n=2,765)**



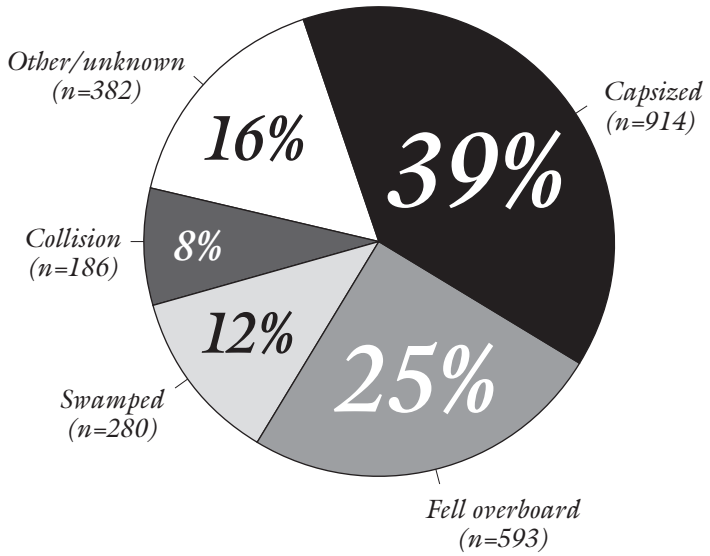
** Includes death from all causes: drowning, immersion hypothermia, and trauma*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

Except where otherwise specified, the remainder of this report deals only with recreational fatalities.

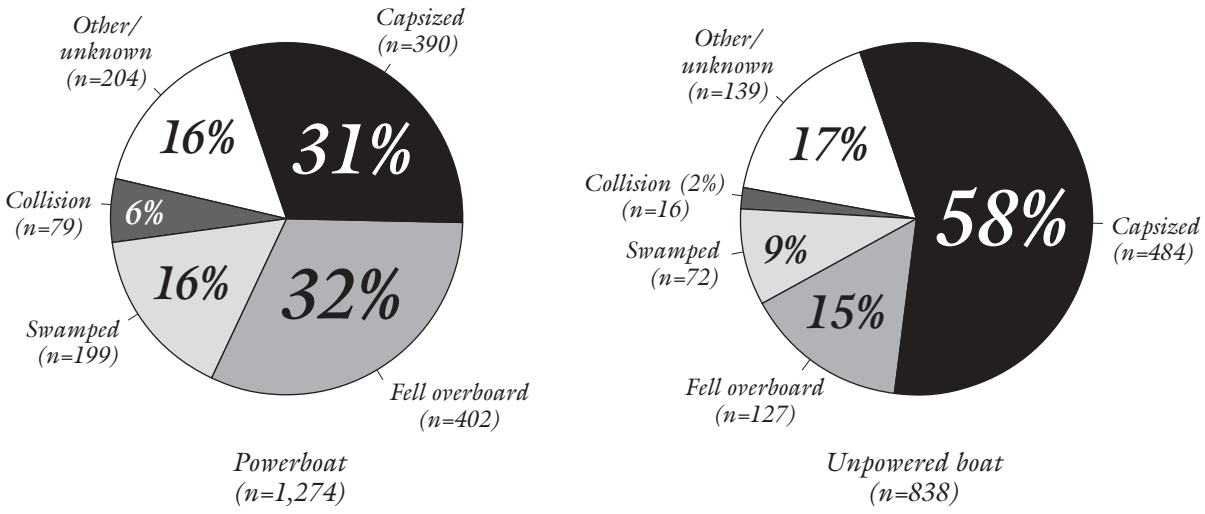
TYPE OF INCIDENT The most common type of incident for recreational fatalities, including both immersion and trauma deaths, was capsizing, at 39%, followed by falling overboard, swamping, and collision (Figure 3, Table 5a). For recreational immersion deaths (i.e. drowning and hypothermia), the proportion due to capsizing in unpowered boats, 58%, was almost double that in powerboats, 31%, while the proportion due to falling overboard was less than half, 15% versus 32% (Figure 4, Table 5b).

Figure 3 **RECREATIONAL BOATING* FATALITIES† BY TYPE OF INCIDENT, CANADA 1991-2006 (n=2,355)**



** Includes boating during recreation and daily life † Includes death from all causes: drowning, immersion hypothermia, and trauma*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

Figure 4 **RECREATIONAL BOATING* IMMERSION DEATHS† BY TYPE OF BOAT AND TYPE OF INCIDENT, CANADA 1991-2006 (n=2,232)‡**

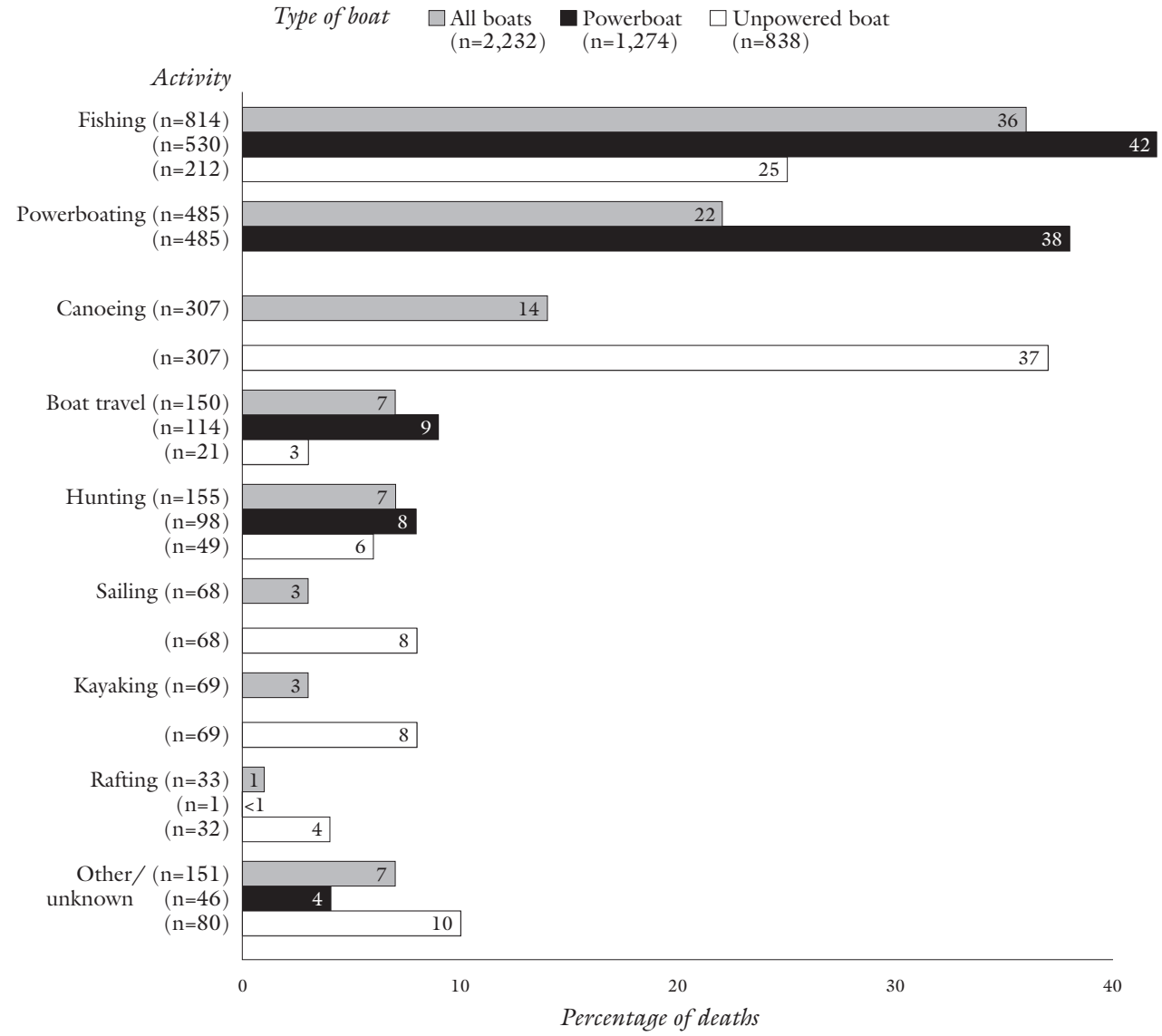


** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ This figure excludes 120 cases where it was unknown if the boat was powered or unpowered

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

TYPE OF ACTIVITY Most immersion deaths occurred during fishing, powerboating, and canoeing (Figure 5, Table 3b), while 76% of trauma deaths occurred during powerboating, including being towed by a powerboat, such as on a tube or water-skis (Table 3c).

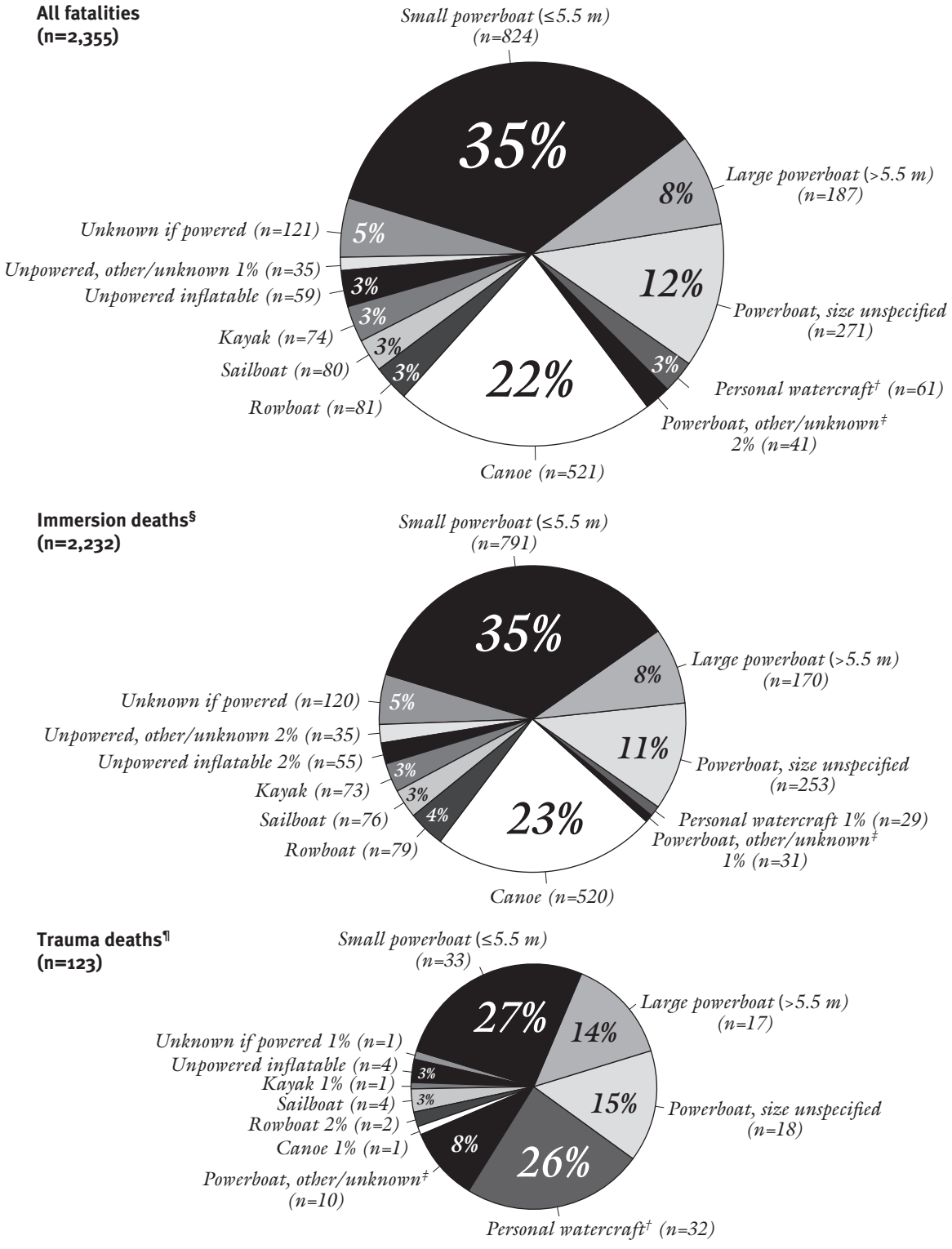
Figure 5 **RECREATIONAL BOATING* IMMERSION DEATHS† BY ACTIVITY, CANADA 1991-2006 (n=2,232)**



** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

TYPE OF BOAT 59% of all recreational fatalities were associated with powerboats and 36% with unpowered boats; for 5% it was unknown whether the boat was powered or unpowered. The most frequent categories of boat involved in immersion deaths were small open fishing type boats and canoes, while for trauma deaths personal watercraft (PWCs), large powerboats, and small open fishing type boats prevailed (Figure 6, Tables 2a, b, c).

Figure 6 **RECREATIONAL BOATING* FATALITIES BY NATURE OF INJURY AND TYPE OF BOAT, CANADA 1991-2006 (n=2,355)**



** Includes boating during recreation and daily life † Included being towed by a personal watercraft (trauma 3)*
‡ Included being towed by a powerboat (immersion 9, trauma 9)
§ Includes drownings and immersion hypothermia deaths ¶ Includes all other injury fatalities

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

There were 2,232 immersion deaths, including drowning and immersion hypothermia, accounting for 95% of recreational boating fatalities during 1991-2006.

PERSONAL FACTORS

AGE & SEX Persons between 15 and 74 years old accounted for 93% of recreational boating immersion deaths, and 93% were males. Children less than 15 years old accounted for less than 4% of deaths. The proportion of fatalities by 10-year age groups was similar for ages 15 to 54 (Table 7a). However, the proportion of fatalities for unpowered boaters was more than double that for powerboats among males 15-24 years-old.

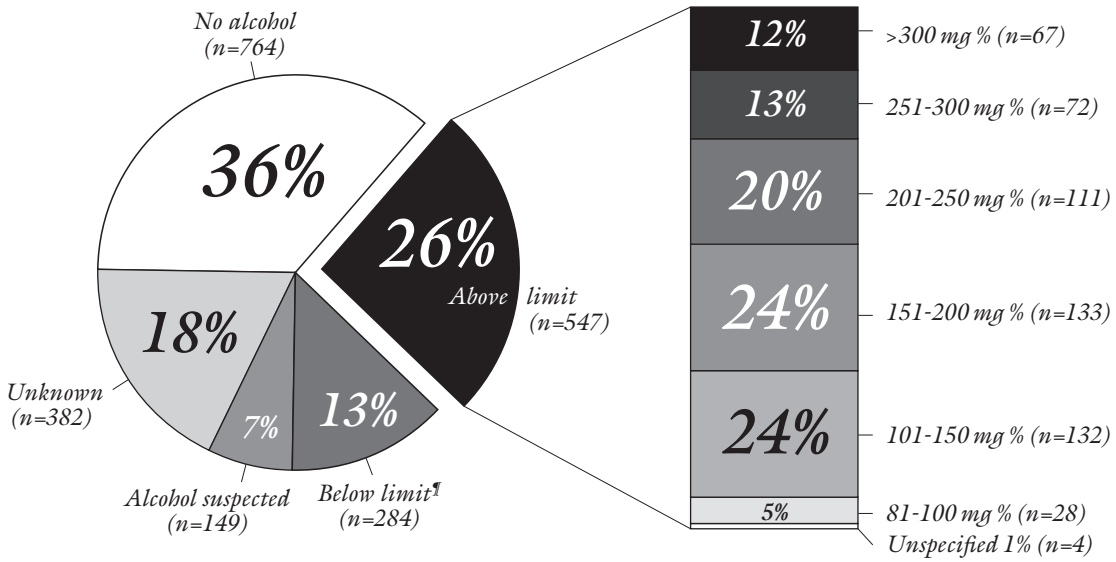
ALCOHOL & ILLEGAL DRUGS Alcohol was present or suspected in 46% of recreational boating immersion deaths for victims 15 years of age and older, with 18% unknown (Figure 7, Table 7b). If deaths with alcohol classified as unknown are excluded, alcohol would be present or suspected for 55%, and so the true figure may lie between 46% and 55%, possibly close to or exceeding 50%. There was greater involvement of alcohol among powerboat victims (Figure 8). Illegal drugs were present or suspected in 7% of deaths of persons 15 and older (Table 7b). When unknowns were excluded (50%), this rose to 14%, so the true figure could lie between these values.

SWIMMING ABILITY This was unknown for 66%; 52% of the remainder were weak or non-swimmers (Table 7a).

BOATING EXPERIENCE This was unknown for 68%, while 67% of the remainder were reported as experienced boaters and 33% as occasional or inexperienced boaters (Table 6a).

ETHNICITY Although aboriginals account for about 4% of the Canadian population, at least 16% of boating victims were aboriginal, probably substantially more since ethnicity was unreported for many victims (28%), especially in Ontario since 1996.

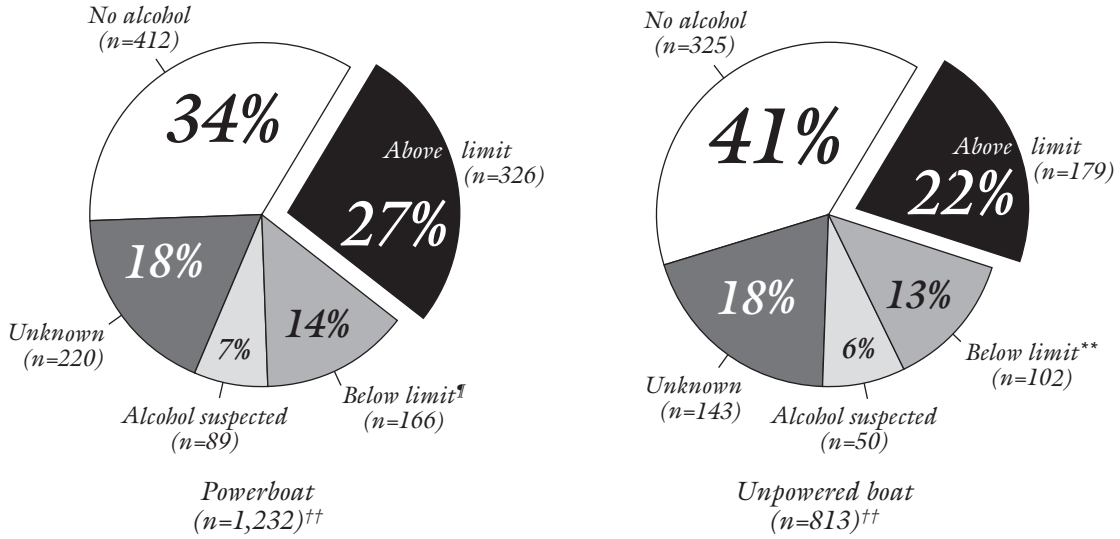
Figure 7 **BLOOD ALCOHOL LEVELS* FOR IMMERSION DEATHS† DURING RECREATIONAL BOATING,‡ CANADA 1991-2006 (VICTIMS ≥15 YEARS OF AGE; n=2,165)§**



** Legal limit is 80 mg% † Includes drownings and immersion hypothermia deaths ‡ Includes boating during recreation and daily life*
§ This figure excludes 39 victims; decomposition rendered blood alcohol unreliable
¶ 106 at 1-49 mg %, 80 at 50-80 mg %, 98 unspecified

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

Figure 8 **BLOOD ALCOHOL LEVELS* FOR IMMERSION DEATHS† DURING RECREATIONAL BOATING‡ BY TYPE OF BOAT, CANADA 1991-2006 (VICTIMS ≥15 YEARS OF AGE; n=2,165)§**



** Legal limit is 80 mg% † Includes drownings and immersion hypothermia deaths ‡ Includes boating during recreation and daily life; excludes occupational boating § This figure excludes 114 cases where it was unknown if the boat was powered or unpowered*
*¶ 70 at 1-49 mg %, 41 at 50-80 mg %, 55 unspecified ** 32 at 1-49 mg %, 35 at 50-80 mg %, 35 unspecified*
†† Charts exclude 33 victims (19, 14); decomposition rendered blood alcohol unreliable

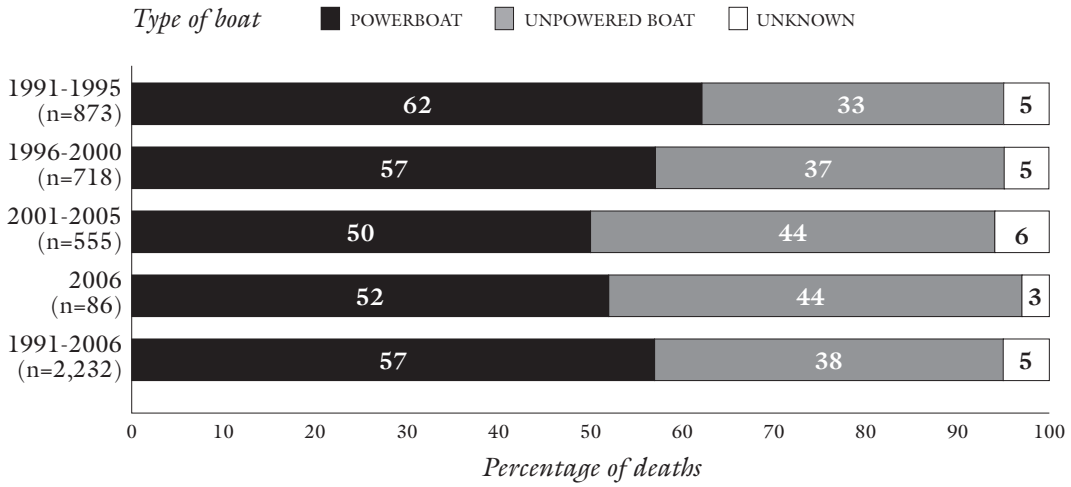
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

EQUIPMENT FACTORS

TYPE OF BOAT 57% of immersion deaths were associated with powerboats and 38% with unpowered boats; for 5% it was unknown whether the boat was powered or not (Table 4b). There has been a trend to decreased proportional involvement of powerboats and increased involvement of unpowered boats during 1991-2006 (Figure 9). For powerboat immersion deaths, 62% involved small powerboats including inflatables, and all other types 13% each or less. The actual proportion may have been close to 80%, since many unknown powerboats and unknown if powered boats were probably small powerboats. For unpowered boats, 62% of immersion deaths involved canoes, with all other types 9% each or less (Table 4b).

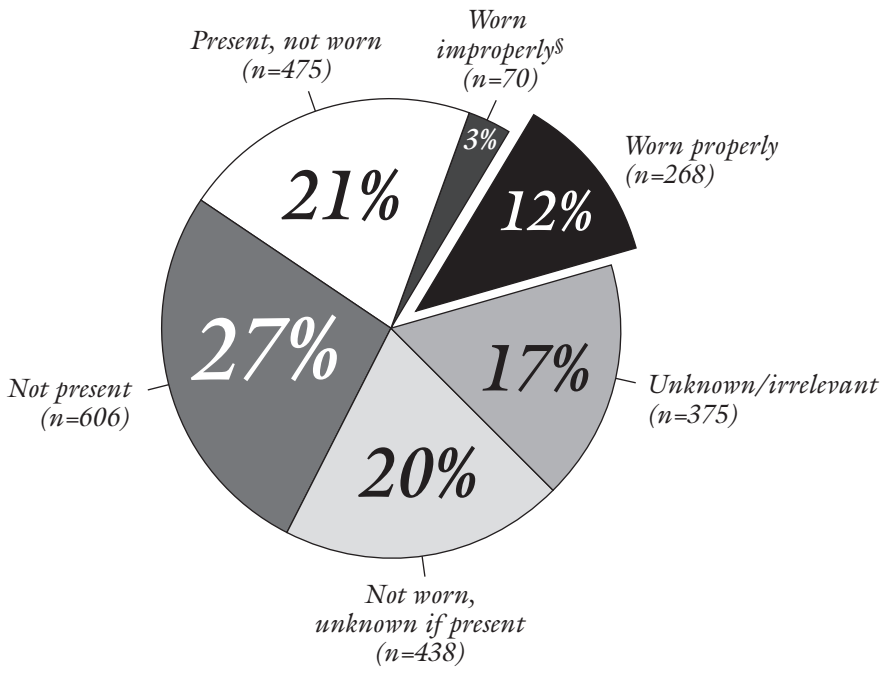
FLOTATION Only 12% of immersion victims were reported to be correctly wearing a flotation device (Figure 10, Table 8), including 10% of powered boaters and 16% of unpowered (Figure 11, Table 8). The low proportion of victims wearing a flotation device was stable throughout the period 1991-2006 (Figure 12, Table 8). The proportion of unknowns has decreased, suggesting police and coroners may be paying greater attention to this essential item of safety equipment. These data cannot address trends in the wearing behaviour of boaters who do not become victims, which could have improved. Field surveys can address this.

Figure 9 **TRENDS IN RECREATIONAL BOATING* IMMERSION DEATHS† BY TYPE OF BOAT, CANADA 1991-2006 (n=2,232)**



** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

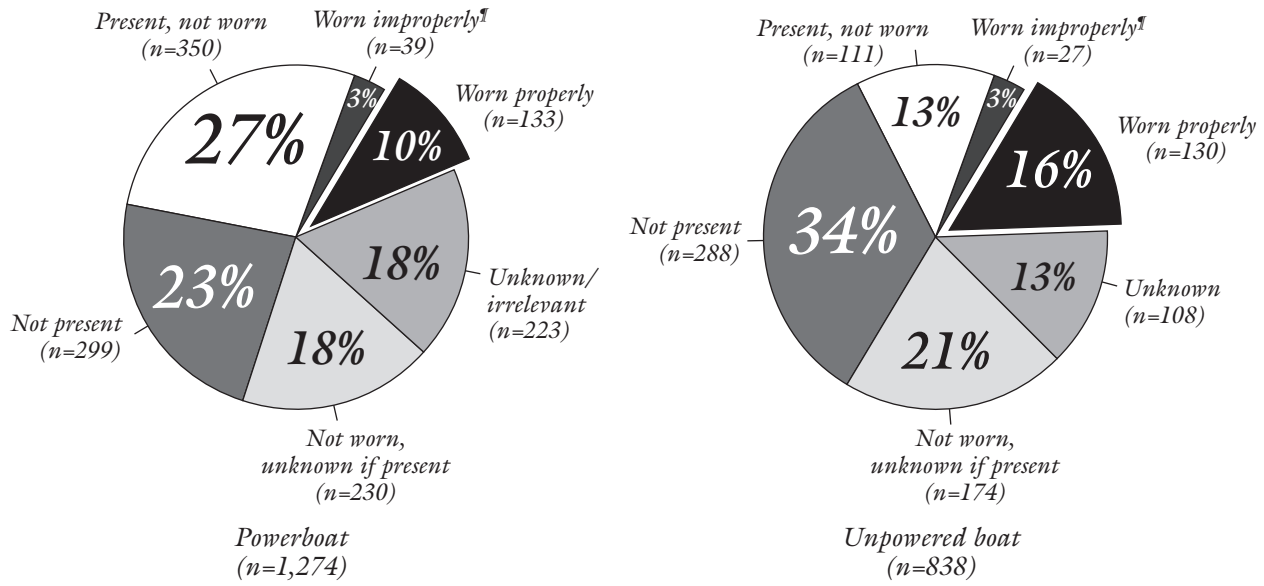
Figure 10 **RECREATIONAL BOATING* IMMERSION DEATHS† BY USE OF A FLOTATION DEVICE,‡ CANADA 1991-2006 (n=2,232)**



** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ Personal flotation device (PFD) or lifejacket § Not fastened or inappropriate size

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

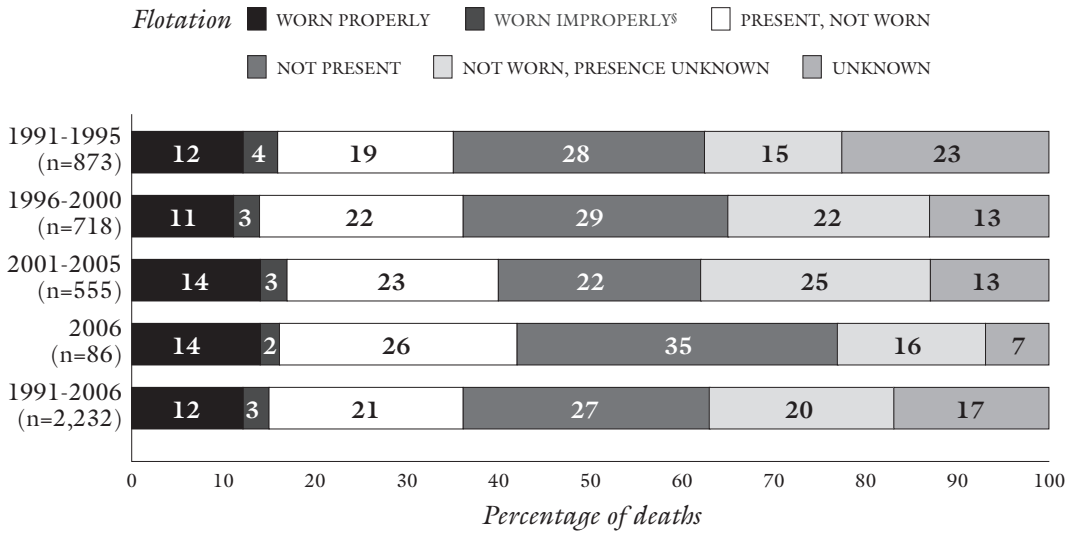
Figure 11 **RECREATIONAL BOATING* IMMERSION DEATHS† BY TYPE OF BOAT AND USE OF A FLOTATION DEVICE,‡ CANADA 1991-2006 (n=2,232)§**



** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ Personal flotation device (PFD) or lifejacket § This figure excludes 120 cases where it was unknown if the boat was powered or unpowered
¶ Not fastened or inappropriate size

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

Figure 12 **TRENDS IN RECREATIONAL BOATING* IMMERSION DEATHS† BY USE OF A FLOTATION DEVICE,‡ CANADA 1991-2006 (n=2,232)**



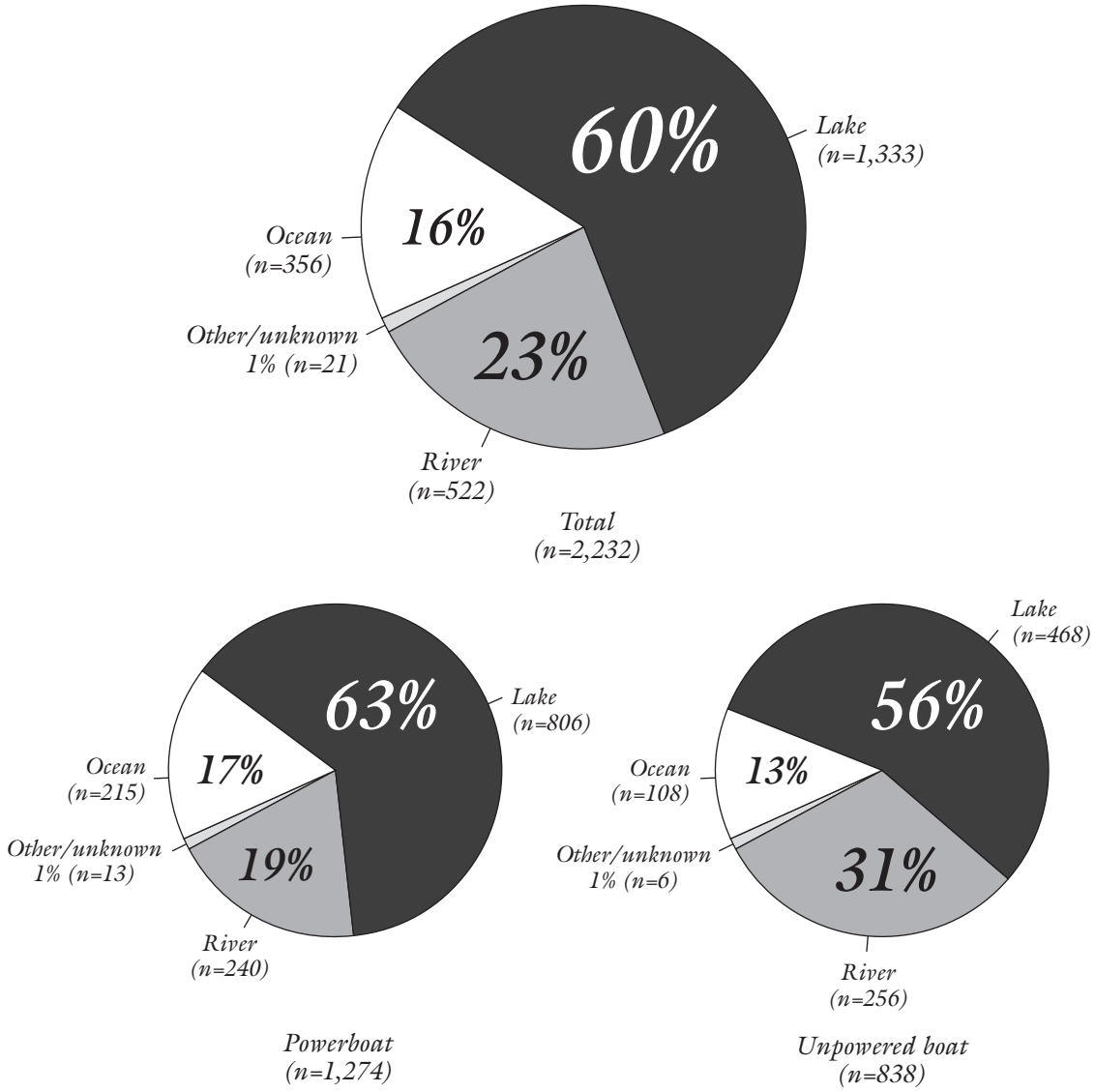
** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ Personal flotation device (PFD) or lifejacket § Not fastened or inappropriate size

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

ENVIRONMENTAL FACTORS

BODY OF WATER Overall, lakes (including ponds and reservoirs) were most frequently involved in boating immersion deaths, followed by rivers and oceans (Figure 13, Table 9a). The proportion of deaths on rivers was significantly greater for unpowered boats.

Figure 13 **RECREATIONAL BOATING* IMMERSION DEATHS† BY BODY OF WATER‡ AND BY TYPE OF BOAT, CANADA 1991-2006 (n=2,232)**

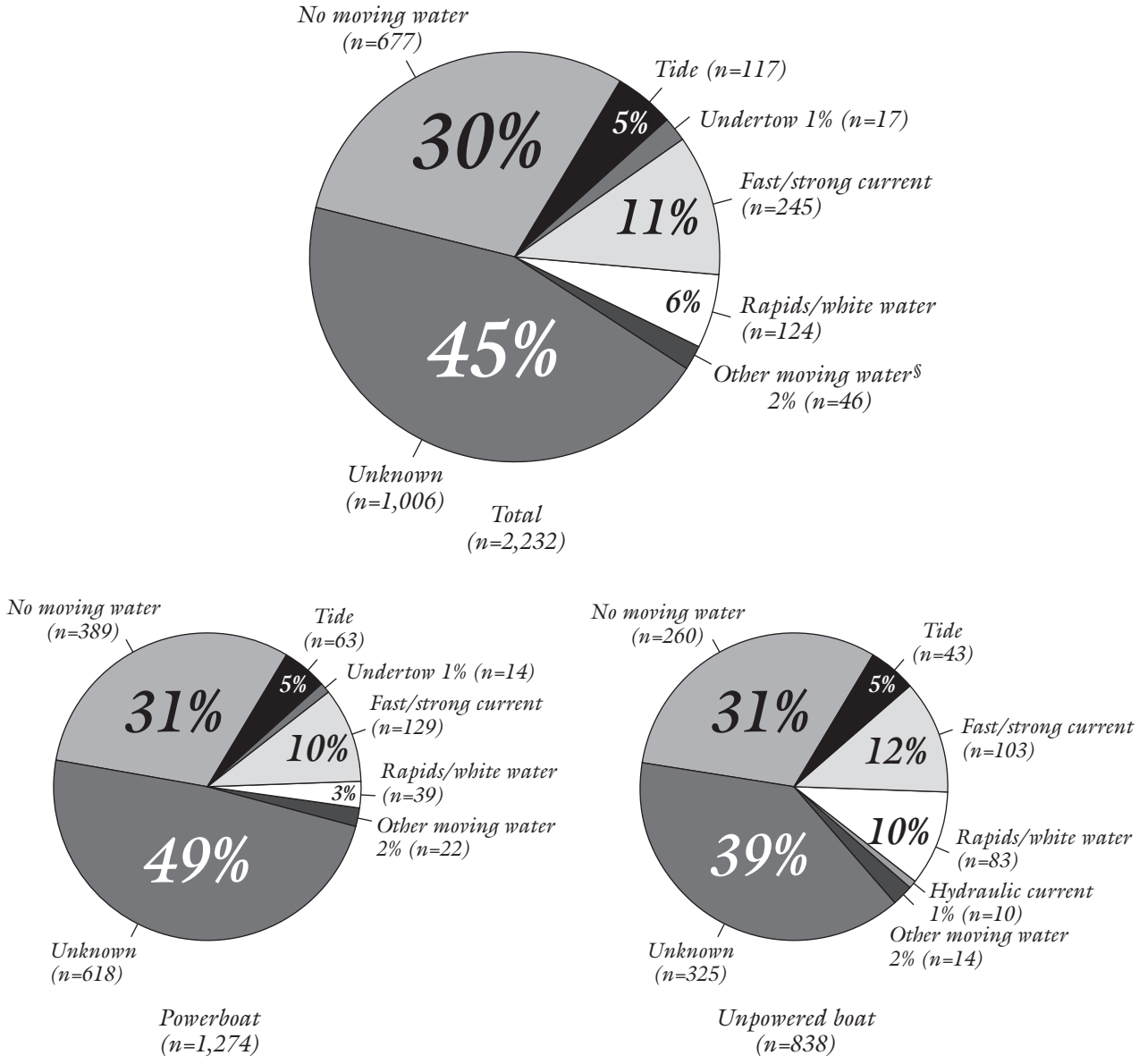


** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ Lake includes pond & reservoir

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

CURRENT The power of moving water, as fast/strong current, rapids or whitewater, hydraulic current, dam spillways, and waterfalls, was associated with 18% of all immersion deaths. Moving water was involved in about 14% of powerboat and 24% of unpowered boat deaths (Figure 14, Table 9a). Moving water was associated with 60% of deaths in rivers (Figure 15, Table 9a).

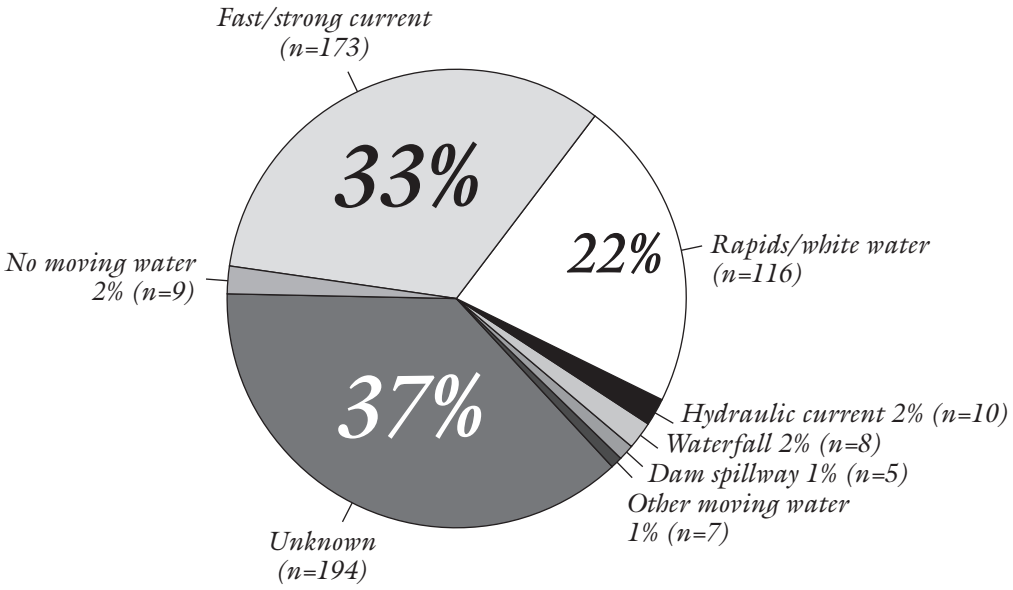
Figure 14 **RECREATIONAL BOATING* IMMERSION DEATHS† BY CURRENT AND BY TYPE OF BOAT, CANADA 1991-2006 (n=2,232)‡**



** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ In 120 cases it was unknown if the boat was powered or unpowered § Included hydraulic current 10, dam spillway 9, waterfall 8, & other 19

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

Figure 15 **RECREATIONAL BOATING* IMMERSION DEATHS† IN RIVERS BY CURRENT, CANADA 1991-2006 (n=522)**



** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

WIND AND WAVES Wind conditions were unknown for 61% of immersion deaths. For the remainder, wind was described as strong for 57%, breezy/windy for 23%, and calm for 20% (Figure 16). Wave conditions were unknown or irrelevant for 54% of victims. For the remainder, it was storm conditions for 7%, rough for 49%, choppy for 20%, and calm for 23% (Table 15b).

LIGHT CONDITIONS Light conditions were unknown for 21% of deaths. For the remainder, 34% occurred during reduced visibility; 12% during twilight, 22% in the dark, and 66% during daylight (Figure 16, Table 9b).

WATER TEMPERATURE Water temperature was unknown for 60% of deaths. For the remainder, it was reported to be extremely cold (<10°C) for 54%, cold or cool (10-20°C) for 42%, and warm or hot (>20°C) for 4% (Figure 16).

AIR TEMPERATURE Air temperature was unknown for 79% of deaths. For the remainder, it was extremely cold to cold for 63%, and moderate to hot for 37% (Table 9b).

ICE AND COLD WATER Based on the criteria used in Module 2 of the Canadian Red Cross's 10-year series (Ice & Cold Water), it is probable that cold water played a role in at least 36% of deaths.

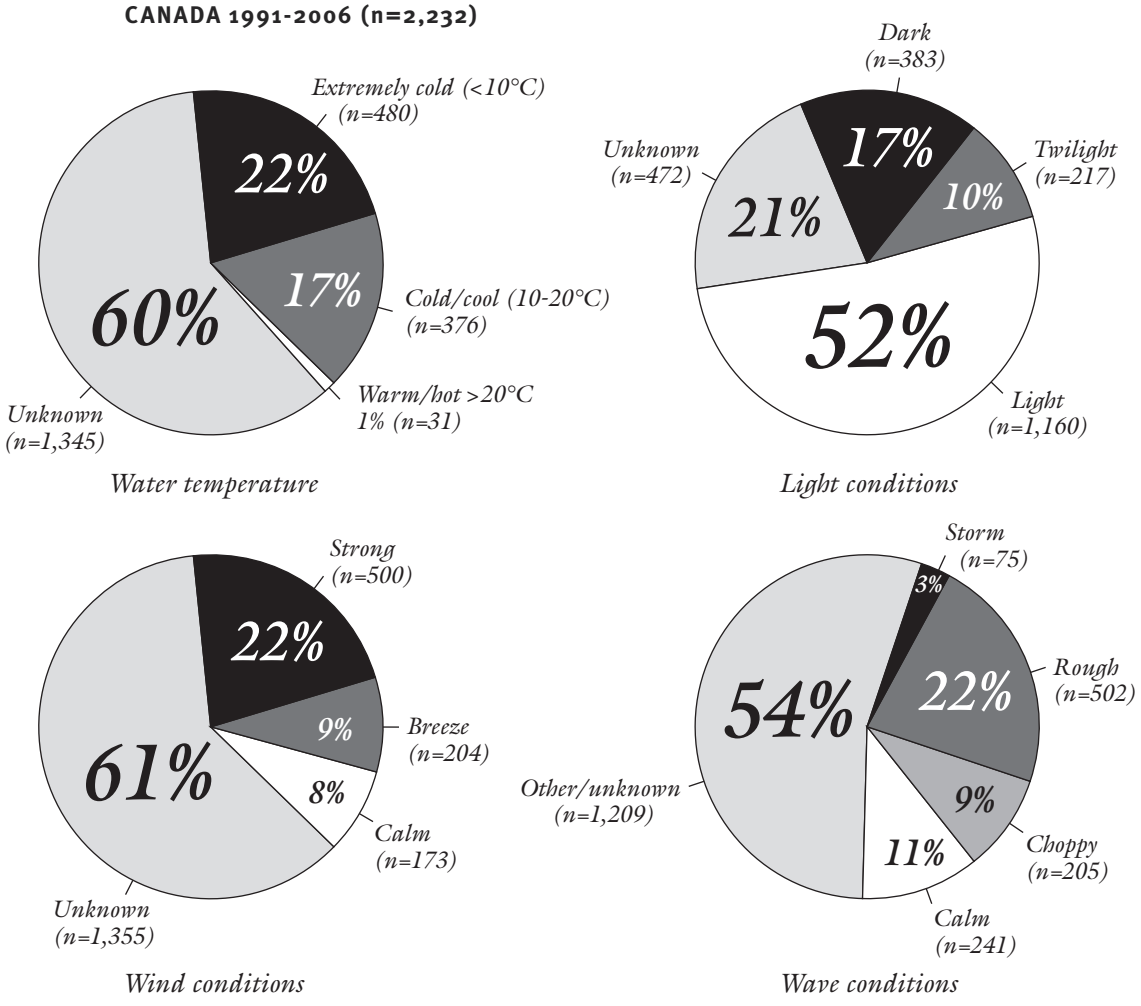
DEPTH OF WATER Depth was unknown for 60% of deaths. For the remainder, 16% actually occurred in water 2.5 metres or less deep (Figure 17, Table 9b).

DISTANCE FROM SHORE This was unknown for 58% of deaths. For the remainder, 46% occurred within 50 metres of shore, i.e., two lengths of a swimming pool, including 9% at 2 metres or less, 18% at 2.1-15m, and 19% at 16-50 metres (Figure 17, Table 9b).

DAY OF THE WEEK 44% of deaths took place on Saturdays and Sunday (Table 8c).

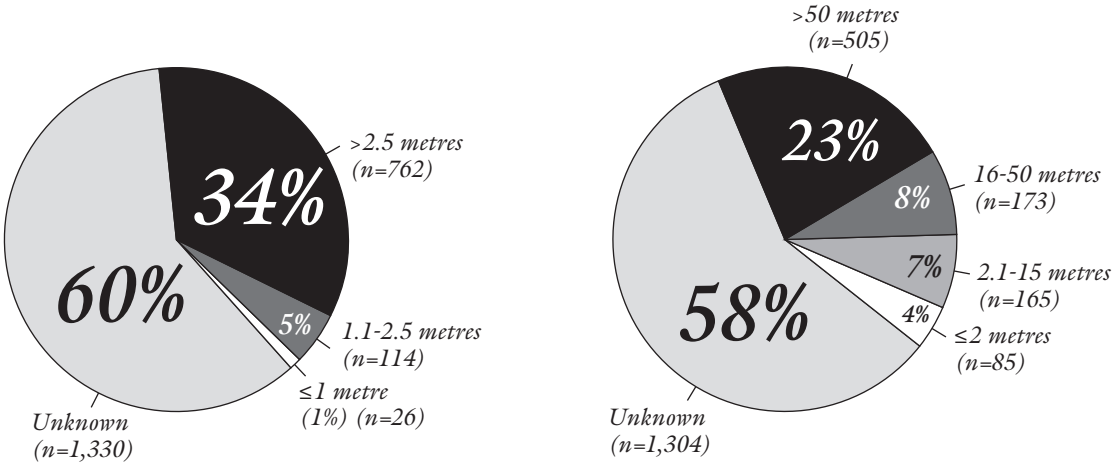
MONTH AND TYPE OF BOAT 86% of deaths occurred between May and October. 10% of unpowered deaths occurred during the spring months of March and April, compared with 5% of powered (Table 9c).

Figure 16 **RECREATIONAL BOATING* IMMERSION DEATHS† BY ENVIRONMENTAL RISK FACTORS, CANADA 1991-2006 (n=2,232)**



** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

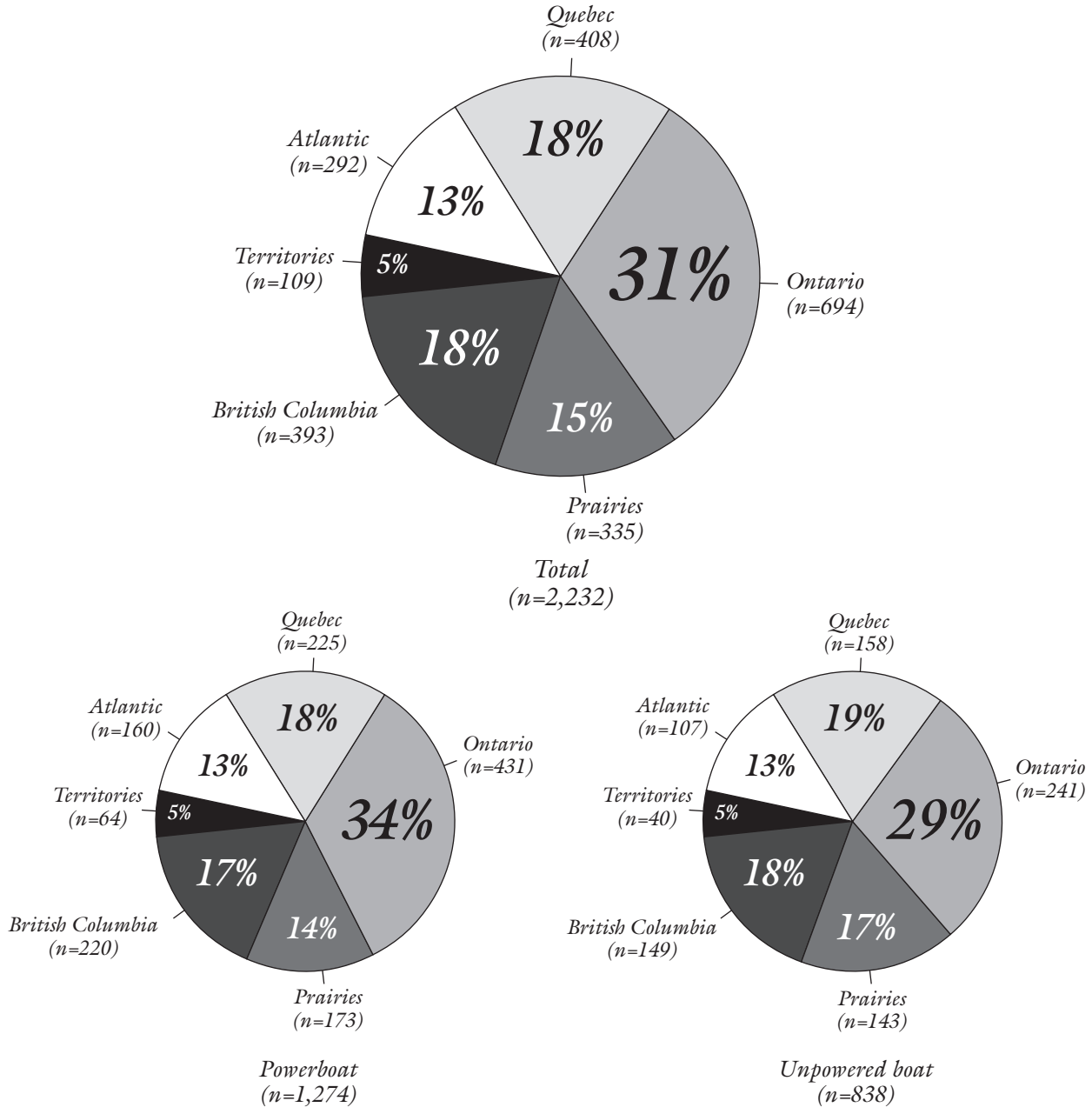
Figure 17 **RECREATIONAL BOATING* IMMERSION DEATHS† BY DEPTH OF WATER AND DISTANCE FROM SHORE, CANADA 1991-2006 (n=2,232)**



** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

REGION The highest proportions of all immersion deaths were seen in the provinces with the largest populations, Ontario, Quebec, and British Columbia (Figure 18, Table 9d).

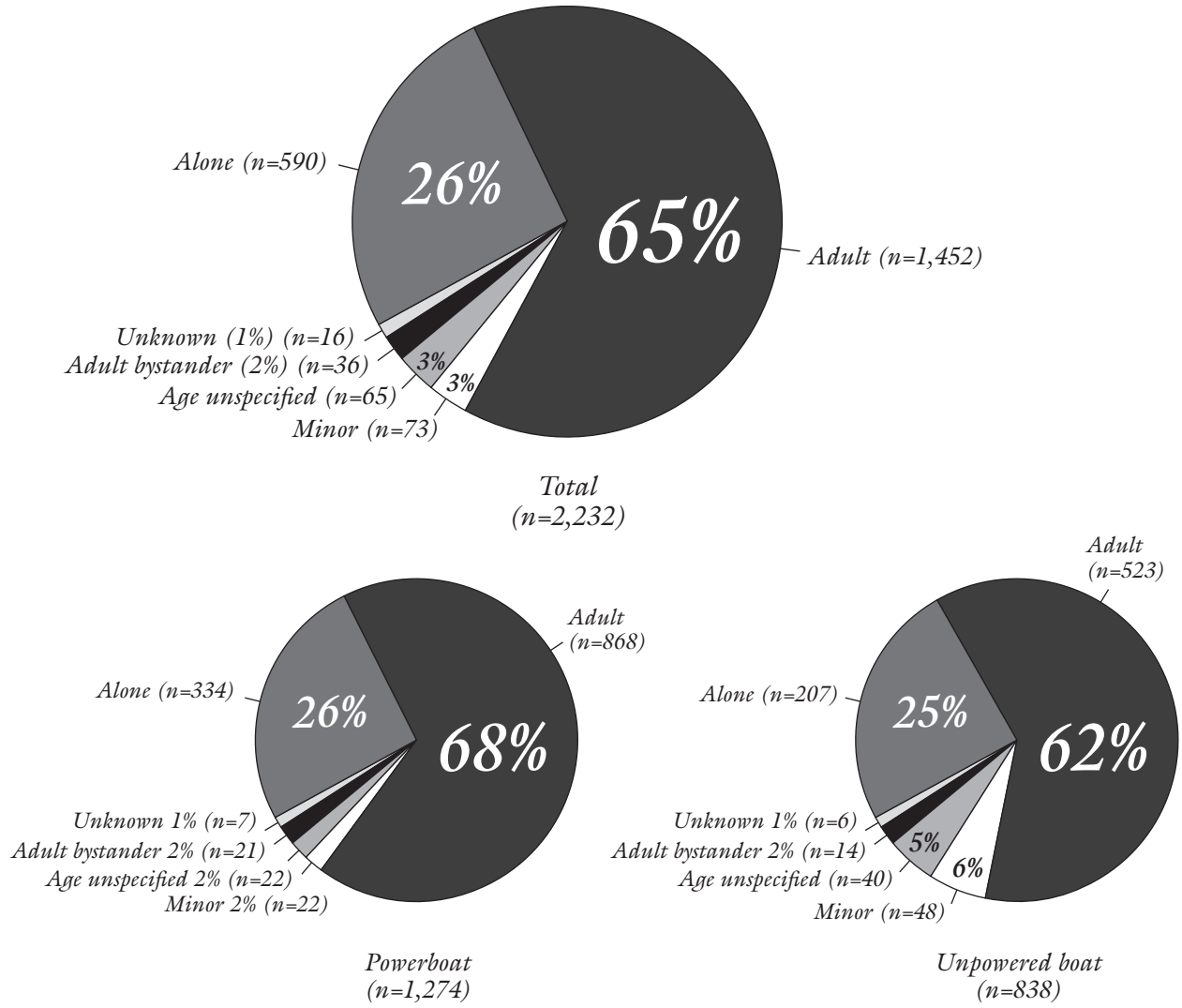
Figure 18 **RECREATIONAL BOATING* IMMERSION DEATHS† BY REGION, CANADA 1991-2006 (n=2,232)‡**



** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ Region was unknown for 1 powerboat victim

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

Figure 19 **RECREATIONAL BOATING* IMMERSION DEATHS† BY ACCOMPANIMENT,‡ CANADA 1991-2006 (n=2,232)**



** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ "Adult" indicates that victim was accompanied by adult(s); does not exclude presence of minor(s) (<18 years); "Minor" indicates presence of minors only

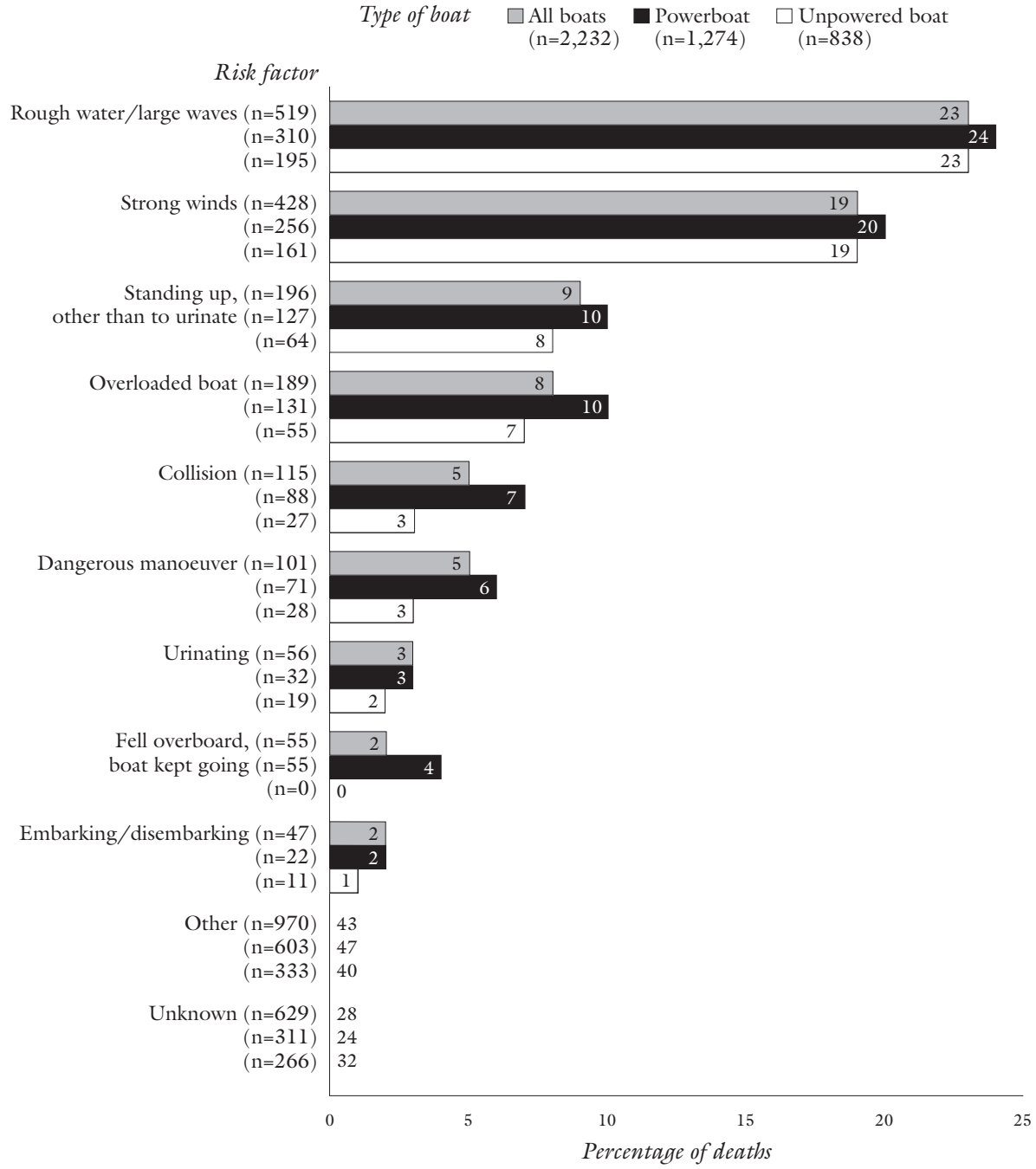
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

ACCOMPANIMENT 26% of immersion victims were alone, while 65% were accompanied by at least one adult, 3% only by minor(s), 3% by someone of unknown age, 2% by bystanders, and for 1% accompaniment was unknown (Figure 19, Table 9d).

MULTIPLE RISK FACTORS

In addition to strong winds and waves, other frequent contributors to immersion fatalities included standing up in the boat, losing balance while urinating, and overloading (Figure 20, Table 5). Wind and waves were a factor for a somewhat greater proportion of powerboat deaths than unpowered. At least 4% of powerboaters, and possibly many more, died after they fell in and the boat continued on without them, presumably due to lack of a dead man's engine cutoff, or non-use even when present. Such boats were often observed circling empty by bystanders on shore. In addition to these immersion deaths, a few boaters died of trauma after being run over and killed by their own boat and/or propeller.

Figure 20 **RECREATIONAL BOATING* IMMERSION DEATHS† BY VARIOUS CONTRIBUTING RISK FACTORS‡ AND BY TYPE OF BOAT, CANADA 1991-2006 (n=2,232)**



** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ There may be more than one contributing risk factor per incident

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

Trauma deaths, including all injury fatalities other than immersions, accounted for 5% of boating fatalities (135/2,765) during 1991-2006.

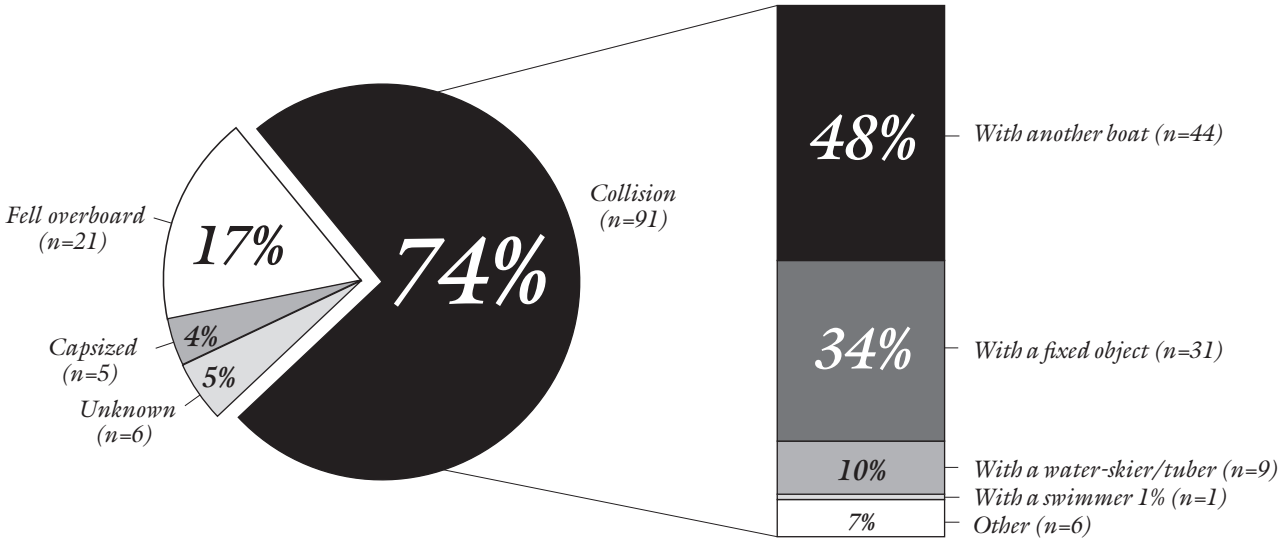
PURPOSE 123 trauma deaths (91%) were recreational, 10 (7%) were occupational, and for 2 (1%) the purpose was other/unknown. Only recreational incidents are discussed here.

TYPE OF BOAT 89% of recreational trauma deaths involved powerboats and 10% unpowered; for the remaining 1% it was unknown whether the boat was powered or not (Table 3c).

TYPE OF INCIDENT 74% of deaths resulted from various types of collisions, 17% from falling overboard, 4% from capsizing and 5% from unknown causes (Figure 21, Table 11c).

COLLISIONS Collisions included 48% between two boats; 34% boat with a fixed object; 10% boat with a person being towed, including 2 water skiers and 7 tubers; and 1% boat with a swimmer or person in the water (Figure 21, Table 11c). 5 collisions resulted in propeller injuries. Collisions accounted for 79% of powerboat and 25% of unpowered boat trauma deaths (Table 5c). (Collisions also contributed to 95 immersion deaths, including 6% of powered and 2% of unpowered; Table 5b).

Figure 21 **RECREATIONAL BOATING* TRAUMA DEATHS† BY TYPE OF INCIDENT AND TYPE OF COLLISION, CANADA 1991-2006 (n=123)**



** Includes boating during recreation and daily life † Includes all injury fatalities other than immersion deaths*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

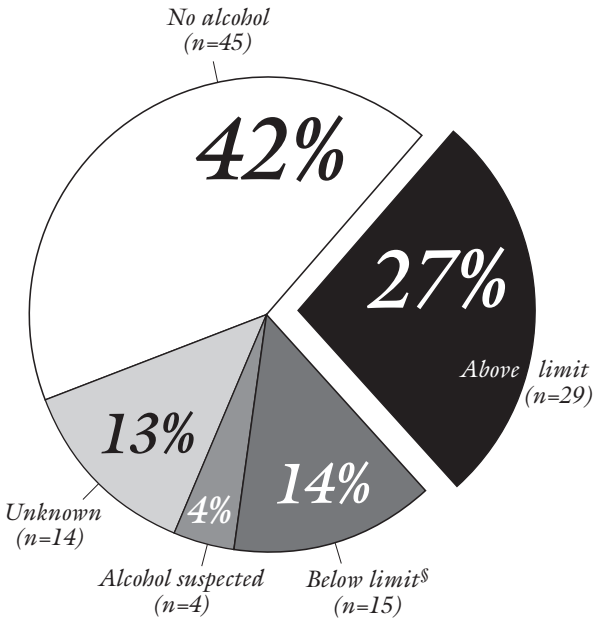
TYPE OF INJURY Traumatic incidents frequently resulted in head injury, which contributed to at least 44% of boating trauma deaths, 44% of powered and 50% of unpowered. Other injuries included spinal injury in 9%, fractures in 15%, and major lacerations in 24% (Table 10c). Victims often sustained multiple injuries.

PERSONAL FACTORS

AGE AND SEX Children less than 15 years old were disproportionally involved in trauma as compared with immersions, accounting for 13% of trauma deaths, compared with 3% of immersion deaths (Tables 16a, 7a). The same applied to females, who represented 25% of trauma deaths compared with only 7% of immersion deaths. Children and females were also overrepresented among personal watercraft (PWC) trauma deaths (Table 16a).

ALCOHOL Trauma-related fatalities during boating were often associated with alcohol. Alcohol was present or suspected for 45% of victims, as compared with 46% for immersion deaths (Figures 22, 7, 8, Tables 15a, 16a, 7b).

Figure 22 **BLOOD ALCOHOL LEVELS* FOR TRAUMA DEATHS† DURING RECREATIONAL BOATING,‡ CANADA 1991-2006 (VICTIMS ≥15 YEARS OF AGE; n=107)**



** Legal limit is 80 mg% † Includes all injury fatalities other than immersion deaths ‡ Includes boating during recreation and daily life; excludes occupational boating § 11 at 1-49 mg %, 3 at 50-80 mg %, 1 unspecified*

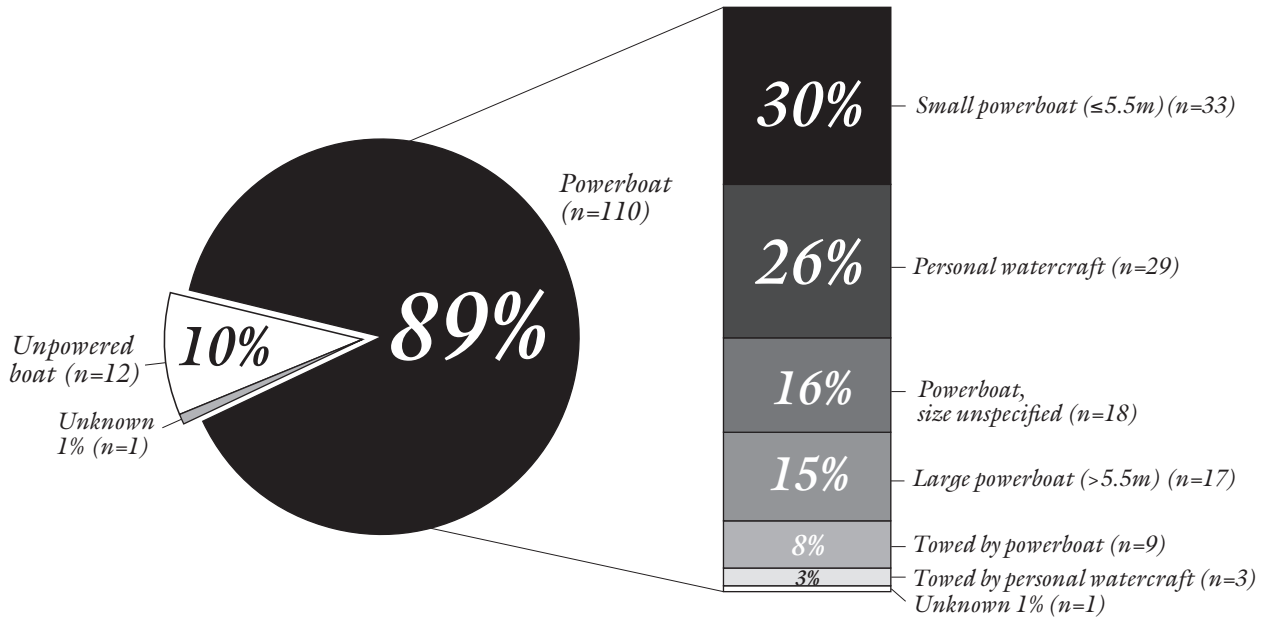
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

EQUIPMENT FACTORS

TYPE OF BOAT AND EXTERNAL CAUSE OF INJURY 79% of powerboat trauma deaths resulted from collisions and most of the remainder from falling in the boat, falling overboard, or being ejected in fast turns. For unpowered boats, only 25% resulted from collisions, with the remainder from falling overboard (Table 5c).

POWERBOATS 89% of victims were boating in or being towed by a powerboat. PWCs and large powerboats were disproportionately associated with death by trauma as compared with death by immersion (Figure 23, Table 4a). Small open powerboats and size unknown powerboats, probably mainly small, were frequently involved in both trauma and immersions deaths.

Figure 23 **RECREATIONAL BOATING* TRAUMA DEATHS† BY TYPE OF BOAT, CANADA 1991-2006 (n=123)**



** Includes boating during recreation and daily life † Includes all injury fatalities other than immersion deaths*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

PERSONAL WATERCRAFT While PWCs accounted for only 2% of powerboat immersion deaths, they were involved in 29% of powerboat trauma fatalities, including 3% of cases where the person was being towed by a PWC (Figure 23, Table 4b). Furthermore, PWCs contributed to some of the unpowered trauma deaths: in one case, a canoeist was fatally injured after being struck by a PWC.

POWERBOAT TRAUMA & SWIMMERS Powerboats including PWCs also pose a risk of blunt trauma or massive propeller chop lacerations to people already in the water, such as swimmers, boaters who have fallen in, and others involved in aquatic activities such as diving and wading. There were at least 7 such victims.

SAFETY HELMET While safety helmets are used by many river kayakers, they are rarely seen on powerboaters, even in high speed jetboats and PWCs. Data are not available for whether any of the PWC or other high speed powerboat victims were wearing a safety helmet.

OTHER EQUIPMENT FACTORS Absent or inappropriate lighting is another risk factor for collisions. A number of collisions did involve boats travelling without lights; however, coroner and police data are incomplete for this variable so it cannot be quantified. Another issue is the lack of steerability and control of a PWC when the throttle and power jet are cut without any rudder to steer the vessel; the frequency of this factor in fatal collisions is unknown. Finally, few high speed powerboats have safety restraints, air bags, dash padding, or collapsible bows to absorb kinetic energy and prevent death in the event of a high-speed crash.

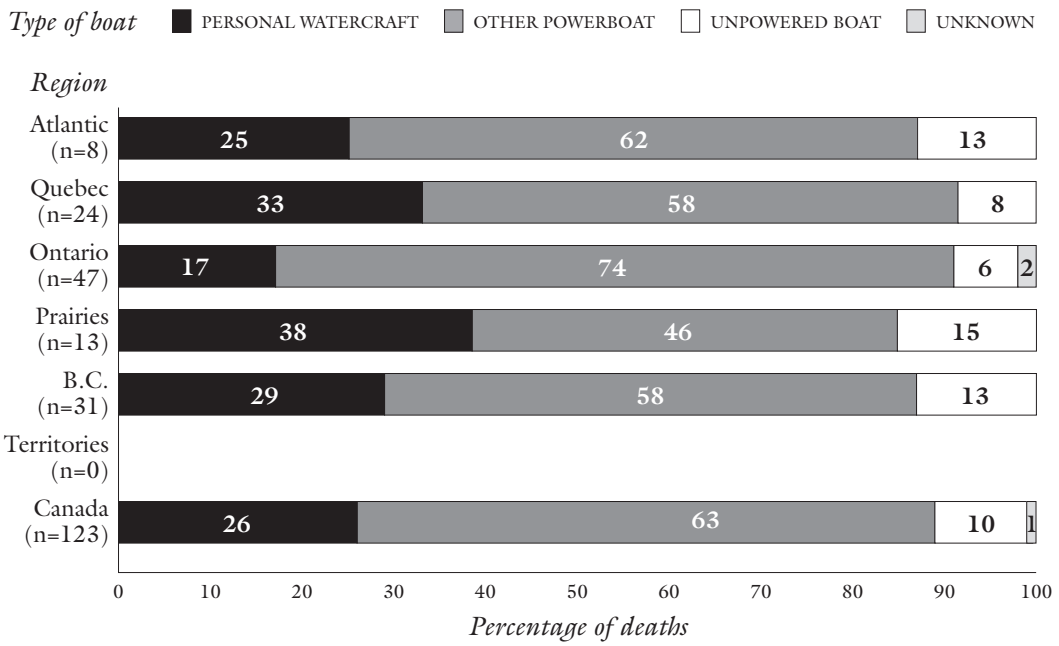
ENVIRONMENTAL FACTORS

LIGHT CONDITIONS The main pertinent environment factor for collisions is probably poor light conditions. 36% of trauma deaths occurred during darkness or twilight (Table 16b).

REGION The proportion of trauma deaths by type of boat varied somewhat by region, with PWCs representing a higher percentage of deaths in the Prairies, Quebec and B.C. and other powerboats representing a higher percentage in Ontario (Figure 24).

Figure 24

RECREATIONAL BOATING* TRAUMA DEATHS† BY TYPE OF BOAT AND REGION, CANADA 1991-2006 (n=123)



** Includes boating during recreation and daily life † Includes all injury fatalities other than immersion deaths*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

There were 64 fatalities involving personal watercraft (PWC, jet ski) during 1991-2006, including 31 immersions and 33 trauma deaths (Table 4a) from head injury, multiple injuries, major lacerations (e.g. from propeller injury when a PWC operator fell in near a larger powerboat), and spinal injury.

PURPOSE 95% died during recreational activities, 2% during occupational activities and 3% during other/unknown activities. Only recreational fatalities will be discussed here.

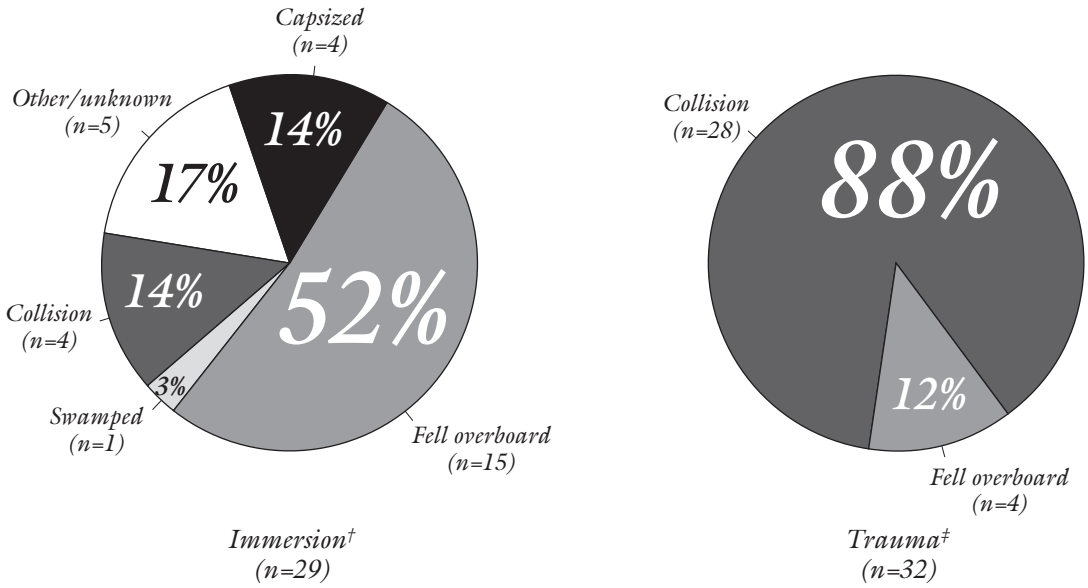
IMMERSIONS AND TRAUMA

There were 61 recreational fatalities involving PWC, including 29 immersion deaths and 32 trauma deaths (including 3 cases where the person was being towed by a PWC). PWCs accounted for 1% of all immersion deaths, 2% of powerboat immersion deaths, 26% of all trauma deaths and 29% of powerboat trauma deaths.

Given the small number of immersion fatalities and the large proportion of trauma victims, this section will combine discussion of immersion and trauma deaths.

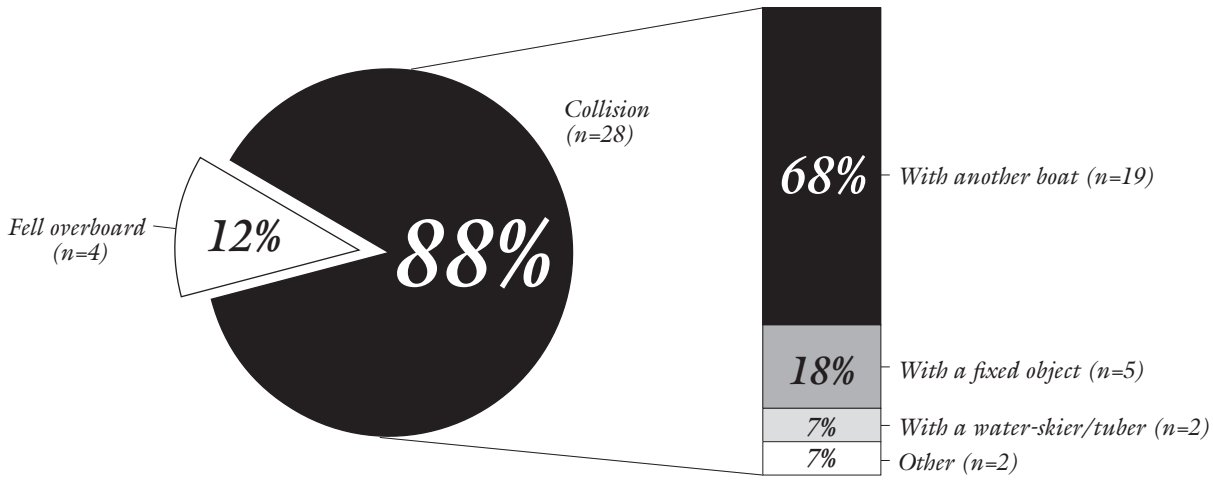
TYPE OF INCIDENT Overall, 32 victims died following a collision (52%), 19 fell overboard (31%), 4 capsized (7%), 1 was swamped (2%), 1 had other causes (2%); circumstances were unknown for the remaining 4 victims (7%) (Table 11a). Immersion deaths most often resulted from falling overboard, while nearly all trauma deaths resulted from collision (Figure 25, Tables 11b, c). Collisions resulting in trauma deaths included boat with another boat 68%, boat with a fixed object 18%, and persons being towed by a PWC 7% (Figure 26, Table 11c). Propeller injury and major chop lacerations accounted for 18% of trauma deaths resulting from collision (Table 11c).

Figure 25 **RECREATIONAL* PERSONAL WATERCRAFT FATALITIES BY NATURE OF INJURY AND TYPE OF INCIDENT, CANADA 1991-2006 (n=61)**



** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths ‡ Includes all other injury fatalities*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

Figure 26 **RECREATIONAL* PERSONAL WATERCRAFT FATALITIES BY TYPE OF INCIDENT AND TYPE OF COLLISION, CANADA 1991-2006 (n=61)**



** Includes boating during recreation and daily life*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

PERSONAL FACTORS

AGE & SEX Males accounted for 85% of PWC fatalities during 1991-2006, with those 15 to 24 years at highest risk for both drowning and trauma (Table 14a). Females and children were overrepresented in PWC trauma deaths. While females accounted for only 3% of PWC immersion deaths, they represented 25% of trauma deaths; similarly, children under 15 accounted for only 3% of immersion deaths but for 19% of trauma deaths (Tables 14a, 15a, 16a).

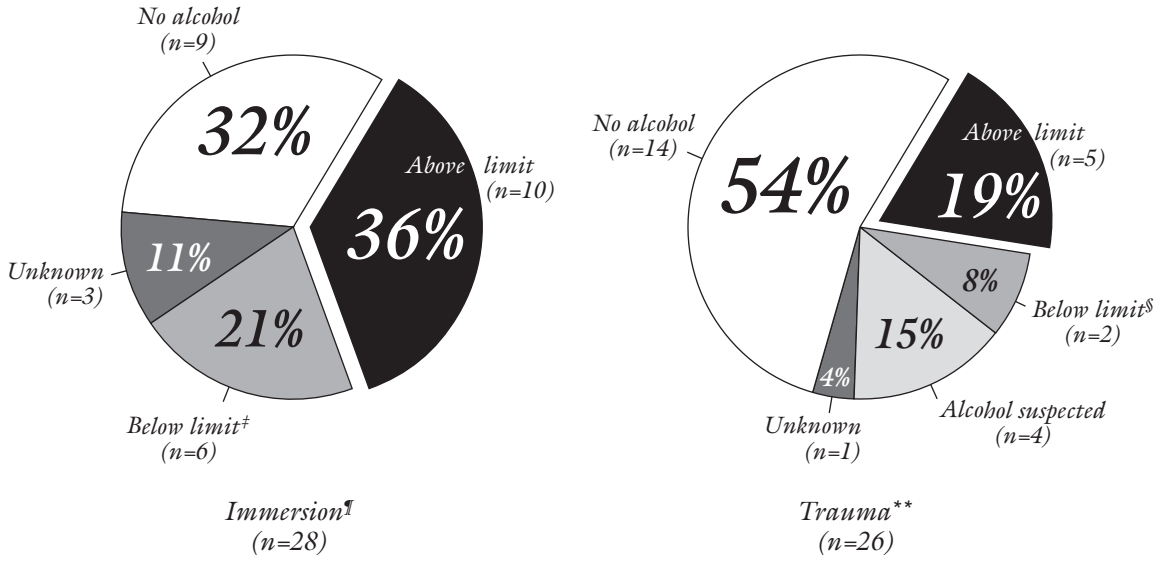
ALCOHOL Alcohol was present or suspected for 50% of PWC victims 15 years of age and older, possibly more since alcohol was unknown in 7% of cases (Table 14a). Alcohol was present or suspected in a higher proportion of immersion deaths than of trauma deaths (Figure 27, Tables 15a, 16a).

SWIMMING ABILITY Swimming ability was unknown for 75% of PWC victims. For the remainder, 33% were weak or non swimmers, 27% were average or strong swimmers and 40% were swimmers of unspecified ability (Table 14a).

BOATING EXPERIENCE Boating experience was unknown for 61% of PWC victims. For the remainder, 42% were experienced boaters, 54% inexperienced and 4% occasional boaters (Table 14a).

ETHNICITY Although aboriginal peoples were over-represented in most categories of water-related fatality, they accounted for only 3% of PWC fatalities, roughly equivalent to the proportion they represent of the Canadian population (Table 14a).

Figure 27 **BLOOD ALCOHOL LEVELS* FOR PERSONAL WATERCRAFT FATALITIES DURING RECREATIONAL BOATING† BY NATURE OF INJURY, CANADA 1991-2006 (VICTIMS ≥15 YEARS OF AGE; n=54)**



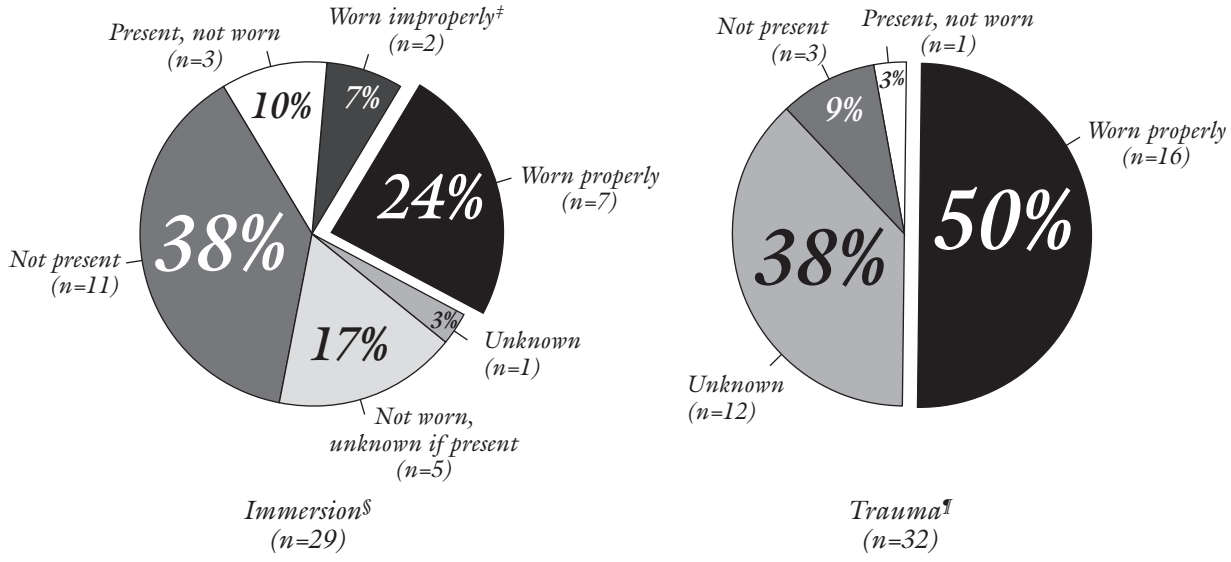
** Legal limit is 80 mg% † Includes boating during recreation and daily life*
‡ 3 at 1-49 mg %, 2 at 50-80 mg %, 1 unspecified § 1 at 1-49 mg %, 1 unspecified
*¶ Includes drownings and immersion hypothermia deaths ** Includes all other injury fatalities*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

EQUIPMENT FACTORS

FLOTATION 24% of immersion victims were properly wearing a flotation device (Figure 28, Tables 13b, c), while 50% of trauma victims were doing so.

Figure 28 **RECREATIONAL* PERSONAL WATERCRAFT FATALITIES BY NATURE OF INJURY AND USE OF A FLOTATION DEVICE,† CANADA 1991-2006 (n=61)**



** Includes boating during recreation and daily life † Personal flotation device (PFD) or lifejacket ‡ Not fastened or inappropriate size*
§ Includes drownings and immersion hypothermia deaths ¶ Includes all other injury fatalities

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2010

ENVIRONMENTAL FACTORS

BODY OF WATER 69% of fatalities occurred in lakes, 18% in rivers, 10% in the ocean, 2% in canals/other locations, and 2% were in an unknown location (Table 14b).

WIND AND WAVES Wind conditions were unknown for 80% of fatalities (Table 15b, 16b). For the remainder, wind was described as strong for 8%, breezy for 58% and calm for 33%. Wave conditions were unknown or other for 75% of victims (Table 15b, 16b). For the remainder, it was calm for 40%, choppy for 40% and rough for 20%; no storm weather was reported.

The next 3 factors were not considered for trauma victims, as water and air temperatures were not significant factors for traumatic incidents.

WATER TEMPERATURE Water temperature was unknown for 69% of PWC immersion fatalities. For the remainder, it was reported to be extremely cold (<10°C) for 44%, cold or cool (10-20°C) for 33%, and warm or hot (>20°C) for 22% (Table 15b).

AIR TEMPERATURE Air temperature was unknown for 76% of PWC immersion deaths. For the remainder, it was cold for 29%, moderate for 29%, warm for 29% and hot for 14%; no extremely cold air temperatures were reported (Table 15b).

ICE AND COLD WATER Based on the criteria used in Module 2 of the 1991-2000 series (Ice & Cold Water), it is probable that cold water was a factor in 17% of PWC immersion deaths.

LIGHT CONDITIONS Light conditions were unknown for 10% of PWC immersion victims. For the remainder 73% of deaths occurred during daylight, 15% at twilight and 12% in darkness (Table 15b). As for PWC trauma deaths, light conditions were unknown for 6%. For the remainder 83% of deaths occurred during daylight, 10% at twilight and 7% in darkness (Table 16b).

MONTH AND DAY All fatalities occurred between April and October, 89% between May and August. 70% of deaths took place between Friday and Sunday (Table 14b).

REGION The highest proportion of immersion fatalities was seen in Quebec and the Prairie provinces, followed by Ontario. The highest proportion of trauma fatalities was seen in British Columbia. There were no PWC deaths identified in the northern territories during 1991-2006, but there were 5 immersion deaths in the northern territories where the type of boat was unknown (Tables 15b, 16b).

ACCOMPANIMENT 17% of immersion victims were alone, while 66% were accompanied by at least one adult, 7% only by minor(s) and 10% by someone of unknown age. 6% of trauma victims were alone, while 72% were accompanied by at least one adult, 9% only by minor(s) and 13% by someone of unknown age (Tables 15b, 16b). For children less than 15 years old who died from trauma or immersion, none was alone, 71% were accompanied by at least one adult, 14% only by minor(s), and 14% by someone of unknown age.

Table 1 **Estimated trends in total boating fatalities by years, Canada 1991-2006**				
Time period	**1991-1995**	**1996-2000**	**2001-2005**	**2006**
Number of deaths in Red Cross database	1098	888	671	108
Estimated % missing deaths	5*	0*	17†	33†
Estimated number missing deaths	56	0	115	35
Estimated total deaths	1154	888	786	143
Census population ‡	27,296,855	28,846,760	30,007,095	31,612,895
Death rate/100,000 pop/year	0.84	0.61	0.52	0.45

** Based on data provided by Quebec: 8% missing (29/364), Alberta: 0% missing & British Columbia: 0% missing*

† Based on data provided by PEI: 43% missing (3/7), New Brunswick: 10% missing (4/ 41), Quebec: 20% missing (32/163), Alberta: 0% missing, British Columbia: 27% missing (43/157) & Yukon: 0% missing ‡ Source: Statistics Canada – 2006 Census. Catalogue Number 97-551-XCB2006005

Table 2a **Boating fatalities* by type of boat and years, Canada 1991-2006 (n=2,765)**										
Time period	**1991-1995 (n=1,098)**		**1996-2000 (n=888)**		**2001-2005 (n=671)**		**2006 (n=108)**		**1991-2006 (n=2,765)**	
Type of boat	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Powerboat†	**731**	**67**	**563**	**63**	**378**	**56**	**66**	**61**	**1,738**	**63**
Small outboard (≤5.5 m)	365	33	238	27	137	20	30	28	770	28
Other small open (e.g. inflatable)	42	4	44	5	49	7	1	1	136	5
Size unknown	105	10	114	13	87	13	14	13	320	12
Large (>5.5 m)	181	16	130	15	88	13	17	15	416	15
Personal watercraft	20	2	30	3	11	2	3	3	64	2
Other powerboat	0	0	1	<1	0	0	0	0	1	<1
Unknown powerboat	18	2	6	1	6	1	1	1	31	1
Unpowered boat	**307**	**28**	**282**	**32**	**255**	**38**	**39**	**36**	**883**	**32**
Canoe	199	18	156	18	151	22	28	26	534	19
Rowboat	32	3	38	4	13	2	5	4	88	3
Sailboat or sailboard	25	2	35	4	22	3	1	1	83	3
Kayak	23	2	20	2	33	5	1	1	77	3
Inflatable	17	2	22	2	18	3	3	3	60	2
Other unpowered boat	9	1	9	1	13	2	1	1	32	1
Unknown unpowered boat	2	<1	2	<1	5	1	0	0	9	<1
Unknown if powered	**60**	**5**	**43**	**5**	**38**	**6**	**3**	**3**	**144**	**5**

** Includes death from all causes: drowning, immersion hypothermia, and trauma*

† Includes cases where the victim was being pulled by a powerboat (included waterskiing 5, riding on a tube or other device 14)

Table 2b **Boating immersion deaths* by type of boat and years, Canada 1991-2006 (n=2,630)**										
Time period	**1991-1995 (n=1,053)**		**1996-2000 (n=838)**		**2001-2005 (n=640)**		**2006 (n=99)**		**1991-2006 (n=2,630)**	
Type of boat	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Powerboat†	**689**	**65**	**516**	**62**	**353**	**55**	**58**	**59**	**1,616**	**61**
Small outboard (≤5.5 m)	355	34	233	28	130	20	27	28	745	28
Other small open (e.g. inflatable)	39	4	38	4	49	8	1	1	127	5
Size unknown	96	9	107	13	79	12	12	12	294	11
Large (>5.5 m)	169	16	118	14	84	13	17	17	388	15
Personal watercraft	12	1	13	2	6	1	0	0	31	1
Other powerboat	0	0	1	<1	0	0	0	0	1	<1
Unknown powerboat	18	2	6	1	5	1	1	1	30	1
Unpowered boat	**304**	**29**	**279**	**33**	**250**	**39**	**38**	**38**	**871**	**33**
Canoe	198	19	156	19	151	23	28	28	533	20
Rowboat	32	3	38	4	12	2	4	4	86	3
Sailboat or sailboard	25	2	33	4	20	3	1	1	79	3
Kayak	23	2	20	2	32	5	1	1	76	3
Inflatable	15	1	21	3	17	3	3	3	56	2
Other unpowered boat	9	1	9	1	13	2	1	1	32	1
Unknown unpowered boat	2	<1	2	<1	5	1	0	0	9	1
Unknown if powered	**60**	**6**	**43**	**5**	**37**	**6**	**3**	**3**	**143**	**6**

** Includes drownings and immersion hypothermia deaths*

† Includes cases where the victim was being pulled by a powerboat (included waterskiing 2, riding on tube or other device 5)

Table 2c **Boating trauma deaths* by type of boat and years, Canada 1991-2006 (n=135)**										
Time period	**1991-1995 (n=45)**		**1996-2000 (n=50)**		**2001-2005 (n=31)**		**2006 (n=9)**		**1991-2006 (n=135)**	
Type of boat	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Powerboat	**42**	**93**	**47**	**94**	**25**	**81**	**8**	**89**	**122**	**90**
Small outboard (≤5.5 m)	10	22	5	10	7	23	3	33	25	18
Other small open (e.g. inflatable)	3	7	6	12	0	0	0	0	9	7
Size unknown	6	13	5	10	7	23	0	0	18	13
Large (>5.5 m)	11	24	12	24	4	13	0	0	27	20
Personal watercraft (PWC)	7	16	16	32	4	13	3	33	30	22
Towed by PWC†	1	2	1	2	1	3	0	0	3	2
Towed by powerboat†	4	9	2	4	1	3	2	23	9	7
Unknown powerboat	0	0	0	0	1	3	0	0	1	1
Unpowered boat	**3**	**7**	**3**	**6**	**5**	**16**	**1**	**11**	**12**	**9**
Canoe	1	2	0	0	0	0	0	0	1	1
Rowboat	0	0	0	0	1	3	1	11	2	1
Sailboat or sailboard	0	0	2	4	2	7	0	0	4	3
Kayak	0	0	0	0	1	3	0	0	1	1
Inflatable	2	5	1	2	1	3	0	0	4	3
Unknown if powered	**0**	**0**	**0**	**0**	**1**	**3**	**0**	**0**	**1**	**1**

** Includes all injury fatalities other than immersion deaths † Included waterskiing 9, riding on tube or other device 3*

Table 3a **Boating fatalities* by purpose, activity, years, and power type, Canada 1991-2006 (n=2,765)†**														
Time period	**1991-1995 (n=1,098)**		**1996-2000 (n=888)**		**2001-2005 (n=671)**		**2006 (n=108)**		**1991-2006 (n=2,765)**		**Powered boating (n=1,738)**		**Unpowered boating (n=883)**	
Activity by purpose	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Recreational‡	**915**	**83**	**763**	**86**	**582**	**87**	**95**	**88**	**2,355**	**85**	**1,384**	**80**	**850**	**96**
Fishing	333	30	254	29	203	30	33	30	823	30	537	31	213	24
Powerboating	229	21	198	22	116	17	23	21	566	20	566	33	0	0
Canoeing	115	10	90	10	89	13	14	13	308	11	0	0	308	35
Boat travel	94	9	31	3	28	4	3	3	156	6	120	7	21	2
Hunting	44	4	66	7	38	6	8	7	156	6	99	6	49	6
Sailing	20	2	30	3	20	3	1	1	71	3	0	0	71	8
Kayaking	19	2	20	2	30	4	1	1	70	3	0	0	70	8
Other activity	22	2	20	2	11	2	2	2	55	2	31	2	10	1
Other, unpowered	11	1	11	1	12	2	2	2	36	1	0	0	35	4
White water rafting	7	1	8	1	7	1	1	1	23	1	1	<1	22	2
Towed by boat§	8	1	5	1	4	1	2	2	19	1	19	1	0	0
Rowing	2	<1	13	1	5	1	1	1	21	1	0	0	21	2
Other rafting	3	<1	8	1	3	<1	0	0	14	1	0	0	14	2
Pedal boating	1	<1	2	<1	8	1	3	3	14	1	0	0	14	2
Embarking/ disembarking	2	<1	4	1	3	1	0	0	9	<1	4	<1	1	<1
Swimming	2	<1	1	<1	2	<1	1	1	6	<1	4	<1	0	0
Partying	0	0	1	<1	2	<1	0	0	3	<1	2	<1	1	<1
Unknown	3	<1	1	<1	1	<1	0	0	5	<1	1	<1	0	0

** Includes death from all causes: drowning, immersion hypothermia, and trauma*

† In 144 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns

‡ Includes boating during recreation and daily life § Included waterskiing 5, riding on tube or other device 14

Table 3a **Boating fatalities* by purpose, activity, years, and power type, Canada 1991-2006 (n=2,765)†** (continued)

Time period	1991-1995 (n=1,098)		1996-2000 (n=888)		2001-2005 (n=671)		2006 (n=108)		1991-2006 (n=2,765)		Powered boating (n=1,738)		Unpowered boating (n=883)	
Activity by purpose	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Occupational	**153**	**14**	**101**	**11**	**68**	**10**	**11**	**10**	**333**	**12**	**315**	**18**	**12**	**1**
Commercial fishing	84	8	64	7	41	6	9	8	198	7	192	11	6	1
Marine shipping	40	4	10	1	3	1	2	2	55	2	55	3	0	0
Fishing guiding or Charter	3	<1	4	1	3	1	0	0	10	<1	7	<1	2	<1
Aquaculture	3	<1	3	<1	1	<1	0	0	7	<1	6	<1	0	0
Other	22	2	19	2	20	3	0	0	61	2	53	3	4	<1
Unknown	1	<1	1	<1	0	0	0	0	2	<1	2	<1	0	0
Rescue	**13**	**1**	**14**	**2**	**10**	**2**	**1**	**1**	**38**	**1**	**19**	**1**	**15**	**2**
Other	**0**	**0**	**4**	**1**	**2**	**<1**	**0**	**0**	**6**	**<1**	**4**	**<1**	**1**	**<1**
Unknown	**17**	**2**	**6**	**1**	**9**	**1**	**1**	**1**	**33**	**1**	**16**	**1**	**5**	**1**

** Includes death from all causes: drowning, immersion hypothermia, and trauma*

† In 144 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns

Table 3b **Boating immersion deaths* by purpose, activity, years, and power Canada 1991-2006 (n=2,630)†**

Time period	1991-1995 (n=1,053)		1996-2000 (n=838)		2001-2005 (n=640)		2006 (n=99)		1991-2006 (n=2,630)		Powered boating (n=1,616)		Unpowered boating (n=871)	
Activity by purpose	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Recreational‡	**873**	**83**	**718**	**86**	**555**	**87**	**86**	**87**	**2,232**	**85**	**1,274**	**79**	**838**	**96**
Fishing	332	32	252	30	198	31	32	33	814	31	530	33	212	24
Powerboating	201	19	164	20	102	16	18	18	485	18	485	30	0	0
Canoeing	114	11	90	11	89	14	14	14	307	12	0	0	307	35
Boat travel	90	9	29	4	28	5	3	3	150	6	114	7	21	2
Hunting	44	4	65	8	38	6	8	8	155	6	98	6	49	6
Sailing	20	2	29	4	18	3	1	1	68	3	0	0	68	8
Kayaking	19	2	20	2	29	5	1	1	69	3	0	0	69	8
Other unpowered boating	11	1	11	1	12	2	2	2	36	1	0	0	35	4
White water rafting	5	<1	7	1	6	1	1	1	19	1	1	<1	18	2
Other rafting	3	<1	8	1	3	<1	0	0	14	1	0	0	14	2
Towed by boat§	3	<1	2	<1	2	<1	0	0	7	<1	7	1	0	0
Rowing	2	<1	13	2	4	1	0	0	19	1	0	0	19	2
Pedal boating	1	<1	2	<1	8	1	3	3	14	1	0	0	14	2
Boarding or leaving boat	2	<1	4	<1	3	<1	0	0	9	<1	4	<1	1	<1
Swimming	2	<1	1	<1	1	<1	1	1	5	<1	3	<1	0	0
Partying	0	0	1	<1	2	<1	0	0	3	<1	2	<1	1	<1
Other activity	21	2	19	2	11	2	2	2	53	2	29	2	10	1
Unknown	3	<1	1	<1	1	<1	0	0	5	<1	1	<1	0	0

** Includes drownings and immersion hypothermia deaths † In 143 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns ‡ Includes boating during recreation and daily life § Included water skiing 2, pulled on tube or other device 5*

Table 3b **Boating immersion deaths* by purpose, activity, years, and power, Canada 1991-2006 (n=2,630)†** (continued)														
Time period	**1991-1995**		**1996-2000**		**2001-2005**		**2006**		**1991-2006**		**Powered boating**		**Unpowered boating**	
	(n=1,053)		**(n=838)**		**(n=640)**		**(n=99)**		**(n=2,630)**		**(n=1,616)**		**(n=871)**	
Activity by purpose	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Occupational	**150**	**14**	**96**	**11**	**66**	**10**	**11**	**11**	**323**	**12**	**305**	**19**	**12**	**1**
Commercial fishing	82	8	63	8	41	7	9	9	195	7	189	12	6	1
Marine shipping	40	4	8	1	2	<1	2	2	52	2	52	3	2	<1
Fishing guiding or charter	3	<1	4	<1	3	<1	0	0	10	<1	7	1	0	0
Aquaculture	3	<1	3	<1	1	<1	0	0	7	<1	6	<1	0	0
Other activity	21	2	17	2	19	3	0	0	57	2	49	3	0	0
Unknown	1	<1	1	<1	**0**	**0**	0	0	2	<1	2	<1	4	<1
Rescue	**13**	**1**	**14**	**2**	**10**	**2**	**1**	**1**	**38**	**2**	**19**	**1**	**15**	**2**
Other	0	0	4	<1	1	<1	0	0	5	<1	3	<1	1	<1
Unknown	**17**	**2**	**6**	**1**	**8**	**1**	**1**	**1**	**32**	**1**	**15**	**1**	5	1

** Includes drownings and immersion hypothermia deaths † In 143 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns*

Table 3c **Boating trauma death* by purpose, activity, and years, Canada 1991-2006 (n=135)†**														
Time period	**1991-1995**		**1996-2000**		**2001-2005**		**2006**		**1991-2006**		**Powered boating**		**Unpowered boating**	
	(n=45)		**(n=50)**		**(n=31)**		**(n=9)**		**(n=135)**		**(n=122)**		**(n=12)**	
Activity by purpose	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Recreational‡	**42**	**93**	**45**	**90**	**27**	**87**	**9**	**100**	**123**	**91**	**110**	**90**	**12**	**100**
Fishing	1	2	2	4	5	16	1	11	9	7	7	6	1	8
Powerboating	28	62	34	68	14	45	5	56	81	60	81	66	0	0
Canoeing	1	2	0	0	0	0	0	0	1	1	0	0	1	8
Boat travel	4	9	2	4	0	0	0	0	6	4	6	5	0	0
Hunting	0	0	1	2	0	0	0	0	1	1	1	1	0	0
Sailing	0	0	1	2	2	7	0	0	3	2	0	0	3	25
Kayaking	0	0	0	0	1	3	0	0	1	1	0	0	1	8
White water rafting	2	5	1	2	1	3	0	0	4	3	0	0	4	33
Towed by boat§	5	11	0	0	2	7	2	22	12	9	12	10	0	0
Rowing	0	0	3	6	1	3	1	11	2	1	0	0	2	17
Other activity	1	2	1	2	0	0	0	0	2	1	2	2	0	0
Swimming	0	0	0	0	1	3	0	0	1	1	1	1	0	0
Occupational	**3**	**7**	**5**	**10**	**2**	**7**	**0**	**0**	**10**	**7**	**10**	**8**		
Commercial fishing	2	5	1	2	0	0	0	0	3	2	3	2	0	0
Marine shipping	0	0	2	4	1	3	0	0	3	2	3	2	0	0
Other activity	1	2	2	4	1	3	0	0	**4**	**3**	4	3	0	0
Other	0	0	0	0	1	3	0	0	1	1	1	1	0	0
Unknown	0	0	0	0	1	3	0	0	1	1	1	1	0	0

** Includes all injury fatalities other than immersion deaths*
† In 1 case it was unknown if the boat was powered or unpowered; it was excluded from the two right columns
‡ Includes boating during recreation and daily life § Included waterskiing 3, riding on tube or other device 9

Table 4 **Boating immersion* and trauma† deaths, Canada, 1991-2006 (n=2,765)**										
	Immersions								**Trauma**	
Categories	**All immersions (n=2,630)**		**Drownings without hypothermia (n=2,114)**		**Drownings with hypothermia & hypothermia with drowning (n=456)**		**Hypothermia without drowning (n=60)**		**All trauma (n=135)**	
4a **All boating by type of boat (n=2,765)‡**										
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Powerboat	**1,616**	**61**	**1,294**	**61**	**282**	**62**	**40**	**67**	**122**	**90**
Small outboard (≤5.5 m)	745	28	592	28	129	28	24	40	25	18
Other small open (e.g. inflatable)	126	5	99	5	22	5	5	8	9	7
Size unknown	288	11	253	12	35	8	0	0	18	13
Large (>5.5 m)	388	15	291	14	87	19	10	17	27	20
Personal watercraft	31	1	27	1	4	1	0	0	30	22
Towed by PWC	0	0	0	0	0	0	0	0	3	2
Towed by powerboat	7	<1	7	<1	0	0	0	0	9	7
Other powerboat	1	<1	1	<1	0	0	0	0	0	0
Unknown powerboat	30	1	24	1	5	1	1	2	1	1
Unpowered boat	**871**	**33**	**694**	**33**	**159**	**35**	**18**	**30**	**12**	**9**
Canoe	533	21	423	20	98	22	12	20	1	1
Rowboat	86	3	67	3	19	4	0	0	2	1
Sailboat or sailboard	79	3	64	3	14	3	1	2	4	3
Kayak	76	3	50	2	22	5	4	6	1	1
Inflatable	56	2	51	3	4	1	1	2	4	3
Other unpowered boat	32	1	31	2	1	<1	0	0	**0**	0
Unknown unpowered boat	9	<1	8	<1	1	<1	0	0	**0**	0
Unknown if powered	**143**	**6**	**126**	**6**	**15**	**3**	**2**	**3**	**1**	**1**
4b **Recreational boating§ by type of boat (n=2,355)**										
	n=2,232	**%**	**n=1,808**	**%**	**n=378**	**%**	**n=46**	**%**	**n=123**	**%**
Powerboat	**1,274**	**57**	**1,035**	**57**	**211**	**56**	**28**	**61**	**110**	**89**
Small outboard (≤5.5 m)	679	31	545	30	115	30	19	41	24	19
Other small open (e.g. inflatable)	112	5	90	5	18	5	4	9	9	7
Size unknown	253	11	223	12	30	8	0	0	18	15
Large (>5.5 m)	170	8	125	7	41	11	4	9	17	14
Personal watercraft	29	1	25	1	4	1	0	0	29	24
Towed by PWC	0	0	0	0	0	0	0	0	3	2
Towed by powerboat	7	<1	7	1	0	0	0	0	9	7
Other powerboat	1	<1	1	<1	0	0	0	0	0	0
Unknown powerboat	23	1	19	1	3	1	1	2	1	1
Unpowered boat	**838**	**38**	**669**	**37**	**153**	**40**	**16**	**35**	**12**	**10**
Canoe	520	23	415	23	94	25	11	24	1	1
Rowboat	79	4	60	3	19	5	0	0	2	2
Sailboat or sailboard	76	4	62	3	14	4	0	0	4	3
Kayak	73	3	49	3	20	5	4	9	1	1
Inflatable	55	3	50	3	4	1	1	2	4	3
Other unpowered boat	26	1	25	1	1	<1	0	0	0	0
Unknown unpowered boat	9	<1	8	1	1	<1	0	0	0	0
Unknown if powered	**120**	**5**	**104**	**6**	**14**	**4**	**2**	**4**	**1**	**1**

** Includes drownings and immersion hypothermia deaths † Includes all other injury fatalities ‡ Included 75 immersion fatalities for which the purpose of the activity was rescue 38, other 5, and unknown 32, and 2 trauma fatalities for which the purpose of the activity was other 1, and unknown 1*

§ Includes boating during recreation and daily life

Table 4 **Boating immersion* and trauma† deaths, Canada, 1991-2006 (n=2,765)** (continued)										
	Immersions								**Trauma**	
Categories	**All immersions (n=2,630)**		**Drownings without hypothermia (n=2,114)**		**Drownings with hypothermia & hypothermia with drowning (n=456)**		**Hypothermia without drowning (n=60)**		**All trauma (n=135)**	
4c **Occupational boating by type of boat (n=333)**										
	n=323	**%**	**n=247**	**%**	**n=66**	**%**	**n=10**	**%**	**n=10**	**%**
Powerboat	**305**	**94**	**231**	**94**	**65**	**98**	**9**	**90**	**10**	**100**
Small outboard (≤5.5 m)	51	16	37	15	11	16	3	30	1	10
Other small open (e.g. inflatable)	10	3	5	2	4	6	1	10	0	0
Size unknown	25	8	23	9	2	3	0	0	0	0
Large (>5.5 m)	211	65	160	65	46	70	5	50	9	90
Personal watercraft (jetski)	1	<1	1	<1	0	0	0	0	0	0
Unknown powerboat	7	2	5	2	2	3	0	0	0	0
Unpowered boat	**12**	**4**	**11**	**4**	**0**	**0**	**1**	**10**	**0**	**0**
Canoe	6	2	5	2	0	0	1	10	0	0
Rowboat	5	2	5	2	0	0	0	0	0	0
Other unpowered boat	1	<1	1	<1	0	0	0	0	0	0
Unknown if powered	**6**	**2**	**5**	**2**	**1**	**2**	**0**	**0**	**0**	**0**

** Includes drownings and immersion hypothermia deaths † Includes all other injury fatalities*

Table 5a **Recreational boating* fatalities† by incident, years and source of power, Canada 1991-2006 (n=2,355)‡**														
Time period	**1991-1995 (n=915)**		**1996-2000 (n=763)**		**2001-2005 (n=582)**		**2006 (n=95)**		**1991-2006 (n=2,355)**		**Powered boating (n=1,384)**		**Unpowered boating (n=850)**	
Incident	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Capsized	331	36	294	39	248	43	41	43	914	39	391	28	488	57
Fell/thrown overboard	245	27	190	25	137	24	21	22	593	25	420	30	130	15
Swamped	110	12	95	12	67	12	8	8	280	12	199	14	72	8
Collision	80	9	67	9	31	5	8	8	186	8	166	12	19	2
Jumped overboard§	2	<1	6	1	6	1	1	1	15	1	11	1	3	<1
Other	32	3	33	4	26	4	3	3	94	4	63	5	21	2
Unknown	115	13	78	10	67	12	13	14	273	12	134	10	117	14

** Includes boating during recreation and daily life † Includes death from all causes: drowning, immersion hypothermia, and trauma*
‡ In 121 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns
§ Jumped in to retrieve person or object

Table 5b **Recreational boating* immersion deaths† by incident, years and source of power, Canada 1991-2006 (n=2,232)‡**														
Time period	**1991-1995 (n=873)**		**1996-2000 (n=718)**		**2001-2005 (n=555)**		**2006 (n=86)**		**1991-2006 (n=2,232)**		**Powered boating (n=1,274)**		**Unpowered boating (n=838)**	
Incident	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Capsized	330	38	291	41	247	45	41	48	909	41	390	31	484	58
Fell/thrown overboard	240	27	184	26	127	23	21	24	572	26	402	32	127	15
Swamped	110	13	95	13	67	12	8	9	280	13	199	16	72	9
Collision	46	5	32	4	16	3	1	1	95	4	79	6	16	2
Jumped overboard§	2	0	6	1	6	1	1	1	15	1	11	1	3	0
Other	30	3	32	4	25	5	1	1	88	4	59	5	19	2
Unknown	115	13	78	11	67	12	13	15	273	12	134	11	117	14

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ In 120 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns § Jumped in to retrieve person or object

Table 5c **Recreational boating* trauma deaths† by incident, years and source of power, Canada 1991-2006 (n=123)‡**

Time period	1991-1995 (n=42)		1996-2000 (n=45)		2001-2005 (n=27)		2006 (n=9)		1991-2006 (n=123)		Powered boating (n=110)		Unpowered boating (n=12)	
Incident	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Capsized	1	2	3	7	1	4	0	0	5	4	1	1	4	33
Fall/thrown overboard	5	12	6	13	10	37	0	0	21	17	18	16	3	25
Collision	34	81	35	78	15	56	7	78	91	74	87	79	3	25
Other	2	5	1	2	1	4	2	22	6	5	4	4	2	17

** Includes boating during recreation and daily life † Includes all injury fatalities other than immersion deaths*
‡ In 1 case it was unknown if the boat was powered or unpowered; it was excluded from the two right columns

Table 6 **Recreational boating* immersion deaths† by contributing risk factors,‡ Canada 1991-2006 (n=2,232)§**

Time period	1991-1995 (n=873)		1996-2000 (n=718)		2001-2005 (n=555)		2006 (n=86)		1991-2006 (n=2,232)		Powered boating (n=1,274)		Unpowered boating (n=838)	
Cause	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Strong winds	132	15	160	22	122	22	14	16	428	19	256	20	161	19
Standing up in craft	64	7	80	11	46	8	6	7	196	9	127	10	64	8
Overloaded boat	61	7	70	10	51	9	7	8	189	8	131	10	55	7
Rough water/ large waves	180	21	188	26	134	24	17	20	519	23	310	24	195	23
Collisions	**43**	**5**	**42**	**6**	**26**	**5**	**4**	**5**	**115**	**5**	**88**	**7**	**27**	**3**
Boat with fixed object	26	3	33	5	24	4	4	5	87	4	66	5	21	3
Boat with another boat	15	2	9	1	2	<1	0	0	26	1	21	2	5	1
Boat with person (eg. swimmer)	2	<1	0	0	0	0	0	0	2	<1	1	<1	1	<1
Lost balance	24	3	18	3	13	2	1	1	56	3	32	3	19	2
Abrupt turn or other dangerous maneuver	13	1	40	6	43	8	5	6	101	5	71	6	28	3
Boarding or leaving moored boat	15	2	14	2	16	3	2	2	47	2	22	2	11	1
Victim fell off boat and boat kept going	0	0	19	3	27	5	9	10	55	2	55	4	0	0
Starting motor (eg. manual pull cord)	9	1	10	1	4	1	1	1	24	1	22	2	2	<1
Swimming to recover drifted boat	3	<1	7	1	13	2	0	0	23	1	12	1	6	1
Wake of power boat	7	1	2	<1	2	<1	1	1	12	1	9	1	3	<1
Speeding	0	0	7	1	7	1	4	5	18	1	18	1	0	0
Engine failure¶	0	0	27	4	18	3	1	1	46	2	42	3	4	<1
Irrelevant	13	1	0	0	2	<1	0	0	15	1	12	1	3	<1
Other	231	26	271	38	260	47	70	81	832	37	488	38	315	38
Unknown	347	40	157	22	118	21	7	8	629	28	311	24	266	32

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths ‡ There may be more than one contributing risk factor per incident § In 120 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns*
¶ Included 5 boats classified as unpowered: canoe 3, sailboat 2

Table 7a **Recreational boating* immersion deaths† by personal factors: sex, age, ethnicity, swimming ability, boating experience, Canada 1991-2006 (n=2,232)‡**

Time period	1991-1995 (n=873)		1996-2000 (n=718)		2001-2005 (n=555)		2006 (n=86)		1991-2006 (n=2,232)		Powered boating (n=1,274)		Unpowered boating (n=838)	
Categories	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Sex														
Males	813	93	652	91	520	94	81	94	2,066	93	1,171	92	780	93
Females	60	7	64	9	35	6	4	5	163	7	101	8	57	7
Unknown	0	0	2	0	0	0	1	1	3	<1	2	<1	1	0
Age group in years														
<1	3	<1	0	0	1	0	0	0	4	<1	3	<1	1	0
1 to 4	9	1	7	1	1	0	0	0	17	1	14	1	2	0
5 to14	18	2	17	2	9	2	2	2	46	2	25	2	20	2
15 to 24	164	19	125	17	97	17	10	12	396	18	162	13	223	27
25 to 34	205	23	141	20	75	14	15	17	436	20	233	18	184	22
35 to 44	185	21	144	20	111	20	11	13	451	20	270	21	156	19
45 to 54	126	14	116	16	115	21	19	22	376	17	233	18	115	14
55 to 64	78	9	89	12	77	14	20	23	264	12	173	14	72	9
65 to 74	61	7	57	8	50	9	5	6	173	8	115	9	47	6
75 +	21	2	18	3	18	3	4	5	61	3	42	3	15	2
Unknown	3	<1	4	1	1	0	0	0	8	<1	4	0	3	0
Ethnicity														
Aboriginal, definite	170	19	76	11	67	12	14	16	327	15	198	16	107	13
Aboriginal, probable	0	0	16	2	7	1	1	1	24	1	18	1	5	1
All other	331	38	473	66	378	68	65	76	1,247	56	671	53	508	61
Unknown	372	43	153	21	103	19	6	7	634	28	387	30	218	26
Swimming ability														
Non-swimmer	116	13	79	11	55	10	10	12	260	12	160	13	93	11
Weak swimmer	38	4	51	7	35	6	5	6	129	6	66	5	59	7
Average swimmer	23	3	27	4	22	4	8	9	80	4	43	3	36	4
Strong swimmer	44	5	25	3	14	3	3	3	86	4	35	3	51	6
Swimmer, level unknown	81	9	58	8	49	9	6	7	194	9	100	8	77	9
Irrelevant	3	0	0	0	0	0	0	0	3	0	2	0	1	0
Unknown	568	65	478	67	380	68	54	63	1,480	66	868	68	521	62
Boating experience														
Experienced boater	181	21	141	20	134	24	22	26	478	21	293	23	158	19
Occasional boater	44	5	49	7	22	4	16	19	131	6	65	5	64	8
Inexperienced boater	30	3	42	6	27	5	5	6	104	5	28	2	76	9
Irrelevant	4	0	0	0	0	0	0	0	0	0	3	0	0	0
Unknown	614	70	486	68	372	67	43	50	1,515	68	885	69	540	64

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*

‡ In 120 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns

Table 7b **Recreational boating* immersion deaths† by personal factors: alcohol & other drugs for victims 15 years and older, Canada 1991-2006 (n=2,165)‡§**

Time period	1991-1995 (n=838)		1996-2000 (n=676)		2001-2005 (n=532)		2006 (n=80)		1991-2006 (n=2,126)		Powered boating (n=1,213)		Unpowered boating (n=799)	
Blood alcohol level¶	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
No alcohol	249	30	280	41	205	39	30	38	764	36	412	34	325	41
Below limit	**121**	**14**	**81**	**12**	**71**	**13**	**11**	**14**	**284**	**13**	**166**	**14**	**102**	**13**
1-49 mg%	50	6	34	5	18	3	4	5	106	5	70	6	32	4
50-80 mg%	34	4	27	4	14	3	5	6	80	4	41	3	35	4
Below limit, unsp.	37	4	20	3	39	7	2	3	98	5	55	5	35	4
Above limit	**226**	**27**	**167**	**25**	**132**	**25**	**22**	**28**	**547**	**26**	**326**	**27**	**179**	**22**
81-99 mg %	5	1	13	2	8	2	2	3	28	1	14	1	13	2
100-150 mg%	47	6	52	8	27	5	6	8	132	6	70	6	54	7
151-200 mg%	64	8	37	5	27	5	5	6	133	6	84	7	41	5
201-250 mg%	42	5	32	5	34	6	3	4	111	5	65	5	34	4
251-299 mg%	34	4	18	3	17	3	3	4	72	3	45	4	20	3
>300 mg%	30	4	15	2	19	4	3	4	67	3	45	4	16	2
Above limit, unsp.	4	<1	0	0	0	0	0	0	0	0	3	<1	1	<1
Alcohol suspected	**52**	**6**	**44**	**7**	**41**	**8**	**12**	**15**	**149**	**7**	**89**	**7**	**50**	**6**
Unknown	190	23	104	15	83	16	5	6	382	18	220	18	143	18

Time period	1991-1995 (n= 842)		1996-2000 (n=671)		2001-2005 (n=527)		2006 (n=81)		1991-2006 (n=2,121)		Powered boating (n=1,206)		Unpowered boating (n=801)	
Other drugs	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
No drugs	273	32	229	34	186	35	35	43	723	34	393	33	298	37
Illegal drugs	**39**	**5**	**48**	**7**	**49**	**9**	**12**	**15**	**148**	**7**	**59**	**5**	**81**	**10**
Consumed	23	3	41	6	37	7	9	11	110	5	46	4	59	7
Cannabis/ marijuana	0	0	30	4	26	5	6	7	62	3	22	2	38	5
Cocaine	0	0	9	1	10	2	1	1	20	1	8	1	10	1
Other (PCP/opiates)	0	0	1	<1	1	<1	1	1	3	<1	1	<1	1	<1
Unknown	23	3	1	<1	0	<1	1	1	25	1	15	1	10	1
Suspected	16	2	7	1	12	2	3	4	38	2	13	1	22	3
Legal drugs	**14**	**2**	**26**	**4**	**16**	**3**	**2**	**2**	**58**	**3**	**30**	**2**	**20**	**2**
Consumed	12	1	21	3	14	3	1	1	48	2	24	2	16	2
Suspected	2	<1	5	1	2	<1	1	1	10	<1	6	<1	4	<1
No suspected drugs	30	4	67	10	28	5	4	5	129	6	78	6	40	5
Unknown	486	58	301	45	248	47	28	35	1063	50	646	54	362	45

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*

‡ This table excludes victims for whom decomposition rendered blood alcohol unreliable (alcohol 39, drugs 44)

§ In 114 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns ¶ Legal limit is 80 mg%

Table 8 **Recreational boating* immersion deaths† by equipment factors: type of boat, flotation device, Canada 1991-2006 (n=2,232)‡**

Time period	1991-1995 (n=873)		1996-2000 (n=718)		2001-2005 (n=555)		2006 (n=86)		1991-2006 (n=2,232)		Powered boating (n=1,274)		Unpowered boating (n=838)	
Type of boat	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Powerboat	**538**	**62**	**412**	**57**	**279**	**50**	**45**	**52**	**1 274**	**57**	**1 274**	**100**	**838**	**100**
Small outboard (≤5.5 m)	321	37	210	29	122	22	26	30	679	31	679	53	0	0
Other small open (e.g. inflatable)	37	4	35	5	39	7	1	1	112	5	112	9	0	0
Size unknown	87	10	92	13	64	12	10	12	253	11	253	20	0	0
Large (>5.5 m)	68	8	53	7	42	8	7	8	170	8	170	13	0	0
Personal watercraft Towed by PWC	11	1	13	2	5	1	0	0	29	1	29	2	0	0
Towed by powerboat	3	<1	2	<1	2	<1	0	0	7	<1	7	1	0	0
Other powerboat	0	0	1	<1	0	0	0	0	1	<1	1	<1	0	0
Unknown powerboat	11	1	6	1	5	1	1	1	23	1	23	2	0	0
Unpowered boat	**288**	**33**	**269**	**37**	**243**	**44**	**38**	**44**	**838**	**38**	**0**	**0**	**0**	**0**
Canoe	193	22	151	21	148	27	28	33	520	23	0	0	520	62
Rowboat	27	3	37	5	11	2	4	5	79	4	0	0	79	9
Sailboat or sailboard	24	3	31	4	20	4	1	1	76	4	0	0	76	9
Kayak	21	2	20	3	31	6	1	1	73	3	0	0	73	9
Inflatable	15	2	21	3	16	3	3	3	55	3	0	0	55	7
Other unpowered boat	6	1	7	1	12	2	1	1	26	1	0	0	26	3
Unknown unpowered boat	2	0	2	<1	5	1	0	0	9	<1	0	0	9	1
Unknown if powered	47	5	37	5	33	6	3	3	120	5	0	0	0	0
Lifejacket/PFD														
Not present	243	28	209	29	124	22	30	35	606	27	299	23	288	34
Present, not worn	164	19	161	22	128	23	22	26	475	21	350	27	111	13
Not worn, uncertain if present	131	15	157	22	136	25	14	16	438	20	230	18	174	21
Present, worn properly	102	12	79	11	75	14	12	14	268	12	133	10	130	16
Present, worn improperly	31	4	19	3	18	3	2	2	70	3	39	3	27	3
Irrelevant	3	<1	0	0	0	0	0	0	3	<1	2	0	0	0
Unknown	199	23	93	13	74	13	6	7	372	17	221	17	108	13
Other equipment factors														
Victim fully clothed	0	0	335	47	293	53	1	1	629	28	356	28	232	28
Wearing hip waders	3	<1	3	<1	0	0	0	0	6	<1	3	<1	3	<1
Engine failure	0	0	4	1	0	0	0	0	4	<1	4	<1	0	0
Other equipment	100	11	71	10	52	9	35	41	258	12	160	13	92	11
None	467	53	261	36	142	26	1	1	871	39	496	39	332	40
Unknown	303	35	44	6	68	12	49	57	464	21	255	20	179	21

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ In 120 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns

Table 9a **Recreational boating* immersion deaths† by environmental factors, Canada 1991-2006 (n=2,232)‡**														
Time period	**1991-1995**		**1996-2000**		**2001-2005**		**2006**		**1991-2006**		**Powered boating**		**Unpowered boating**	
	(n=873)		**(n=718)**		**(n=555)**		**(n=86)**		**(n=2,232)**		**(n=1,274)**		**(n=838)**	
Categories	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Body of water														
Lake or pond	517	59	424	59	322	58	47	55	1,310	59	790	62	461	55
River, stream, creek, waterfall	182	21	179	25	137	25	24	28	522	23	240	19	256	31
Ocean	155	18	104	14	84	15	13	15	356	16	215	17	108	13
Reservoir	12	1	5	1	5	1	1	1	23	1	16	1	7	1
Canal	2	<1	2	<1	3	1	0	0	7	<1	4	<1	2	<1
Dam, inlet, spillway	2	<1	1	<1	3	1	1	1	7	<1	6	<1	1	<1
Other	1	<1	0	0	1	<1	0	0	2	<1	1	<1	1	<1
Unknown	2	<1	3	<1	0	0	0	0	5	<1	2	<1	2	<1
Current for all bodies of water														
Fast/strong current	85	10	107	15	45	8	8	9	245	11	129	10	103	12
Rapids, white water	49	6	35	5	35	6	5	6	124	6	39	3	83	10
Hydraulic current	0	0	1	<1	6	1	3	3	10	<1	0	0	10	1
Waterfall	2	<1	1	<1	5	1	0	0	8	<1	4	<1	4	<1
Dam spillway	1	<1	5	1	3	1	0	0	9	<1	5	<1	3	<1
Undertow	7	1	7	1	3	1	0	0	17	1	14	1	1	<1
Tide	28	3	54	8	32	6	3	3	117	5	63	5	43	5
Other moving water	4	<1	5	1	10	2	0	0	19	1	13	1	6	1
Not moving water	184	21	266	37	191	34	36	42	677	30	389	31	260	31
Unknown	513	59	237	33	225	41	31	36	1,006	45	618	49	325	39
Current for rivers (n=522)														
	n=182	**%**	**n=179**	**%**	**n=137**	**%**	**n=24**	**%**	**n=522**	**%**	**n=240**	**%**	**n=256**	**%**
Fast/strong current	45	25	83	46	37	27	8	33	173	33	83	35	80	31
Rapids, white water	45	25	34	19	32	23	5	21	116	22	31	13	83	32
Hydraulic current	0	0	1	1	6	4	3	13	10	2	0	0	10	4
Waterfall	2	1	1	1	5	4	0	0	8	2	4	2	4	2
Dam spillway	0	0	4	2	1	1	0	0	5	1	2	1	2	1
Undertow	2	1	0	0	0	0	0	0	2	<1	2	1	0	0
Tide	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other moving water	2	1	3	2	0	0	0	0	5	1	3	1	2	1
No moving water	3	2	3	2	1	1	2	8	9	2	4	2	3	1
Unknown	83	46	50	28	55	40	6	25	194	37	111	46	72	28
Wind														
Strong winds	193	22	163	23	128	23	14	16	500	22	307	24	177	21
Breeze	99	11	57	8	43	8	5	6	204	9	136	11	62	7
Calm	75	9	55	8	41	7	2	2	173	8	102	8	64	8
Unknown	506	58	441	61	343	62	65	76	1,355	61	729	57	535	64
Waves														
Storm	17	2	38	5	20	4	0	0	75	3	47	4	25	3
Rough	224	26	156	22	107	19	15	17	502	22	306	24	181	22
Choppy	93	11	51	7	50	9	11	13	205	9	119	9	81	10
Calm	83	10	77	11	66	12	15	17	241	11	146	11	87	10
Other	0	0	8	1	1	0	0	0	9	<1	7	1	2	<1
Unknown	452	52	380	53	300	54	45	52	1177	53	639	50	451	54
Irrelevant	4	<1	8	1	11	2	0	0	23	1	10	1	11	1

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*

‡ In 120 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns

Table 9b **Recreational boating* immersion deaths† by environmental factors, Canada 1991-2006 (n=2,232)‡**														
Time period	**1991-1995 (n=873)**		**1996-2000 (n=718)**		**2001-2005 (n=555)**		**2006 (n=86)**		**1991-2006 (n=2,232)**		**Powered boating (n=1,274)**		**Unpowered boating (n=838)**	
Categories	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Water Temperature														
Extremely cold (<10C)	158	18	205	29	103	19	14	16	480	22	266	21	193	23
Cold or cool (10 to 20C)	138	16	106	15	110	20	22	26	376	17	220	17	137	16
Warm/Hot (≥21C)	10	1	4	1	12	2	5	6	31	1	15	1	16	2
Unknown	567	65	403	56	330	59	45	52	1345	60	773	61	492	59
Air Temperature§														
Extremely Cold (≤-6°C)	15	2	6	1	6	1	0	0	27	1	18	1	9	1
Very cold (-5 – +5°C)	17	2	32	4	15	3	1	1	65	3	37	3	27	3
Cool/Cold (-5 – +14°C)	44	5	0	0	0	0	0	0	44	2	23	2	20	2
Cold (6 – 15°C)	59	7	58	8	47	8	0	0	164	7	99	8	54	6
Moderate/Warm (15 – 32°C)	30	3	0	0	0	0	0	0	30	1	24	2	5	1
Moderate (16 – 27°C)	43	5	53	7	35	6	0	0	131	6	62	5	58	7
Hot (≥28°C)	5	1	6	1	4	1	0	0	15	1	6	<1	8	1
Unknown	660	76	563	78	448	81	85	99	1756	79	1005	79	657	78
Weather														
Snowing	2	<1	4	1	1	<1	0	0	7	<1	6	<1	1	<1
Foggy	14	2	10	1	8	1	0	0	32	1	19	1	13	2
Raining	49	6	32	4	19	3	3	3	103	5	66	5	31	4
Cloudy	62	7	44	6	19	3	1	1	126	6	74	6	49	6
Clear	102	12	87	12	75	14	0	0	264	12	152	12	103	12
Other	20	2	11	2	10	2	0	0	41	2	28	2	11	1
Unknown	624	71	530	74	423	76	82	95	1659	74	929	73	630	75
Light Conditions														
Dark	174	20	111	15	83	15	15	17	383	17	216	17	137	16
Twilight	81	9	79	11	49	9	8	9	217	10	135	11	78	9
Light	385	44	406	57	317	57	52	60	1160	52	661	52	449	54
Unknown	233	27	122	17	106	19	11	13	472	21	262	21	174	21
Time of Incident														
Reported/known	197	23	215	30	166	30	35	41	613	27	363	28	230	27
Estimated	396	45	269	37	170	31	22	26	857	38	473	37	333	40
Unknown	280	32	234	33	219	39	29	34	762	34	438	34	275	33
Place Occurred														
Rural	672	77	535	75	419	75	63	73	1689	76	990	78	613	73
Urban	188	22	158	22	133	24	22	26	501	22	266	21	205	24
Unknown	13	1	25	3	3	1	1	1	42	2	18	1	20	2
Water depth														
0-1 meter (0-3.2ft)	8	1	6	1	11	2	1	1	26	1	13	1	11	1
1.1-2.5 m (3.3-8.1ft)	54	6	30	4	25	5	5	6	114	5	60	5	48	6
>2.5 m (8.1 ft)	288	33	256	36	186	34	32	37	762	34	481	38	246	29
Unknown	523	60	426	59	333	60	48	56	1330	60	720	57	533	64
Distance to shore														
0-2 metres (0-6ft)	36	4	23	3	22	4	4	5	85	4	50	4	19	2
2.1–15 m (7-49ft)	71	8	50	7	41	7	3	3	165	7	84	7	74	9
16-50 m (50-162ft)	78	9	51	7	37	7	7	8	173	8	90	7	78	9
>50 m (162ft)	214	25	175	24	94	17	22	26	505	23	314	25	177	21
Unknown	474	54	419	58	361	65	50	58	1304	58	736	58	490	58

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ In 120 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns
§ The overlap of temperatures in this table is due to the fact that classification categories were revised in 1993

Table 9c **Recreational boating* immersion deaths† by environmental factors, Canada, 1991-2006 (n=2,232)‡**

Time period	1991-1995 (n=873)		1996-2000 (n=718)		2001-2005 (n=555)		2006 (n=86)		1991-2006 (n=2,232)		Power boating (n=1,274)		Unpowered boating (n=838)	
Categories	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Day of week														
Monday	94	11	69	10	53	10	17	20	233	10	141	11	77	9
Tuesday	96	11	61	8	57	10	11	13	225	10	132	10	80	10
Wednesday	102	12	61	8	50	9	10	12	223	10	133	10	78	9
Thursday	93	11	81	11	55	10	11	13	240	11	141	11	86	10
Friday	107	12	82	11	79	14	5	6	273	12	154	12	109	13
Saturday	204	23	176	25	144	26	15	17	539	24	313	25	199	24
Sunday	157	18	165	23	112	20	17	20	451	20	237	19	187	22
Unknown	20	2	23	3	5	1	0	0	48	2	23	2	22	3
Month														
January	7	1	8	1	8	1	0	0	23	1	17	1	4	<1
February	6	1	3	<1	7	1	1	1	17	1	10	1	7	1
March	18	2	16	2	11	2	2	2	47	2	18	1	26	3
April	38	4	34	5	21	4	8	9	101	5	42	3	55	7
May	112	13	129	18	82	15	14	16	337	15	175	14	143	17
June	154	18	117	16	105	19	22	26	398	18	234	18	141	17
July	160	18	109	15	116	21	9	10	394	18	213	17	159	19
August	135	15	90	13	81	15	12	14	318	14	201	16	97	12
September	98	11	92	13	59	11	10	12	259	12	168	13	76	9
October	99	11	63	9	43	8	4	5	209	9	126	10	75	9
November	29	3	25	3	14	3	3	3	71	3	41	3	27	3
December	8	1	9	1	4	1	1	1	22	1	11	1	11	1
Unknown	9	1	23	3	4	1	0	0	36	2	18	1	17	2
Date of pronounced death														
Date of incident	465	53	367	51	279	50	29	34	1140	51	630	49	442	53
Different date	355	41	325	45	257	46	55	64	992	44	571	45	371	44
Presumed dead§	26	3	26	4	19	3	2	2	73	3	53	4	19	2
Unknown	27	3	0	0	0	0	0	0	27	1	20	2	6	1

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ In 120 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns § Body never recovered

Table 9d **Recreational boating* immersion deaths† by environmental factors, Canada, 1991-2006 (n= 2,232)‡**

Time period	1991-1995 (n=873)		1996-2000 (n=718)		2001-2005 (n=555)		2006 (n=86)		1991-2006 (n=2,232)		Power boating (n=1,274)		Unpowered boating (n=838)	
Categories	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Region														
Atlantic	109	12	89	12	81	15	13	15	292	13	160	13	107	13
Quebec	154	18	140	19	102	18	12	14	408	18	225	18	158	19
Ontario	265	30	221	31	176	32	32	37	694	31	431	34	241	29
Prairies	121	14	108	15	90	16	16	19	335	15	173	14	143	17
British Columbia	171	20	137	19	79	14	6	7	393	18	220	17	149	18
Territories	52	6	23	3	27	5	7	8	109	5	64	5	40	5
Unknown	1	<1	0	0	0	0	0	0	1	<1	1	<1	0	0
Location														
Open water	222	25	0	0	0	0	0	0	222	10	153	12	65	8
Cottage/cabin	54	6	46	6	31	6	3	3	134	6	67	5	65	8
Provincial park	54	6	33	5	28	5	10	12	125	6	47	4	72	9
Aboriginal reserve	30	3	46	6	27	5	6	7	109	5	63	5	39	5
Marina	17	2	26	4	17	3	2	2	62	3	38	3	16	2
Municipal park	26	3	10	1	12	2	0	0	48	2	16	1	30	4
Conservation area	20	2	8	1	17	3	4	5	49	2	32	3	17	2
Private campground	10	1	11	2	10	2	0	0	31	1	15	1	13	2
Private residence	8	1	10	1	7	1	3	3	28	1	5	<1	18	2
National park	6	1	4	1	7	1	1	1	18	1	5	<1	13	2
All other locations	298	34	452	63	340	61	53	62	1,143	51	675	53	406	48
Unknown	128	15	72	10	59	11	4	5	263	12	158	12	84	10
Accompaniment														
Alone	218	25	186	26	157	28	29	34	590	26	334	26	207	25
≥1 adult companions	509	58	437	61	326	59	51	59	1,323	59	770	60	492	59
≥1 adults and minors	52	6	52	7	24	4	1	1	129	6	98	8	31	4
≥1 minors	38	4	15	2	18	3	2	2	73	3	22	2	48	6
≥1 adult bystanders	19	2	12	2	4	1	1	1	36	2	21	2	14	2
Others-age unknown	26	3	15	2	24	4	0	0	65	3	22	2	40	5
Unknown	11	1	1	<1	2	<1	2	2	16	1	7	1	6	1

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ In 120 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns

Table 10a **Recreational boating* deaths†: autopsy and coroner findings for nature of traumatic injuries, drowning, and hypothermia by years and source of power, Canada 1991-2006 (n=2,355)‡**

Time period	1991-1995 (n=915)		1996-2000 (n=763)		2001-2005 (n=582)		2006 (n=95)		1991-2006 (n=2,355)		Power boating (n=1,384)		Unpowered boating (n=850)	
Autopsy findings§	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Head injuries	34	4	26	3	18	3	2	2	80	3	62	4	17	2
Spinal injuries	5	1	6	1	1	<1	2	2	14	1	14	1	0	0
Fractures/ dislocation	10	1	9	1	3	1	3	3	25	1	22	2	3	<1
Major lacerations	20	2	8	1	5	1	4	4	37	2	32	2	5	1
No injuries	274	30	3	<1	5	1	0	0	282	12	180	13	92	11
Other injuries	29	3	31	4	15	3	7	7	82	3	68	5	11	1
Drowning	331	36	502	66	388	67	71	75	1,292	55	726	52	488	57
Hypothermia	51	6	69	9	32	5	5	5	157	7	92	7	58	7
Irrelevant	44	5	0	0	0	0	0	0	44	2	25	2	15	2
Unknown	67	7	8	1	10	2	0	0	85	4	47	3	34	4

** Includes boating during recreation and daily life † Includes death from all causes: drowning, immersion hypothermia, and trauma*
‡ In 121 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns
§ There may be more than one response per victim

Table 10b **Recreational boating* immersion deaths†: autopsy and coroner findings for nature of traumatic injuries, drowning, and hypothermia by years and source of power, Canada 1991-2006 (n=2,232)‡**

Time period	1991-1995 (n=873)		1996-2000 (n=718)		2001-2005 (n=555)		2006 (n=86)		1991-2006 (n=2,232)		Power boating (n=1,274)		Unpowered boating (n=838)	
Autopsy findings§	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Head injuries	15	2	6	1	5	1	0	0	26	1	14	1	11	1
Spinal injuries	2	<1	0	0	0	0	1	1	3	<1	3	<1	0	0
Fractures/dislocation	4	<1	3	<1	0	0	0	0	7	<1	5	<1	2	<1
Major lacerations	7	1	0	0	0	0	0	0	7	<1	5	<1	2	<1
No injuries	272	31	3	<1	5	1	0	0	280	13	178	14	92	11
Other injuries	22	3	19	3	6	1	2	2	49	2	37	3	9	1
Drowning	322	37	492	69	378	68	71	83	1,263	57	701	55	484	58
Hypothermia	51	6	68	9	32	6	5	6	156	7	91	7	58	7
Irrelevant	43	5	0	0	0	0	0	0	43	2	24	2	15	2
Unknown	65	7	8	1	10	2	0	0	83	4	45	4	34	4

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ In 120 cases it was unknown if the boat was powered or unpowered; they were excluded from the two right columns § There may be more than one response per victim

Table 10c **Recreational boating* trauma deaths†: autopsy and coroner findings for nature of traumatic injuries, drowning, and hypothermia by years and source of power, Canada 1991-2006 (n=123)‡**

Time period	1991-1995 (n=42)		1996-2000 (n=45)		2001-2005 (n=27)		2006 (n=9)		1991-2006 (n=123)		Power boating (n=110)		Unpowered boating (n=12)	
Autopsy findings§	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Head injuries	19	45	20	44	13	48	2	22	54	44	48	44	6	50
Spinal injuries	3	7	6	13	1	4	1	11	11	9	11	10	0	0
Fractures/dislocation	6	14	6	13	3	11	3	33	18	15	17	15	1	8
Major lacerations	13	31	8	18	5	19	4	44	30	24	27	25	3	25
No injuries	2	5	0	0	0	0	0	0	2	2	2	2	0	0
Other injuries	7	17	12	27	9	33	5	56	33	27	31	28	2	17
Drowning	9	21	10	22	10	37	0	0	29	24	25	23	4	33
Hypothermia	0	0	1	2	0	0	0	0	1	1	1	1	0	0
Irrelevant	1	2	0	0	0	0	0	0	1	1	1	1	0	0
Unknown	2	5	0	0	0	0	0	0	2	2	2	2	0	0

** Includes boating during recreation and daily life † Includes all injury fatalities other than immersion deaths*
‡ In 1 case it was unknown if the boat was powered or unpowered; it was excluded from the two right columns § There may be more than one response per victim

Table 11a **Recreational boating* deaths†: type of incident for personal watercraft compared with other boats, Canada, 1991-2006 (n=2,355)‡**

Categories	All boats (n=2,355)		Personal watercraft (n=61)		Other powerboats (n=1,323)		Unpowered boats (n=850)	
	n	%	n	%	n	%	n	%
Type of incident								
Capsized	914	39	4	7	387	29	488	57
Fell/thrown overboard	593	25	19	31	401	30	130	15
Swamped	280	12	1	2	198	15	72	8
Collision	186	8	32	52	134	10	19	2
Jumped overboard§	15	1	0	0	11	1	3	<1
Other	94	4	1	2	62	5	21	2
Unknown	273	12	4	7	130	10	117	14

** Includes boating during recreation and daily life † Includes death from all causes: drowning, immersion hypothermia, and trauma*
‡ In 121 cases it was unknown if the boat involved was a personal watercraft, another powerboat, or an unpowered boat
§ Jumped in to retrieve person or object

Table 11b **Recreational boating* immersion deaths†: type of incident for personal watercraft compared with other boats, Canada, 1991-2006 (n=2,232)‡**

Categories	All boats (n=2,232)		Personal watercraft (n=29)		Other powerboats (n=1,245)		Unpowered boats (n=838)	
	n	%	n	%	n	%	n	%
Type of incident								
Capsized	909	41	4	14	386	31	484	58
Fell/thrown overboard	572	26	15	52	387	31	127	15
Swamped	280	13	1	3	198	16	72	9
Collision	95	4	4	14	75	6	16	2
Jumped overboard§	15	1	0	0	11	1	3	0
Other	88	4	1	3	58	5	19	2
Unknown	273	12	4	14	130	10	117	14

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ In 120 cases it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat
§ Jumped in to retrieve person or object

Table 11c **Recreational boating* trauma deaths†: type of incident for personal watercraft compared with other boats, Canada, 1991-2006 (n=123)‡§**

Categories	All boats (n=123)		Personal watercraft (n=32)		Other powerboats (n=78)		Unpowered boats (n=12)	
	n	%	n	%	n	%	n	%
Type of incident								
Capsized	**5**	**4**	**0**	**0**	**1**	**1**	**4**	**33**
Fell/thrown overboard	**21**	**17**	**4**	**13**	**14**	**18**	**3**	**25**
Waterskiing/tubing¶	1	1	1	3	0	0	0	0
Collision	**91**	**74**	**28**	**88**	**59**	**76**	**3**	**25**
Boat with another boat	44	36	19	59	21	27	3	25
Boat with fixed object	31	25	5	16	26	32	0	0
Boat with person (eg. swimmer)	1	1	0	0	1	1	0	0
Waterskiing/tubing§	9	7	2	6	7	9	0	0
Other/unknown collision	6	5	2	6	4	5	0	0
Other	**6**	**5**	**0**	**0**	**4**	**5**	**2**	**17**
Waterskiing/tubing§	2	2	0	0	2	3	0	0

** Includes boating during recreation and daily life † Includes all injury fatalities other than immersion deaths*
‡ In 1 case it was unknown if the boat was a personal watercraft, another powered boat, or an unpowered boat
§ There were 11 propeller injuries identified; 5 were due to a collision ¶ Included waterskiing 9, riding on tube or other device 3

Table 12a **Recreational boating* deaths†: autopsy and coroner findings for personal watercraft compared with other boats, Canada, 1991-2006 (n=2,355)‡**

Categories	All boats (n=2,355)		Personal watercraft (n=61)		Other powerboats (n=1,323)		Unpowered boats (n=850)	
	n	%	n	%	n	%	n	%
Autopsy findings§								
Head injuries	80	3	11	18	51	4	17	2
Spinal injuries	14	1	5	8	9	1	0	0
Fractures/dislocation	25	1	6	10	16	1	3	<1
Major lacerations	37	2	10	16	22	2	5	1
No injuries	282	12	2	3	178	13	92	11
Other injuries	82	3	9	15	59	4	11	1
Drowning	1292	55	19	31	707	53	488	57
Hypothermia	157	7	2	3	90	7	58	7
Irrelevant	44	2	0	0	25	2	15	2
Unknown	85	4	2	3	45	3	34	4

** Includes boating during recreation and daily life † Includes death from all causes: drowning, immersion hypothermia, and trauma*
‡ In 121 cases it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat
§ There may be more than one response per victim

Table 12b **Recreational boating* immersion deaths†: type of injury for personal watercraft compared with other boats, Canada, 1991-2006 (n=2,232)‡**

Categories	All boats (n=2,232)		Personal watercraft (n=29)		Other powerboats (n=1,245)		Unpowered boats (n=838)	
	n	%	n	%	n	%	n	%
Autopsy findings§								
Head injuries	26	1	1	3	13	1	11	1
Spinal injuries	3	<1	0	0	3	<1	0	0
Fractures/dislocation	7	<1	2	7	3	<1	2	<1
Major lacerations	7	<1	1	3	4	<1	2	<1
No injuries	280	13	2	7	176	14	92	11
Other injuries	49	2	0	0	37	3	9	1
Drowning	1263	57	18	62	683	55	484	58
Hypothermia	156	7	1	3	90	7	58	7
Irrelevant	43	2	0	0	24	2	15	2
Unknown	83	4	1	3	44	4	34	4

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ In 120 cases it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat
§ There may be more than one response per victim

Table 12c **Recreational boating* trauma deaths†: type of injury for personal watercraft compared with other boats, Canada, 1991-2006 (n=123)‡**

Categories	All boats (n=123)		Personal watercraft (n=32)		Other powerboats (n=78)		Unpowered boats (n=12)	
	n	%	n	%	n	%	n	%
Autopsy findings§								
Head injuries	54	44	10	31	38	49	6	50
Spinal injuries	11	9	5	16	6	8	0	0
Fractures/dislocation	18	15	4	13	13	17	1	8
Major lacerations	30	24	9	28	18	23	3	25
No injuries	2	2	0	0	2	3	0	0
Other injuries	33	27	9	28	22	28	2	17
Drowning	29	24	1	3	24	31	4	33
Hypothermia	1	1	1	3	0	0	0	0
Irrelevant	1	1	0	0	1	1	0	0
Unknown	2	2	1	3	1	1	0	0

** Includes boating during recreation and daily life † Includes all injury fatalities other than immersion deaths*
‡ In 1 case it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat
§ There may be more than one response per victim

Table 13a **Recreational boating* deaths† by equipment factors: flotation device for personal watercraft compared with other boats, Canada 1991-2006 (n=2,355)‡**

Categories	All boats (n=2,355)		Personal watercraft (n=61)		Other powerboats (n=1,323)		Unpowered boats (n=850)	
	n	%	n	%	n	%	n	%
Lifejacket/PFD								
Not present	611	26	14	23	290	22	288	34
Present, not worn	490	21	4	7	360	27	112	13
Not worn, uncertain if present	453	19	5	8	238	18	176	21
Worn properly	300	13	23	38	136	10	136	16
Worn improperly	72	3	2	3	38	3	28	3
Irrelevant	3	0	0	0	2	<1	0	0
Unknown	426	18	13	21	259	20	110	13

** Includes boating during recreation and daily life † Includes death from all causes: drowning, immersion hypothermia, and trauma*
‡ In 121 cases it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat

Table 13b **Recreational boating* immersion deaths† by equipment factors: flotation device for personal watercraft compared with other boats, Canada 1991-2006 (n=2,232)‡**

Categories	All boats (n=2,232)		Personal watercraft (n=29)		Other powerboats (n=1,245)		Unpowered boats (n=838)	
	n	%	n	%	n	%	n	%
Lifejacket/PFD								
Not present	606	27	11	38	288	23	288	34
Present, not worn	475	21	3	10	347	28	111	13
Not worn, uncertain if present	438	20	5	17	225	18	174	21
Worn properly	268	12	7	24	126	10	130	16
Worn improperly	70	3	2	7	37	3	27	3
Irrelevant	3	<1	0	0	2	<1	0	0
Unknown	372	17	1	3	220	18	108	13

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ In 120 cases it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat

Table 13c **Recreational boating* trauma deaths† by equipment factors: flotation device for personal watercraft compared with other boats, Canada 1991-2006 (n=123)‡**

Categories	All boats (n=123)		Personal watercraft (n=32)		Other powerboats (n=78)		Unpowered boats (n=12)	
	n	%	n	%	n	%	n	%
Lifejacket/PFD								
Not present	5	4	3	9	2	3	0	0
Present, not worn	15	12	1	3	13	17	1	8
Not worn, uncertain if present	15	12	0	0	13	17	2	17
Worn properly	32	26	16	50	10	13	6	50
Worn improperly	2	2	0	0	1	1	1	8
Unknown	54	44	12	38	39	50	2	17

** Includes boating during recreation and daily life † Includes all injury fatalities other than immersion deaths*
‡ In 1 case it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat

Table 14a **Recreational boating* deaths†: personal factors for personal watercraft compared with other boats, Canada, 1991-2006 (n=2,355)‡**

Categories	All boats (n=2,355)		Personal watercraft (n=61)		Other powerboats (n=1,323)		Unpowered boats (n=850)	
	n	%	n	%	n	%	n	%
Age								
<1	5	0	0	0	4	0	1	0
1 to 4	21	1	1	2	17	1	2	0
5 to14	57	2	6	10	30	2	20	2
15 to 24	425	18	20	33	166	13	228	27
25 to 34	458	19	13	21	239	18	187	22
35 to 44	475	20	12	20	281	21	157	18
45 to 54	395	17	6	10	243	18	117	14
55 to 64	270	11	2	3	176	13	73	9
65 to 74	176	7	1	2	117	9	47	6
75 +	65	3	0	0	46	3	15	2
Unknown	8	0	0	0	4	0	3	0
Sex								
Male	2,158	92	52	85	1,202	91	789	93
Female	194	8	9	15	119	9	60	7
Unknown	3	0	0	0	2	0	1	0
Blood alcohol level§ for victims 15 years and older (n=2,272)¶								
	n=2,233		n=54		n=1,253		n=811	
No alcohol	809	36	23	43	424	34	335	41
Below limit	**299**	**13**	**8**	**15**	**172**	**14**	**103**	**13**
1-49 mg%	117	5	4	7	77	62	32	4
50-80 mg%	83	4	2	4	41	3	36	4
Below limit, unsp.	99	4	2	4	54	4	35	4
Above limit	**576**	**26**	**15**	**28**	**340**	**27**	**179**	**22**
Alcohol suspected	**153**	**7**	**4**	**7**	**89**	**7**	**50**	**6**
Unknown	396	18	4	7	228	18	144	18
Swimming ability								
Non-swimmer	264	11	3	5	161	12	93	11
Weak swimmer	129	5	2	3	64	5	59	7
Average swimmer	82	3	3	5	42	3	36	4
Strong swimmer	88	4	1	2	35	3	52	6
Swimmer, level unknown	200	8	6	10	99	7	78	9
Irrelevant	4	0	0	0	3	0	1	0
Unknown	1,588	67	46	75	919	69	531	62
Boating experience								
Experienced boater	501	21	10	16	301	23	163	19
Occasional boater	134	6	1	2	66	5	65	8
Inexperienced boater	115	5	13	21	26	2	76	9
Irrelevant	5	0	0	0	4	0	0	0
Unknown	1,600	68	37	61	926	70	546	64
Ethnicity								
Aboriginal, definite	330	14	2	3	199	15	107	13
Aboriginal, probable	24	1	0	0	18	1	5	1
All other	1,324	56	41	67	696	53	518	61
Unknown	677	29	18	30	410	31	220	26

** Includes boating during recreation and daily life † Includes death from all causes: drowning, immersion hypothermia, and trauma*
‡ In 121 cases it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat
§ Legal limit is 80 mg% ¶ This table excludes 39 victims for whom decomposition rendered blood alcohol unreliable

Table 14b **Recreational boating* deaths†: environmental factors for personal watercraft compared with other boats, Canada, 1991-2006 (n=2,355)‡**

Categories	All boats (n=2,355)		Personal watercraft (n=61)		Other powerboats (n=1,323)		Unpowered boats (n=850)	
	n	%	n	%	n	%	n	%
Body of water								
Lake	1,388	59	42	69	822	62	465	55
River	549	23	11	18	249	19	262	31
Ocean	369	16	6	10	221	17	109	13
Other	42	2	1	2	28	2	12	1
Unknown	7	<1	1	2	3	<1	2	<1
Day of week								
Monday	246	10	6	10	145	11	80	9
Tuesday	235	10	1	2	140	11	81	10
Wednesday	230	10	5	8	132	10	81	10
Thursday	252	11	6	10	146	11	87	10
Friday	296	13	10	16	167	13	109	13
Saturday	570	24	14	23	326	25	202	24
Sunday	478	20	19	31	244	18	188	22
Unknown	48	2	0	0	23	2	22	3
Month								
January	23	1	0	0	17	1	4	0
February	17	1	0	0	10	1	7	1
March	48	2	0	0	19	1	26	3
April	103	4	1	2	43	3	55	6
May	348	15	9	15	176	13	144	17
June	416	18	6	10	245	19	142	17
July	436	19	20	33	230	17	164	19
August	350	15	19	31	212	16	98	12
September	272	12	5	8	172	13	80	9
October	211	9	1	2	127	10	75	9
November	72	3	0	0	42	3	27	3
December	23	1	0	0	12	1	11	1
Unknown	36	2	0	0	18	1	17	2
Region								
Atlantic	300	13	5	8	162	12	108	13
Quebec	432	18	16	26	231	17	160	19
Ontario	741	31	14	23	460	35	244	29
Prairies	348	15	13	21	171	13	145	17
British Columbia	424	18	13	21	234	18	153	18
Territories	109	5	0	0	64	5	40	5
Unknown	1	0	0	0	1	0	0	0
Accompaniment								
Alone	614	26	7	11	348	26	210	25
≥1 adult companions	1,390	59	33	54	796	60	499	59
≥1 adults and minors	141	6	5	8	103	8	33	4
≥1 minors	78	3	5	8	22	2	48	6
≥1 adult bystanders	40	2	4	7	21	2	14	2
Others-age unknown	75	3	7	11	25	2	40	5
Unknown	17	1	0	0	8	1	6	1

** Includes boating during recreation and daily life † Includes death from all causes: drowning, immersion hypothermia, and trauma*
‡ In 121 cases it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat

Table 15a **Recreational boating* immersion deaths†: personal factors for personal watercraft compared with other boats, Canada, 1991-2006 (n=2,232)‡**

Categories	All boats (n=2,232)		Personal watercraft (n=29)		Other powerboats (n=1,245)		Unpowered boats (n=838)	
	n	%	n	%	n	%	n	%
Age								
<1	4	<1	0	0	3	<1	1	<1
1 to 4	17	1	1	3	13	1	2	<1
5 to14	46	2	0	0	25	2	20	2
15 to 24	396	18	9	31	153	12	223	27
25 to 34	436	20	8	28	225	18	184	22
35 to 44	451	20	6	21	264	21	156	19
45 to 54	376	17	3	10	230	18	115	14
55 to 64	264	12	2	7	171	14	72	9
65 to 74	173	8	0	0	115	9	47	6
75 +	61	3	0	0	42	3	15	2
Unknown	8	<1	0	0	4	<1	3	<1
Sex								
Male	2,066	93	28	97	1,143	92	780	93
Female	163	7	1	3	100	8	57	7
Unknown	3	<1	0	0	2	<1	1	<1
Blood alcohol level§ for victims 15 years and older (n=2,165)¶								
	n=2,126		n=28		n=1,185		n=799	
No alcohol	764	36	9	32	403	34	325	41
Below limit	**284**	**13**	6	21	160	14	102	13
1-49 mg%	106	5	3	11	67	6	32	4
50-80 mg%	80	4	2	7	39	3	35	4
Below limit, unsp.	98	5	1	4	54	5	35	4
Above limit	**547**	**26**	10	36	316	27	179	22
Alcohol suspected	149	7	0	0	89	8	50	6
Unknown	382	18	3	11	217	18	143	18

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ In 120 cases it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat
§ Legal limit is 80 mg% ¶ This table excludes 39 victims for whom decomposition rendered blood alcohol unreliable

Table 15b **Recreational boating* immersion deaths†: environmental factors for personal watercraft compared with other boats, Canada, 1991-2006 (n=2,232)‡**

Categories	All boats (n=2,232)		Personal watercraft (n=29)		Other powerboats (n=1,245)		Unpowered boats (n=838)	
	n	%	n	%	n	%	n	%
Body of Water								
Lake	1,310	59	18	62	772	62	461	55
River	522	23	7	24	233	19	256	31
Ocean	356	16	4	14	211	17	108	13
Other	39	2	0	0	27	2	11	1
Unknown	5	<1	0	0	2	<1	2	<1
Wind								
Strong winds	500	22	1	3	306	25	177	21
Breeze	204	9	5	17	131	11	62	7
Calm	173	8	1	3	101	8	64	8
Unknown	1,355	61	22	76	707	57	535	64
Waves								
Storm	75	3	0	0	47	4	25	3
Rough	502	22	3	10	303	24	181	22
Choppy	205	9	4	14	115	9	81	10
Calm	241	11	2	7	144	12	87	10
Other	9	0	0	0	7	1	2	0
Unknown	1,177	53	20	69	619	50	451	54
Irrelevant	23	1	0	0	10	1	11	1
Water Temperature								
Extremely cold (<10°C)	480	22	4	14	262	21	193	23
Cold (10 to 20°C)	376	17	3	10	217	17	137	16
Warm (≥21°C)	31	1	2	7	13	1	16	2
Unknown	1,345	60	20	69	753	60	492	59
Air Temperature§								
Extremely Cold (≤-6°C)	27	1	0	0	18	1	9	1
Very cold (-5 – +5°C)	65	3	0	0	37	3	27	3
Cool/cold (-5 – +14°C)	44	2	0	0	23	2	20	2
Cold (6 – 15°C)	164	7	2	7	97	8	54	6
Moderate/warm (15 – 32°C)	30	1	2	7	22	2	5	1
Moderate (16 – 27°C)	131	6	2	7	60	5	58	7
Hot (≥28°C)	15	1	1	3	5	0	8	1
Unknown	1,756	79	22	76	983	79	657	78
Light Conditions								
Dark	383	17	3	10	213	17	137	16
Twilight	217	10	4	14	131	11	78	9
Light	1160	52	19	66	642	52	449	54
Unknown	472	21	3	10	259	21	174	21

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ In 120 cases it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat
§ The overlap of temperatures in this table is due to the fact that classification categories were revised in 1993

Table 15b **Recreational boating* immersion deaths†: environmental factors for personal watercraft compared with other boats, Canada, 1991-2006 (n=2,232)‡** (continued)

Categories	All boats (n=2,232)		Personal watercraft (n=29)		Other powerboats (n=1,245)		Unpowered boats (n=838)	
	n	%	n	%	n	%	n	%
Month								
January	23	1	0	0	17	1	4	<1
February	17	1	0	0	10	1	7	1
March	47	2	0	0	18	1	26	3
April	101	5	0	0	42	3	55	7
May	337	15	5	17	170	14	143	17
June	398	18	2	7	232	19	141	17
July	394	18	11	38	202	16	159	19
August	318	14	7	24	194	16	97	12
September	259	12	3	10	165	13	76	9
October	209	9	1	3	125	10	75	9
November	71	3	0	0	41	3	27	3
December	22	1	0	0	11	1	11	1
Unknown	36	2	0	0	18	1	17	2
Region								
Atlantic	292	13	3	10	157	13	107	13
Quebec	408	18	8	28	217	17	158	19
Ontario	694	31	6	21	425	34	241	29
Prairies	335	15	8	28	165	13	143	17
British Columbia	393	18	4	14	216	17	149	18
Territories	109	5	0	0	64	5	40	5
Unknown	1	<1	0	0	1	<1	0	0
Accompaniment								
Alone	590	26	5	17	329	26	207	25
≥1 adult companions	1,323	59	14	48	756	61	492	59
≥1 adults and minors	129	6	2	7	96	8	31	4
≥1 minors	73	3	2	7	20	2	48	6
≥1 adult bystanders	36	2	3	10	18	1	14	2
Others – age unknown	65	3	3	10	19	2	40	5
Unknown	16	1	0	0	7	1	6	1

** Includes boating during recreation and daily life † Includes drownings and immersion hypothermia deaths*
‡ In 120 cases it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat

Table 16a **Recreational boating* trauma deaths†: personal factors for personal watercraft compared with other boats, Canada, 1991-2006 (n=123)‡**

Categories	All boats (n=123)		Personal watercraft (n=32)		Other powerboats (n=78)		Unpowered boats (n=12)	
	n	%	n	%	n	%	n	%
Age								
<1	1	1	0	0	1	1	0	0
1 to 4	4	3	0	0	4	5	0	0
5 to14	11	9	6	19	5	6	0	0
15 to 24	29	24	11	34	13	17	5	42
25 to 34	22	18	5	16	14	18	3	25
35 to 44	24	20	6	19	17	22	1	8
45 to 54	19	15	3	9	13	17	2	17
55 to 64	6	5	0	0	5	6	1	8
65 to 74	3	2	1	3	2	3	0	0
75 +	4	3	0	0	4	5	0	0
Sex								
Male	92	75	24	75	59	76	9	75
Female	31	25	8	25	19	24	3	25
Blood alcohol level§ for victims 15 years and older (n=107)								
	n=107		n=26		n=68		n=12	
No alcohol	45	42	14	54	21	31	10	83
Below limit	15	14	2	8	12	18	1	8
1-49 mg%	11	10	1	4	10	15	0	0
50-80 mg%	3	3	0	0	2	3	1	8
Below limit, unsp.	1	1	1	4	0	0	0	0
Above limit	29	27	5	19	24	35	0	0
Alcohol suspected	4	4	4	15	0	0	0	0
Unknown	14	13	1	4	11	16	1	8

** Includes boating during recreation and daily life † Includes all injury fatalities other than immersion deaths*
‡ In 1 case it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat
§ Legal limit is 80 mg%

Table 16b **Recreational boating* trauma deaths†: environmental factors for personal watercraft compared with other boats, Canada, 1991-2006 (n=123)‡**

Categories	All boats (n=123)		Personal watercraft (n=32)		Other powerboats (n=78)		Unpowered boats (n=12)	
	n	%	n	%	n	%	n	%
Body of Water								
Lake	78	63	24	75	50	64	4	33
River	27	22	4	13	16	21	6	50
Ocean	13	11	2	6	10	13	1	8
Other	3	2	1	3	1	1	1	8
Unknown	2	2	1	3	1	1	0	0
Wind								
Strong winds	9	7	0	0	7	9	2	17
Breeze	7	6	2	6	4	5	1	8
Calm	20	16	3	9	17	22	0	0
Unknown	87	71	27	84	50	64	9	75
Waves								
Storm	1	1	0	0	1	1	0	0
Rough	11	9	0	0	5	6	6	50
Choppy	5	4	2	6	3	4	0	0
Calm	28	23	4	13	22	28	2	17
Other	2	2	1	3	0	0	1	8
Unknown	76	62	25	78	47	60	3	25

** Includes boating during recreation and daily life † Includes all injury fatalities other than immersion deaths*
‡ In 1 case it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat

Table 16b **Recreational boating* trauma deaths†: environmental factors for personal watercraft compared with other boats, Canada, 1991-2006 (n=123)‡** (continued)

Categories	All boats (n=123)		Personal watercraft (n=32)		Other powerboats (n=78)		Unpowered boats (n=12)	
	n	%	n	%	n	%	n	%
Water Temperature								
Extremely cold (<10C)	8	8	0	0	6	8	2	17
Cold or cool (10 to 20C)	16	16	7	22	6	8	3	25
Warm/Hot (≥21C)	5	5	1	3	3	4	1	8
Unknown	94	94	24	75	63	81	6	50
Air Temperature								
Extremely Cold (≤-6C)	1	1	0	0	0	0	1	8
Cold (+6 to +15C)	2	2	0	0	1	1	1	8
Moderate (16C to 27C)	23	19	5	16	17	22	1	8
Hot (≥28C)	2	2	1	3	1	1	0	0
Unknown	95	77	26	81	59	76	9	75
Light Conditions								
Dark	33	27	2	6	29	37	1	8
Twilight	11	9	3	9	8	10	0	0
Light	65	53	25	78	30	38	10	83
Unknown	14	11	2	6	11	14	1	8
Month								
March	1	1	0	0	1	1	0	0
April	2	2	1	3	1	1	0	0
May	11	9	4	13	6	8	1	8
June	18	15	4	13	13	17	1	8
July	42	34	9	28	28	36	5	42
August	32	26	12	38	18	23	1	8
September	13	11	2	6	7	9	4	33
October	2	2	0	0	2	3	0	0
November	1	1	0	0	1	1	0	0
December	1	1	0	0	1	1	0	0
Region								
Atlantic	8	7	2	6	5	6	1	8
Quebec	24	20	8	25	14	18	2	17
Ontario	47	38	8	25	35	45	3	25
Prairies	13	11	5	16	6	8	2	17
British Columbia	31	25	9	28	18	23	4	33
Accompaniment								
Alone	24	20	2	6	19	24	3	25
≥1 adult companions	67	54	19	59	40	51	7	58
≥1 adults and minors	12	10	3	9	7	9	2	17
≥1 minors	5	4	3	9	2	3	0	0
≥1 adult bystanders	4	3	1	3	3	4	0	0
Others-age unknown	10	8	4	13	6	8	0	0
Unknown	1	1	0	0	1	1	0	0

** Includes boating during recreation and daily life † Includes all injury fatalities other than immersion deaths*
‡ In 1 case it was unknown if the boat was a personal watercraft, another powerboat, or an unpowered boat

OVERVIEW OF ACTIVITIES & RISK FACTORS FOR ALL BOATS

Boating accounted for an estimated total of nearly 3,000 injury deaths in Canada during 1991-2006, of which the **purpose** of activity was 85% recreational, including activities of daily life, 12% occupational, and the remainder other purposes such as rescue. For recreational boating, 95% of deaths resulted from immersion including drowning with or without cold exposure, and 5% by trauma such as head injury from incidents such as collisions and falls. Boating was associated with about 40% of water-related injury deaths (excluding land and air transport). Thus boating is by far the most frequent type of activity leading to water-related injury fatality in Canada.

RECREATIONAL BOATING

For recreational boating, deaths associated with powerboats accounted for 59% of deaths and unpowered boats for 36%; for the remaining 5% it was unknown whether the boat was powered or unpowered. The most frequent recreational boating activity was fishing, accounting for 36% of immersion deaths. Other activities included powerboating 22%, canoeing 14%, boat travel 7%, hunting 7%, sailing 3%, kayaking 3%, rafting 1% and other/unknown 7%.

The type of incident leading to immersion death varied between categories of boating. Type of incident during powered boating included falling overboard 32%, capsizing 31%, swamping 16%, collision 6%, and other/unknown 16%, while for unpowered boating incidents included capsizing 58%, falling overboard 15%, swamping 9%, collision 2%, and other/unknown 17%. Type of incident also varied between immersion and trauma fatalities; while collisions accounted for only 4% of immersion deaths, they resulted in 74% of trauma deaths. A disproportionate number of collision deaths involved personal watercraft (PWCs).

Considering personal factors such as age, sex, and alcohol consumption, the peak of risk for powerboating immersions was a plateau for males between 25 and 74 years, contrasting with unpowered boating where there was a peak at 15-24 years with deaths tapering off somewhat for older age groups. Children under 15 years accounted for only 3% of immersion deaths, females of all ages for only 8%. Hence males 15 and older accounted for about 90% of victims, making them the key target group for prevention. On the other hand, children under 15 accounted for 13% of trauma deaths. Alcohol was associated with nearly 50% of recreational immersion deaths — possibly more, since alcohol was unknown for 18% of victims, and was more frequently found among powerboaters than non-powerboaters.

As for equipment factors, small powerboats predominated in recreational immersion deaths, most probably accounting for about 45% considering that most unknown boats were likely mainly small ones, followed by canoes at 23%. For trauma deaths, small powerboats probably accounted for about 40%, PWCs for 26%, and large powerboats for about 15%. 44% of powerboating trauma fatalities had sustained a head injury, with no reports of helmet use.

Clearly the most fundamental item of safety equipment for prevention of immersion deaths is a properly worn flotation device; this was borne out by the fact that only 12% of all recreational immersion victims were known to have worn one, including 10% of powered and 16% of unpowered victims, with another 3% improperly wearing one. Even fewer non-swimmers and weak swimmers were reported to have worn flotation. It is difficult to imagine how a boater experiencing the shock of a fall overboard, capsize, or swamping, especially under the adverse wind, wave, cold water, and light conditions when such incidents frequently occur, could manage to retrieve and properly don a flotation device. Furthermore, without the initial buoyancy of worn flotation, the first moment of immersion could be fatal due to hyperventilation and inhalation of water, as discussed below in the section entitled “Understanding hazards and prevention of cold immersion”. Unfortunately, there was no change in the proportion of victims wearing flotation during 1991-2006.

A key environmental factor for boating immersion deaths in Canada is cold water, which has been associated with at least 38% of fatalities. Most recreational incidents occurred on lakes, followed by rivers. For lakes and oceans, strong winds and waves are frequent environmental factors, while current was a factor for at least 60% of deaths in rivers. Wind, waves, extremely cold water, and twilight or darkness were associated with many recreational boating deaths. 86% of deaths occurred between May and October. At least 19% and possibly many more boating immersion victims died within about 50 metres from shore, and should have been able to swim to shore if wearing a flotation device.

The possibility of rescue plus resuscitation was available for only about 1 in 8 victims, emphasizing the importance of personal knowledge and preparedness for pre-event and event phases of potential injury incidents, especially avoiding boating during adverse conditions, in unsafe boats, and with lack of safety equipment such as properly worn flotation.

As for trends, there was a 27% decrease in the rate of all boating fatalities between 1991-1995 and 1996-2000. The trends during 2001-2006 are less clear due to an increased proportion of deaths missing from the surveillance database during this period, but estimates suggest at least a small decrease.

In summary, the main personal risk factors for boating deaths included ages 15 years and older, male gender, and alcohol; very few women or children were involved. Failure to wear a flotation device was an equipment factor for up to 90% of victims, and for an even higher proportion of non-swimmers and those who had consumed alcohol. Important environmental factors were extremely cold water, wind, waves, current and darkness. Fishing was the most frequent activity associated with boating immersion deaths.

ACTIVITIES & RISK FACTORS FOR PERSONAL WATERCRAFT

For all types of boat, immersion (i.e. drowning and/or hypothermia) accounted for 95% of deaths and trauma for only 5%; however, the situation was quite different for PWCs, where trauma accounted for 52% and immersion for 48%. A high proportion of immersion deaths, 52%, resulted from falling or being ejected from the PWC, whereas for trauma deaths, 88% followed a collision and 12% resulted from falling off the PWC. Nearly half of the incidents resulted from dangerous manoeuvres such as abrupt turns. Collisions accounted for 52% of all PWC deaths, suggesting that even when death was attributed to immersion, victims may have incurred inapparent injuries such as mild traumatic brain damage sufficient to cause drowning.

Considering personal factors, the age profile was younger and more females were involved than for other categories of recreational boating; 11% of victims were less than 15 years old, 84% were between 5 and 44 years old, and 15% were female.

Alcohol was associated with at least 50% of PWC deaths. For PWC operators, lower levels of alcohol may be sufficient to trigger a fatal incident, suggesting a higher baseline level of risk for this type of boat.

As for equipment factors, PWCs differ from other powerboats in a number of ways. For one thing, boaters ride on rather than in the craft, making them more susceptible to falling off, and more vulnerable to injury in the event of a collision. In addition, this type of boat has no propeller or rudder. Instead, the engine drives a water jet pump which provides both power and steering. Without a rudder, the operator can only steer when the throttle is engaged. In the event of a potential collision, the intuitive tendency — particularly for an inexperienced operator — is to cut the gas and turn away from the other boat or object. But since gas is required for steering, the craft will not turn but simply continue on its original trajectory. This lack of off-throttle steering capacity may help to explain why so many PWC fatalities resulted from collisions.

PWCs have engines of up to 250 horsepower that can accelerate to 80 km per hour within 3 seconds and attain maximum speeds in excess of 100 km per hour, so clearly power and speed were probable factors in many incidents, although such details are not routinely recorded by police and coroners.

Flotation devices were worn properly by 24% of immersion victims, about double that for other boaters; however, the data are based on small numbers. Wearing of flotation was 50% among victims of trauma from collisions and falling off the PWC.

Although the type of flotation device is not specified in police and coroner reports, it is probable that most were personal flotation devices (PFDs) and not lifejackets, which are capable of supporting the victim's mouth and nose clear of the water during temporary loss of consciousness. Helmets were also not routinely mentioned in PWC death reports; however, the high proportion of victims with head injury suggests that few if any wore helmets.

Environment factors such as wind, waves, cold water, current and darkness were rarely associated with deaths involving PWCs, compared with other types of boat.

HOW TO AVOID BOATING INJURIES

Sixteen years of research across Canada show that the vast majority of boaters who die — whether in powered or unpowered boats — have neglected basic principles of boating safety such as always wearing a flotation device, using protective equipment against cold immersion, and verifying weather conditions such as wind, waves, and water temperature. It is probable that most victims failed to obtain appropriate training in boating safety, and that many had inadequate swimming skills to cope with unexpected immersion. Furthermore, most victims died of immersion on lakes in small open powerboats and canoes. Such boats are generally not designed to a standard level of safety so as to facilitate survival in adverse wind, wave, and cold conditions. Such conditions can rapidly arise on open bodies of water such as lakes.

While certain types of boating — such as running river rapids, with its associated hazards — require specialised training, skills, and equipment, most boating deaths result from neglect of basic principles with which every boater should be familiar, and from poorly designed small boats. Most deaths described in this report could have been averted if the following fundamentals had been respected:

- Immersions during boating are sudden unexpected events requiring advance preparation by proper wearing of a comfortable flotation device appropriate to the type of boating activity;
- All adverse conditions, especially water temperatures 15°C or less, necessitate wearing of supplementary hypothermia protection;
- Sudden wind, waves and cold arise frequently and are a major threat for boaters far from sheltered waters in lakes and on the ocean; therefore, advance verification of weather, including wind and wave conditions, is required, and only boats with approved designs should be used where such conditions are to be expected;
- River currents, especially when concentrated around rocks, bridge pilings, and in hydraulics at the base of dams, have enormous kinetic energy that can trap the unwary;
- Since many boating deaths occur from unexpected events such as falls into water and wind and waves, operators and passengers who have consumed even small amounts of alcohol increase their risk. Current federal BAC levels may be adequate. Probably more important is improved enforcement, especially at popular sites for high speed powerboats including PWCs, and at holiday events where many boats may congregate.

On the other hand, it has been found that errors people make tend to be related to the type of boat they habitually use (McKnight et al., 2006), as well as to the specific hazards of different bodies of water. Therefore, general training on key safety issues needs to be

followed up by specific information and practice for the boat(s) of main interest for the trainee, and knowledge about issues related to the body of water where boating will occur. In illustration, ocean boaters require navigational skills, and data on tides and currents in their region, while river boaters must be aware of hazards such as fallen log strainers, dam hydraulics, and large rocks, how to avoid them, and what to do if they cannot be avoided.

Effectiveness of educational interventions is not well proven for injury prevention, and they require frequent repetition, so it is not wise to rely on such measures alone. However, swimming training (Brenner et al., 2009) and research-based water safety training (Canadian Red Cross, Module 1, 2006) appear to help prevention of immersion deaths of children, and should help more adult boaters to survive. Boating and swimming instruction should include practical experience with cold and current in the requirements. Written examinations should be supplemented by research-based training on the hazards of current and of cold immersion and how to prevent problems with them, including the value of flotation devices. Piloting and evaluation of water safety training in high schools should be considered for targeting older students, including immigrants who may not have sufficient information about the hazards of cold immersion and river current, swimming training, and flotation devices. Since basic swimming ability is protective against immersion deaths (Brenner et al., 2009), pilot programmes are needed to test mandatory basic swim testing at school entry, followed by school-based training sufficient for the student to swim a pool length, so as to be able to survive a fall into water, whether from a boat that has capsized or swamped, or from shore or pool side.

Population-based survey and experimental research is also needed to assess the effect of current mandatory boating licensing and training requirements on knowledge, attitude, and practices at intervals after testing. It would be helpful if a national database of persons taking current and improved boating examinations and training could be linked with national coroner data from Statistics Canada to verify training status of deceased boaters. Improved research-based programmes with training in swimming, cold exposure, and coping with current should be piloted and evaluated.

A structured comprehensive approach to prevention is essential. Modern principles of injury prevention include careful assessment of personal, equipment, and environment risk factors for different time phases of potential injury incidents, including pre-event, event, and post-event phases. Pre-event phase interventions include evidence-based personal training of all boaters in open-water boating hazards and skills so that life-threatening immersions do not occur. A well designed boat can help avoid immersion, and should promote rapid reentry and survival even if immersion occurs. A flotation device is an item of safety equipment; when worn by a boater, it helps to prevent injury (drowning and/or hypothermia) during an immersion in water due to swamping or capsizing, i.e., the event phase of an incident. A properly worn and activity-appropriate flotation device is the single most valuable and essential item of safety equipment; other safety equipment includes bags with throw ropes for rescue, and cold-protective equipment such as wet and dry suits to enhance survival of cold water immersions. Post-event phase interventions include personal rescue skills for retrieving boaters safely from high seas or current, and cardiopulmonary resuscitation (CPR) for revival if needed.

Small open powerboats are the most frequent type of boat associated with recreational boating fatalities. Such boats are frequently manufactured in stackable form for easy transport and sale. As a result, many include minimal flotation insufficient to keep the boat well out of the water when swamped or overturned, especially with a heavy engine attached and possibly other heavy loads aboard. Such boats also lack design features to facilitate re-entry and emptying the vessel of water in the event of a swamping, or to get out onto an overturned vessel in order to keep the boater's body out of cold water. Since wind and waves are frequent on lakes where such boats tend to be used, strict safety requirements should be mandatory and proven by laboratory and field testing. Experimental research should be funded to test different designs of small open fishing boats for such survivability design issues. This could be done at the defence and civil environmental labs in Toronto, at other suitable laboratories elsewhere in Canada, or at

private survival research and training companies such as in Halifax. Field testing under real conditions would also be essential. Safety ratings should then be required based on a full load or preferably a slight overload including engine to simulate real-life conditions, provided to all potential purchasers, and be clearly visible to the operators in large letters.

Other experimental research could include development and evaluation of water temperature sensors as a research basis for subsequent legislation to make them mandatory on all standard powerboats, small and large, with visible warnings at 15°C (orange) for severe cold and 10°C (red) for extreme cold. This could provide a research basis for legislation. PWCs lose steering capability when power is cut. Some means of steering other than the power jet might help to avoid collisions. Research could help with this issue and provide a basis for legislation. Dead man's controls not easily disabled are needed for all powerboats. Experimental research with different designs of dead man's controls could also be complemented by field surveys to verify acceptability, functionality, and use. Population-based survey research could also assess reasons why they are not used, or are disabled by many boaters. This could provide a sound research basis for legislation and enforcement for mandatory use. Other research could focus on energy absorbing padded dashes, operator areas, possible automatic release safety belts for high speed jetboats and similar models where high energy crashes are to be expected, as well as on the safety of powerboats that have open bow areas with seating. Similar research on padding and other protective structures could be useful for PWCs.

For flotation devices, experiments with users and non-users could help to create designs that are comfortable and cool enough for different seasons and activities, and others that offer at least partial protection in the event of cold weather immersion, while retaining comfort and functionality for different activities. Field research and programmes for loaner or free or subsidised flotation devices in northern and aboriginal communities should be assessed, and continued or expanded if effective in increasing wearing.

It has been difficult to conduct national epidemiologic research on risk factors and prevention of boating deaths for aboriginal populations with frequent exposure to risk of fatalities in water-related activities. All provincial and territorial coroners, particularly in the largest province of Ontario, should require the collection and making available of data on aboriginal ethnicity in anonymous form for aggregate use in research and prevention of water-related injury fatalities.

For traumatic injuries, even momentary minor injury or concussion of the brain is potentially fatal on the water, so helmets and padded dashboards are needed where a blow to the head is likely, such as for travel on PWCs and other high speed boats, and in kayaks or canoes in high grade rapids. Helmets are already required by all reputable clubs and instructors for most white water kayaking, rafting and some canoeing. Fatalities involving PWCs, including immersions and trauma, mainly resulted from collisions. Most passengers on high speed boats, as on motorcycles and snowmobiles, do not wear safety restraints; therefore, helmets should be required as on other high-speed transport where passengers are unrestrained. Head injury could occur from falling off, and a brief loss of consciousness accompanied by immersion could be fatal. Therefore, as well as lifejackets, powerboaters who travel at high speed need helmets that will keep their head out of the water in the event of brain injury. Our findings confirm that head injuries are frequent among victims of boating trauma deaths. Hospital studies of trauma among PWC users in the United States found that about half of the victims sustained head injury; mandatory helmet use was recommended (Rubin et al., 2003, Jones 2000). Due to many fatal head and multiple injuries in children and adults on personal watercraft in Canada, helmets should be obligatory, and specialised flotation devices assessed for protection against chest and abdominal injuries.

PERCEPTION OF RISK

A key issue in prevention is perception of risk for different activities. Actual risk of water-related injury and death per exposure to water tends to be much higher than commonly perceived. Thus while the risk of death or severe injury from a motor vehicle crash is quite low per trip, nearly all drivers and passengers in Canada now wear a safety belt and avoid alcohol. On the other hand, people are often seen loading their boat with alcohol, and forgetting to bring or sitting on their flotation devices rather than wearing them. Strangely enough, the research has shown that non-swimmers were even less likely than other boating victims to correctly wear flotation — particularly alarming given that many unpowered boats are small and narrow, and hence relatively unstable and easily capsizable. The lesson for those who train and educate the public is that a first priority should be to discuss risk perception. Only then can misperceptions be corrected so that each individual has a realistic appreciation of the risk of injury for boating activities. At that point, the discussion can move on to risk factors for specific activities and environments, and essential training and equipment. In the end, risk of injury needs to be reduced to a sensible and reasonable level. Otherwise, boating makes no sense.

BOAT SMART

Wearing rates for flotation devices in boats lag far behind those for seatbelts in cars: only 12% of recreational boaters who drowned during 1991-2006 were wearing a flotation device. This is a major opportunity for prevention by good legislation and enforcement, and of course individual safety practices such as taking time in advance to choose and purchase an appropriate flotation device for the activity that is planned, to ensure that the device is cool and comfortable and will be worn. Nearly all victims of boating drowning are males 15 years and older, so this is the key target group for prevention. It is best to focus on youth and adult male or family wearing, rather than child wearing; in order to help and protect any children who may be present in boats, adults first need to protect themselves by wearing their own flotation.

UNDERSTANDING HAZARDS AND PREVENTION OF COLD IMMERSION

The overall trend for Canada in cold-water boating immersions has been discouraging, with a rate of 0.28 deaths per 100,000 population per year in 1991-1995 and 0.26 during 1996-2000 (Canadian Red Cross, Module 2, 2006). It is probable that the only highly effective means of bringing about a major reduction in the overall cold-water boating immersion death rate is legislation and enforcement to ensure wearing of appropriate personal protective equipment. While research-based education and training are essential, on their own they have proven relatively ineffective, as for other injury prevention measures such as safety belts in cars.

Users of all boats, especially those who travel on the ocean, large lakes, and fast rivers, and during spring and fall when the hazards of cold immersion are greater, should be familiar with how to avoid cold immersion and how to respond when it occurs. It is highly recommended that all boaters review Module 2 of the Canadian Red Cross 10-year research, Ice & Cold Water. A brief summary of its main points is reproduced here.

The ***four stages of death*** from cold immersion (Brooks/Transport Canada, 2003; Golden & Hervey, 1984), include:

STAGE 1. Gasping and cold shock
STAGE 2. Swimming failure
STAGE 3. Hypothermia
STAGE 4. Post-rescue collapse

Most cold-water immersion deaths occur during the first two stages, rather than from generalized hypothermia. Knowledge of the effects of these stages is essential for prevention, and should be well understood by all boaters. Unexpected falls from powerboats are frequent, while unpowered boats are relatively unstable and immersion can occur at any time without warning. Because immersion in cold water at ≤15°C can kill almost immediately without the presence and proper use of flotation equipment, any immersion is potentially fatal and should be avoided if at all possible.

For larger boats, life rafts are strongly recommended to help avoid immersion (Brooks/ Transport Canada 2003), but since this is impractical for many small powerboats and most unpowered boats, flotation is essential to minimize the degree of immersion as well as to prevent submersion of the airways. Prevention of hypothermia is necessary mainly where immersion is prolonged, such as during incidents far from shore on large lakes or oceans, or near dangerous rocks and cliffs in rough seas. Prevention of post-rescue collapse after prolonged immersion involves appropriate handling of a victim during and after rescue.

Since they are least understood and most important for the general public, now consider details of stages 1 and 2 of the event phase of cold immersions:

STAGE 1. GASPING/COLD SHOCK Death can occur rapidly during the first few minutes of immersion from so-called cold shock. The use of the term "shock" for this stage could be misleading, since in most types of clinical shock the blood pressure drops dangerously low, whereas in response to cold it can rise very high. It is helpful to remember that the "shock" or stress of sudden immersion in cold water leads to various responses by the body, the most serious of which is involuntary gasping respirations, which, if the airways are below the surface when this response occurs, can lead to *aspiration of water* resulting in drowning. A temporary decrease in or loss of consciousness due to the effects on the brain of rapid deep breathing (hyperventilation) could also be fatal in the context of immersion (Mantoni et al., 2007). Death may also occur as a result of cardiac arrhythmias. The biochemical effects of hyperventilation on muscles might also impair the ability to swim or tread water.

STAGE 2. LOSS OF MANUAL PERFORMANCE Next in the time sequence is l*oss of strength in the limbs* due to cooling of muscles and nerves. Nerves may fail to signal muscle to contract, and muscle may be unable to contract (Tipton and Golden, 2006). First to go may be the fine muscles of the hands. Ability to hang on to an overturned boat is lost, the individual is unable to perform activities such as putting on or fastening a flotation device, and, more gradually, loses the ability to swim effectively. The effects of stage two may result from both local cooling and from the shutdown of blood to the limbs in response to cold. Limb strength is necessary for a person floating in water to help keep the face turned away from wind and waves so that water is not aspirated into the lungs. If the victim is unable to keep the airways above the surface or away from waves, drowning will occur.

On a positive note, it was found in experiments in Sweden and the United Kingdom that volunteers were able to swim for at least an hour in water at 10°C, and most swam for 90 minutes (Tipton et al., 1999). Even among volunteers who swam for 90 minutes in water at 10°C, the problem leading to swim failure was not hypothermia, which by definition is generalized and affects the core of the body, but rather local muscle cooling of the limbs. Other experiments with swimmers wearing a personal flotation device (PFD) showed that they were able to swim an average of 889 metres in water at 14°C and 650 metres at 10°C before swim failure (Wallingford et al., 2000, Kenny et al., 2000). During another study in Canada of both novice and expert swimmers, it was observed that both groups could swim for about 45 minutes in 10°C water before incapacitation. The expert swimmers could swim faster and were able to swim an average 1.4 km, compared with 820 m for the novices, with an average distance for both groups of 1.1 km (Lounsbury 2004, Lounsbury and Ducharme 2005). However, these results may not always apply to an unexpected injury incident in dark and/or stormy conditions.

Now consider some ***practical implications*** of the four stages of death from immersion. First, for people who fall into very cold water, *protection of the airway* from gasping associated with sudden exposure to cold is very important. Otherwise, water can be inhaled and drowning initiated rapidly. Thus from a practical perspective, this stage is a phase of *gasping/acute drowning* and also of sudden cardiovascular effects. For prevention of sudden drowning, use of appropriate flotation helps keep the body higher and the mouth and nose out of the water to minimize inhalation, i.e., prevents submersion of the head during this critical phase. Appropriate flotation should also help to avoid submersion of the airways if consciousness or use of muscles is temporarily impaired due to hyperventilation. Such findings provide strong support for mandatory wearing of a flotation device by boaters, since a submersed boater will be at high risk of immediate death before he has the opportunity to find and put on a flotation device, a difficult task even in warm water. Specialized flotation devices are now available to boost the body high out of the water during this stage of immersion. Other protection of airways such as splashguards has been recommended. Better yet is complete avoidance of immersion by use of a life raft.

Whatever the equipment that happens to be available, the victim of a sudden cold immersion should concentrate on protecting their airway from cold water inhalation until their breathing stabilizes and gasping stops (Ducharme, 2006). This would include avoiding swimming for a few minutes during the cold shock period, until the massive gasping, rapid breathing, high blood pressure, and rapid heart rate have a chance to subside. Only then should the individual decide on a course of action.

Practical implications of the sequence of progression and rapidity of loss of strength of hands and later limbs, known as the *incapacitation phase,* include the fact that hanging on to an overturned boat is a reasonable survival strategy only if rescue will be rapid. If rescue is delayed, the immersed person will lose the ability to hang on — this can occur within 10-15 minutes — or even to keep the face away from wind and waves, and will drown. Unfortunately, with both nerve conduction and muscle contraction blocked, and with no blood flowing to the limbs, mind cannot control matter.

Therefore, if one is immersed in cold water, unable to climb out of the water onto a stable object, drifting away from shore, and rapid rescue is unlikely, it may be preferable to swim to safety, especially if the distance is not too great, one is a good swimmer, and wearing a flotation device, i.e., immediate self-rescue. Red Cross drowning data support such an approach (Sawyer and Barss, 1998). As noted above, it may be feasible to swim up to about one kilometre in cold water.

On the other hand, if the distance is great and/or rapid rescue by others is known or probable, the victim should immediately make every effort to get as much of the body as possible out of the water as quickly as possible if there is something to climb onto; although it may feel colder out of the water than in, it is always better to be out of the water (Tipton and Golden, 2006). If this cannot be achieved in the first 10 to 20 minutes or so, it may rapidly become impossible due to loss of hand and arm strength. Other options include raising the probability of detection and rescue by immediate use of flares and other measures (Ducharme, 2006). This must be done right away, as the ability to open and deploy flares is also rapidly lost in cold water. As noted by Ducharme, *the goal or ultimate objective is not to preserve body heat, but to move out of the water as quickly as possible.*

Furthermore, since boaters have been found dead on land after surviving an initial cold immersion, those who travel in isolated conditions should always carry a change of warm dry clothing in a waterproof float bag so that if immersion does occur, dry clothing can be donned immediately upon reaching shore.

DON'T UNDERESTIMATE CURRENT

Current was a factor in most river drownings involving unpowered boats, and was a probable factor for many powerboat drownings as well. As with many sources of powerful kinetic energy, current can be dangerous for boaters who have not dedicated sufficient time to the study of river currents, and received expert practical training in navigating with current — ferrying their boat or body by setting a proper angle against the current — and in river rescue.

A boater, swimmer or wader who underestimates the power of current can be swept away in an instant. At best one may be swept into calmer water and escape to shore, at worst be trapped underwater against an immovable object or in recirculating current. Many a river paddler who decided to shoot an innocent-looking small dam, or powerboater who got swept over a dam, has been trapped underwater by the immense power of a recirculating hydraulic, to be expected at the base of most such man-made structures. Boaters may also at times need to walk in current, so must be familiar with the hazards of foot entrapment when moving about on the rocky bottoms of fast-flowing rivers.

Rivers were the site of drowning for 23% of recreational boating deaths, including 19% of powered and 31% of unpowered incidents, resulting in at least 549 deaths over 16 years, and probably more. Current is also a factor in some ocean drownings. Effective evidence-based training in how to manage the hazards of current for boating and — since boaters sometimes end up immersed in current unexpectedly — for swimming, wading, and falls into water could have helped *avert about 25% of boating immersion deaths per year, saving over 500 lives.*

Education and training should include the theory of current and the types of scenarios to be expected based on epidemiologic analysis of the determinants of many incidents. Training needs to include how to safely manoeuvre a boat in current, how to avoid hazards such as tree/log strainers and dam hydraulics, how to use the power of current for self-rescue, and how to rescue others. Other important issues include the selection and use of appropriate boats for river, including a smooth rounded bottom with sufficient rocker for rapid turning in current; adequate freeboard or safety skirts so the boat does not fill with water in turbulent zones; basic safety equipment such as bow and stern ropes; and, for canoes and kayaks, flotation bags to keep water out and prevent collapse and pinning. Kayakers, canoeists and rafters who run rapids at high levels of difficulty and hazard also need to protect themselves against brain injury from collision with rocks by always wearing a helmet, since even a momentary loss of consciousness can be fatal in water.

Armed with the right knowledge and training, the individual should be much better protected during all time phases of injury, including pre-event, event, and post-event. And, of course, the right attitude is essential to avoid unwise risks.

Research-based water safety instruction and swimming instruction on how to deal with current for high school students, and later reinforcement for youth and young adults, represent a grand opportunity for prevention. In our country, covered with innumerable rivers and streams, every Canadian should be able to safely manoeuvre in current when the need arises.

SPECIAL OPPORTUNITIES FOR LARGE GAINS IN PREVENTION

There are several major opportunities for prevention of boating fatalities in Canada which could limit the suffering of affected families and reduce the enormous costs associated with these deaths. While all of the above recommendations would be beneficial and mutually supportive in many incidents, **the single most effective initiative, based on the research, would be the mandatory wearing of appropriate flotation by all recreational boaters at all times, for an annual cost savings of about $330 million.** Mandatory wearing would render enforcement much simpler, since it would be apparent from a distance whether or not boaters were wearing flotation. (Enforcement of the current regulation of carrying flotation devices in the boat is difficult, since officers must stop the boat and ask to see the flotation devices. Such enforcement is intrusive, time consuming, and impractical.)

To support this intervention:

- Legislation and enforcement for wearing of a flotation device should include all boats, except perhaps when at anchor or tied up at a wharf. Legislation should include drifting boats, since persons who fall or jump into the water are often unable to regain a drifting boat;
- Operators need to be legally responsible for PFD-wearing by all occupants. For unstable small boats such as canoes and kayaks, wearing a PFD at all times is especially critical. Special emphasis and enforcement is necessary for adult males;
- Shops selling flotation devices for all boaters should be required to stock both models for inactive boating (powerboats) and active boating (at least canoeing). For PWCs, specialised models may be needed to help protect from chest and abdominal trauma in high speed crashes;
- Comfortable models suitable for hot weather, and others when water temperatures are extremely low, should be available where flotation devices are sold. Cold water models could be required early in the season when water temperatures are cold. Specific designs for kayaking and other activities such as rowing of racing shells could be sold at more specialised shops.

CONCLUSION

From the above, it is clear that by an appropriate combination of preventive measures, the vast majority of boating deaths could be prevented. Since most boating victims were economically active young to middle-aged adult males, a conservative estimate of the average **economic loss** per victim would be about $2 million direct and indirect costs, including human capital losses of lifetime family earnings, for a total loss of $6 billion during the period, nearly $400 million per year. If even a proportion of such losses were allocated by government to research-based prevention, evaluation, training, and education, and especially to legislation and enforcement of flotation-wearing, the economic return on investment would be great.

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