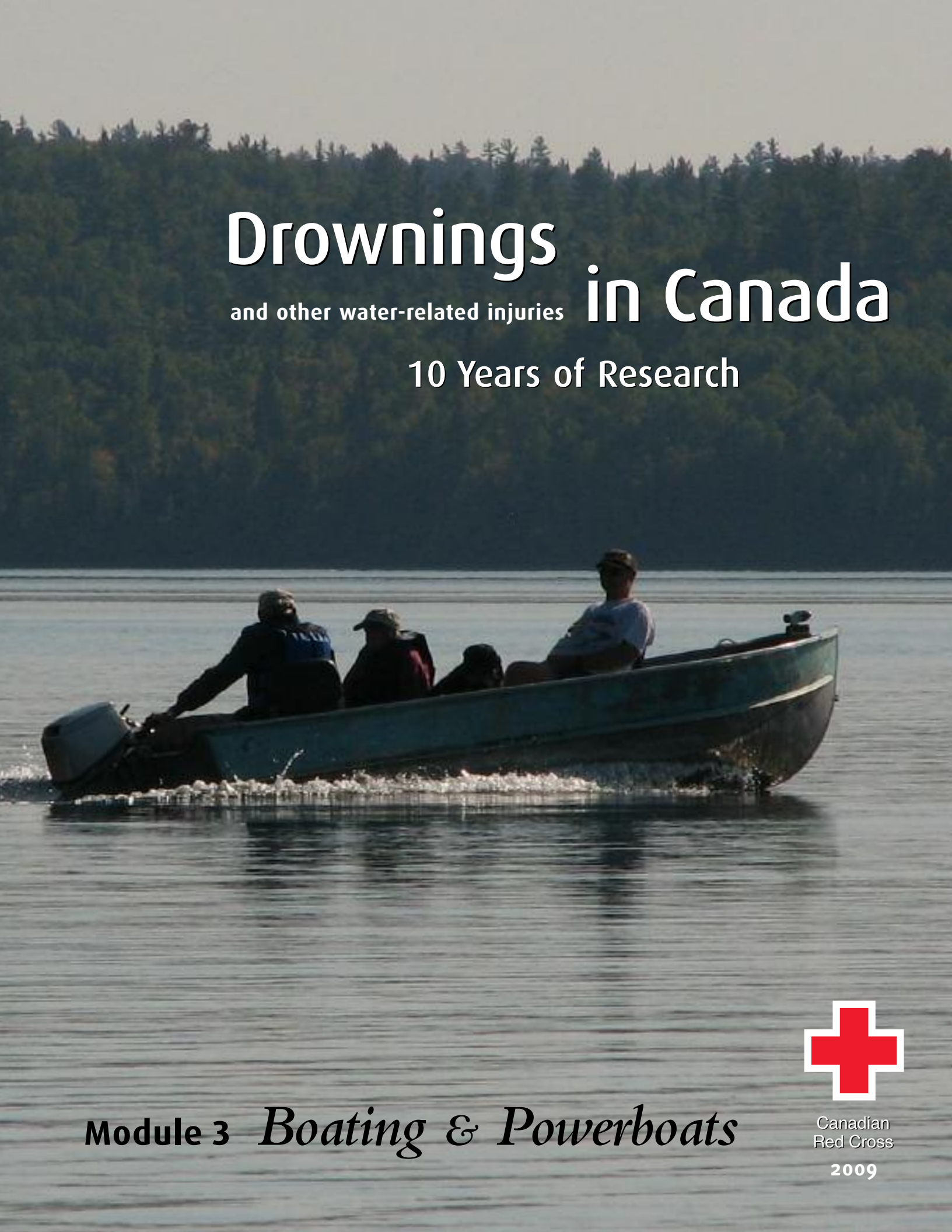


Drownings and other water-related injuries in Canada

10 Years of Research

Module 3 *Boating & Powerboats*

Canadian Red Cross

2009

This research is dedicated to the 1,952 people who died during boating, and in particular the 1,243 who died during powered boating in Canada during 1991-2000.
May the evidence of the circumstances of their deaths be a guide to safety for the Canadians who use powerboats or personal watercraft for recreation, daily life, or work,
and for professionals and decision makers with a duty to protect the vulnerable.

But on November twenty-first, when it seemed we might be making the final run of the season, I turned and he was not there and I knew even in that instant that he would never be again.

On November twenty-first the waves of the grey Atlantic are very high and the waters are very cold and there are no signposts on the surface of the sea. You cannot tell where you have been five minutes before and in the squalls of snow you cannot see. And it takes longer than you would believe to check a boat that has been running before a gale and turn her ever so carefully in a wide and stupid circle, with timbers creaking and straining, back into the face of storm.

– Alistair MacLeod, "The Boat," 1968

Drownings and Other Water-Related Injuries in Canada, 1991-2000
Module 3: Boating and Powerboats

For a pdf version of this module, please visit our website at www.redcross.ca

This Visual Surveillance Report was developed and written by Dr. Peter Barss in collaboration with the Canadian Red Cross and with the assistance of Cait Beattie. Sophie Lapointe, research technician, carried out the data analysis.

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. Data coding, verification, and entry were supported by the Canadian Red Cross and the Lifesaving Society, and carried out by Isabelle Masson, Peter Barss, and Sophie Lapointe.

The National Search and Rescue Secretariat and the Canadian Red Cross Society funded data analysis and writing, as well as editing, design, and layout of this 10-year report. Shelley Dalke of the Canadian Red Cross coordinated this process. The Canadian Red Cross translation department supervised the translation of this module with the assistance of Cait Beattie; additional revisions in French were completed by Monique Edwards. The Canadian Coast Guard and Transport Canada sponsored the project and monitored its progress. The Research Institute of the McGill University Health Centre provided administrative support for data management.

For the initial six years, the National Drowning Report and related special interest reports were generously 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. Rosemary Hong, former coordinator for drowning research at the Canadian Red Cross, inititated this 10-year modular project.

Design, layout and cover photo: Cait Beattie and Jean Louis Martin, Résolutique globale
Translation: Lexi-tech International (text), Résolutique globale (figures)

Ce rapport est aussi publié en français.

Module 3: Boating & Powerboats

wearalifejacket.com

A website supported by The Cook-Rees Memorial Fund For Water Search And Safety.

A central location of information on how to find and choose the best flotation device for various water-related activities, and to learn about recent advances in lifejacket design for individual comfort, style and protection.

Sport and safety organizations, policy makers and the media can also consult the website to share knowledge, research and drowning prevention campaigns to help inform the public about the need to wear a lifejacket in, on and around the water.

INTRODUCTION

Canada is a country surrounded by oceans to the east, west, and north, covered with lakes in the flatter areas of the country, and linked by the high-energy currents of countless fast–flowing rivers in the hills and mountains of eastern and western regions. Hence various types of boats have been essential in this environment for travel, trade, nourishment, and survival for thousands of years.

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 purposes, recreation, occupation, and activities of daily life, including travel and subsistence fishing and hunting. At present recreational activities, including power boating and fishing, 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 immersion fatalities. Other main causes include aquatic activities such as swimming and wading, falls into water, and bathing; further details are available in module one of this series.

This module includes an overview of 10 years of research on all deaths in boats in Canada together with details of incidents involving powerboats. The report focuses on the incidence or rate of death and trends during 1991-2000, and on personal, equipment, and environment risk factors. Readers with a specific interest in details of deaths associated with unpowered boating in canoes, kayaks, rafts, rowboats, and sailboats should also consult module four of this series.

Sadly, year after year boaters continue to 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. Indeed, although alcohol is ill advised while boating for 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 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.

From the results of detailed epidemiologic studies, such as this report, it is evident that injuries such as drowning do not strike randomly as thunderbolts from the sky. While the exact moment of downfall is not always predictable, usual combinations of circumstances are monotonous in familiarity.

In the optimistic belief that knowledge of the circumstances of water-related deaths offers a source of longevity for all who use the waters of our vast land, this report on the circumstances of death for nearly 2000 Canadian boaters is dedicated to their memory, and offered as an instrument of survival for future boaters, operators and passengers, since each one of us carries 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 and equipment that are essential for their chosen activity.

Decision makers carry a heavy burden of responsibility for survival of their boating populations, especially in Canada with so many vulnerable peoples at risk. Political leaders and their civil servants have a duty to act, ensuring 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 wearing of an appropriate flotation device by all. It is astounding to note that in exposure to boating, where the most frequent injury incidents involve capsizing and falling overboard, even 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.

The 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 coroners and police, and recorded in provincial and territorial coroners' files across Canada. The data in this report required more than 10 years of dedicated work by voluntary Red Cross and other data collectors, managerial and research professionals. The 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 requires about two year's work. The analysis of 10 years of data, including trends, is naturally much more complex than for a single year.

Due to the fact that much of the work was done on a voluntary basis, the total costs of collecting, analyzing, and reporting on incidence and risk factors of 5,900 drowning deaths, including the deaths described in this report, was accomplished for the modest amount of about $C2 million, and has already resulted in averting hundreds of deaths, with about $C500 million savings in direct and human capital costs. Our hope is that this report will help to bring about similar savings in lives and economic losses specifically for immersions and trauma during boating, especially powered boating, an important outdoor activity for many Canadians.

METHODS

STUDY POPULATION AND TIME PERIOD All drownings and other water-related injury deaths in Canada were monitored between 1 January 1991 and 31 December 2000; during this period there were 5,900 water-related deaths, including 5,535 drownings with or without hypothermia reported, 92 immersion hypothermia deaths without drowning, and 273 other injuries. In the 1996 census, the total population of Canada was 30,300,000. Thus, the powered boating deaths in 1991-2000 occurred on the background of about 303 million person years of exposure to risk for all ages. As denominators for incidence and trends for 1991-1995 we used 1991 census data, for 1996-2000, the 1996 census population, and for 1991-2000 the mean of the 1991 and 1996 census populations. We chose these two years since they are actual census data, and not the less valid inter-censual projections.

DROWNING AND IMMERSION HYPOTHERMIA For the purposes of this paper, 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 autopsy or other coroner's finding excluded drowning as among the causes of death. Drownings with and without hypothermia were analyzed together. Drownings with and without hypothermia were analyzed together. This was done because hypothermia is reported inconsistently, due to lack of clear criteria for such a diagnosis as well as lack of training in immersion deaths on the part of some coroners. On the other hand, immersion hypothermia without drowning tends to be based on lack of autopsy findings of drowning, and other supporting factors that exclude drowning, such as wearing of a flotation device.

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.

NATIONAL SURVEILLANCE DATABASE In the early 1990's, the Canadian Red Cross implemented a national drowning surveillance database. This was developed with 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).

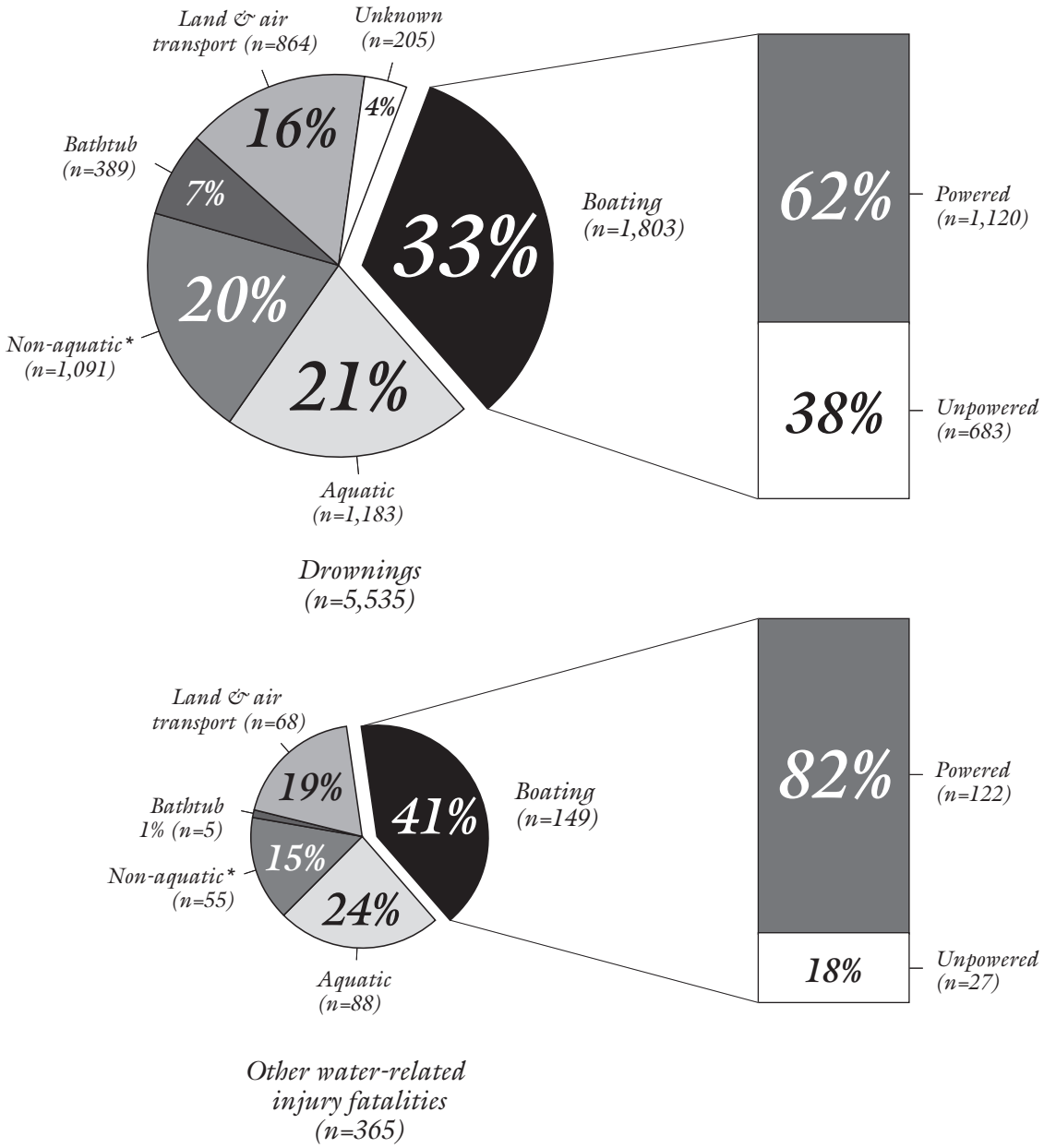
DATA COLLECTION The surveillance database relies upon annual structured reviews of the mandatory coroner and police reports for all water-related deaths. A questionnaire with 48 questions is used to obtain data on cause of death, activity and purpose of activity, along with personal, equipment, and environment risk factors. Project managers supervise volunteer data collectors in each province.

DATA VERIFICATION AND ANALYSIS All completed questionnaires are verified and corrected at national level by a medically trained injury epidemiologist and demographer. 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 controls, including double entry and compare. Data are analyzed annually, but for this paper 10 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 the incidents by about two years. This is not of major consequence for prevention, since major trends usually occur slowly.

In the early development years, the analytical work was considered research. In later years, much of the analysis was done by a research technician and was considered surveillance. Detailed reports on new topics, such as the present paper, were considered research. Hence it was possible to provide both surveillance and a research basis for new programming. Recommendations were also supported by periodic monitoring of the scientific literature on injury prevention in international citation databases.

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). Boating accounted for 33% of drownings and 41% of non-drowning deaths (Figure 1). When land and air transport are excluded, boating represented 39% of drownings and 50% of other water-related fatalities.

Figure 1 **BOATING FATALITIES AS A PROPORTION OF DROWNINGS AND OTHER WATER-RELATED FATALITIES, CANADA 1991-2000 (n=5,900)**



** Falls into water during non-aquatic activities*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

DROWNINGS

TYPE OF INCIDENT The most common type of boating incident was capsizing, followed by falling/jumping overboard, swamping, and collision (Figure 2).

PURPOSE 76% of boating drownings (1,362/1,803) occurred during recreational activities, 10% (187) during daily living activities, 11% (201) during occupational activities, 2% (28) during attempted rescue, and 2% (4, 24) during other/unknown activities.

TYPE OF ACTIVITY: RECREATIONAL Most recreational boating drownings occurred during fishing, powerboating* and canoeing (Figure 3).

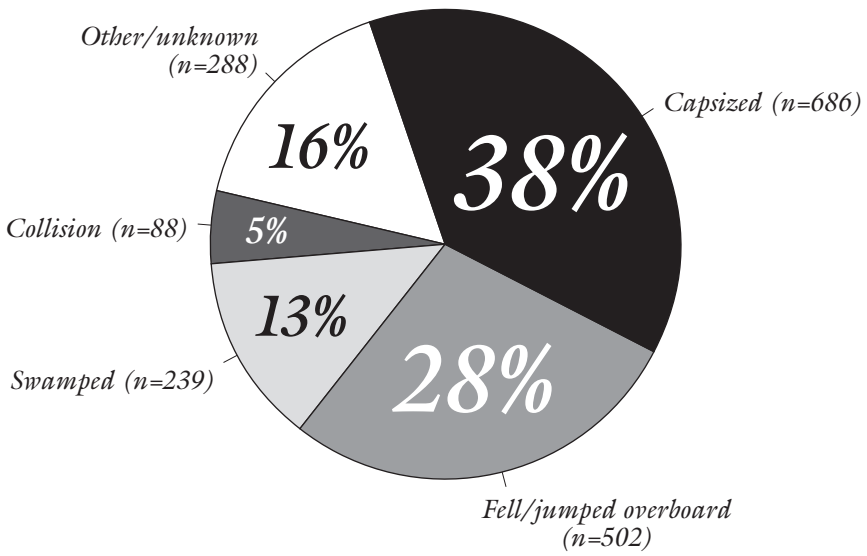
OCCUPATIONAL 75% of occupational drownings (151/201) occurred during fishing-related activities (commercial fishing 139, fishing guiding 6, aquaculture 6); 8% (16) during shipping; and 16% (33) during other activities such as construction work, logging, trapping and water surveying; activity was unknown for <1% (1) of victims.

DAILY LIVING 60% (112/187) of daily living drownings occurred during boat travel, 18% (33) during fishing and 22% (42) during other activities such as hunting and trapping.

PERSONAL FACTORS

AGE & SEX Males between 15 and 74 years accounted for 87% of boating victims. The drowning rate for unpowered boating was highest for males 15-24 years, while for powered boating those between 25 and 74 were at highest risk (Figure 4).

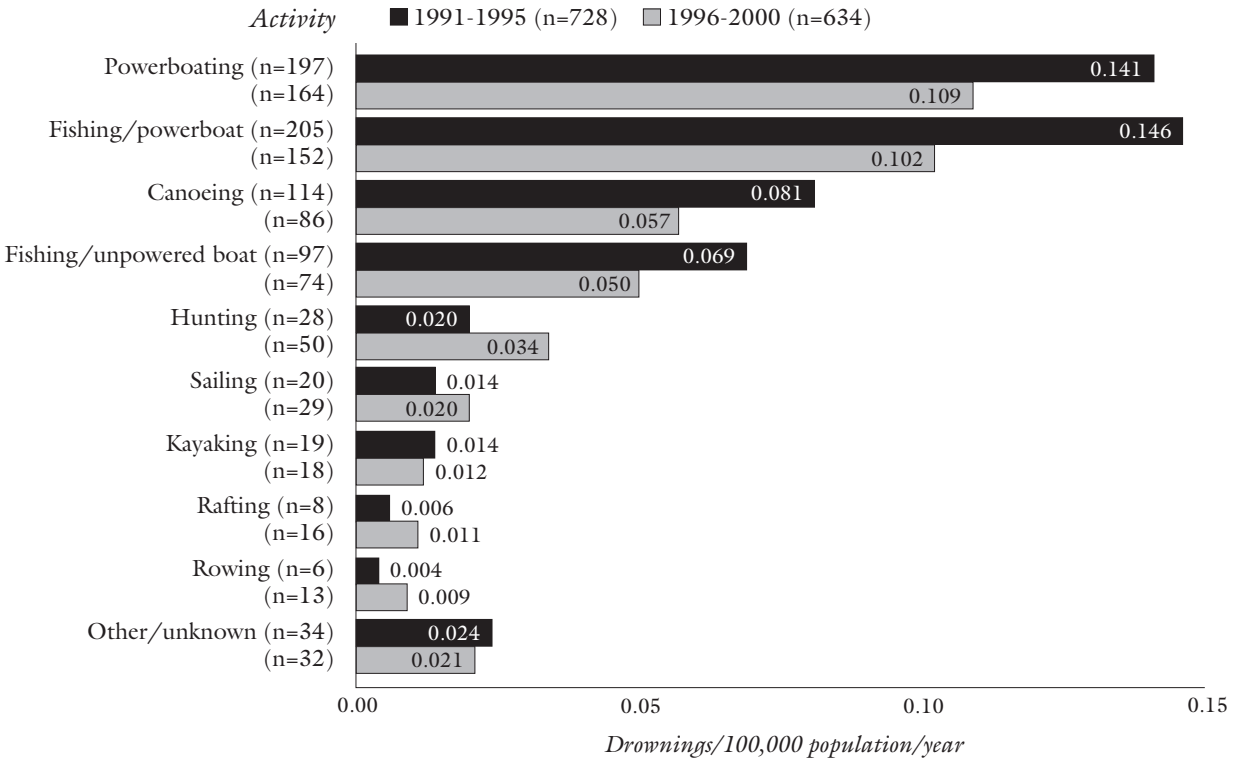
Figure 2 **BOATING DROWNINGS BY TYPE OF INCIDENT, CANADA 1991-2000 (n=1 803)**



Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

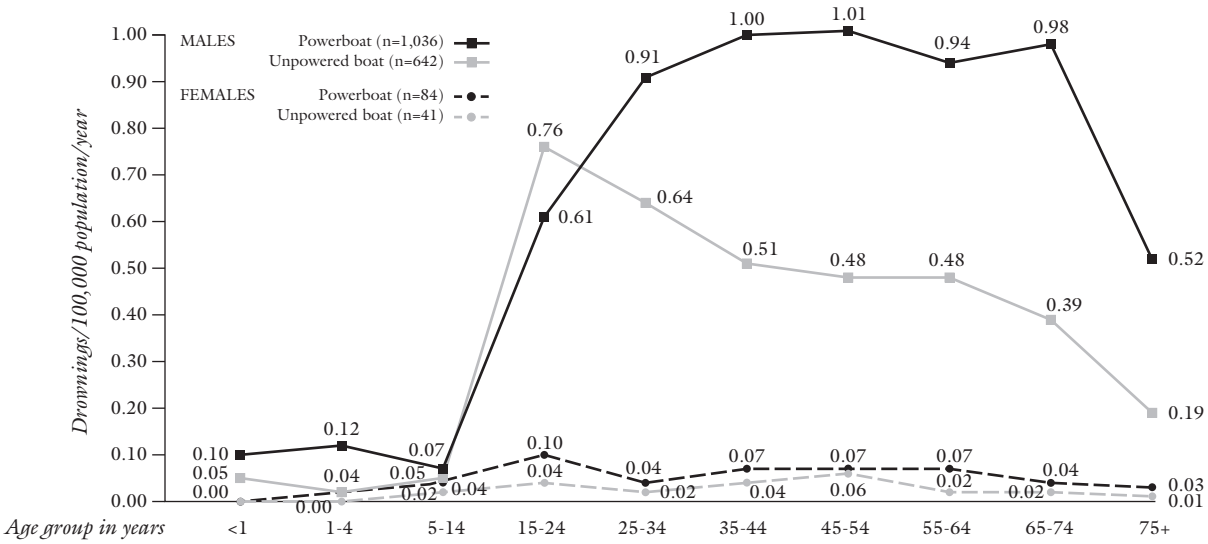
** The term "powerboating" refers to the recreational use of a powerboat as a activity in itself, whereas the term "powered boating" includes all cases of boating in a powered boat. (A similar distinction is made between "canoeing," "rafting" etc. and boating in a canoe, raft, etc.)*

Figure 3 **RATE AND NUMBER OF RECREATIONAL BOATING DROWNINGS BY ACTIVITY, CANADA 1991-2000 (n=1,362)**



Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 4 **RATE AND NUMBER OF BOATING DROWNINGS BY AGE & SEX AND BY TYPE OF BOAT,* CANADA 1991-2000 (n=1,803)†**

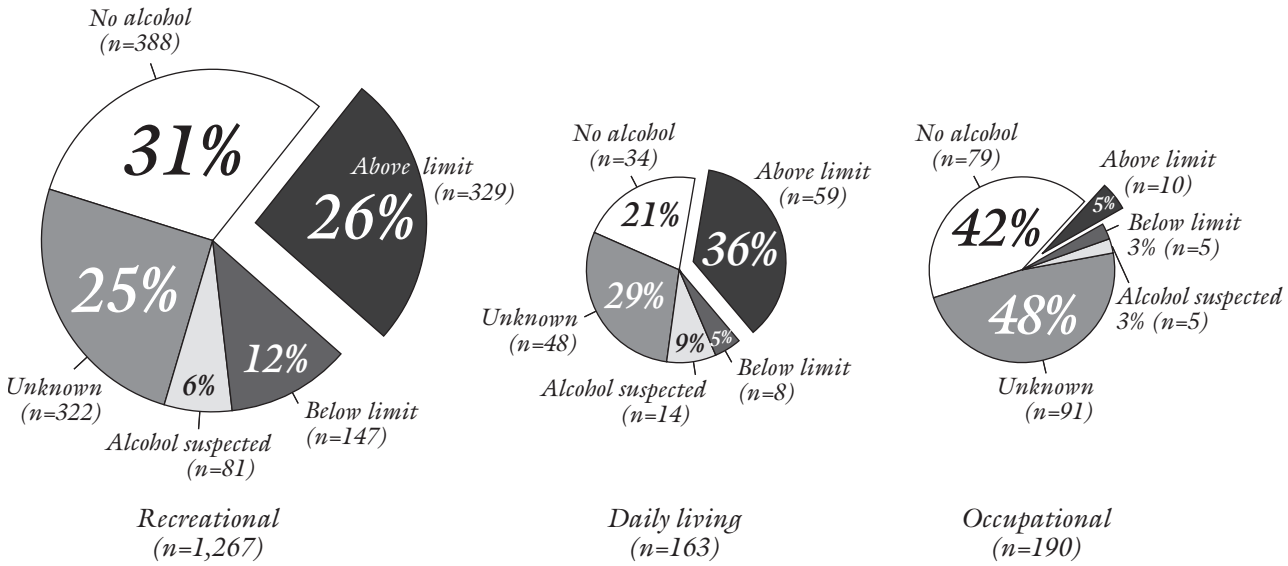


Number of drownings in age group

		<1	1-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75+
MALES	Powerboat	2	10	14	125	226	238	172	115	89	27
	Unpowered boat	1	3	11	156	159	121	82	59	36	10
FEMALES	Powerboat	0	3	8	19	10	16	12	9	4	3
	Unpowered boat	0	0	3	8	5	9	1	0 3	2	1

** Powerboat includes personal watercraft † Age unknown for 22 victims (males 17, 4; sex unknown, imputed male 1, 0)*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 5 **BLOOD ALCOHOL LEVELS* FOR BOATING DROWNINGS BY PURPOSE, CANADA 1991-2000 (VICTIMS ≥15 YEARS OF AGE; n=1,748)†‡§**



** Legal limit is 80 mg % † This figure excludes 51 victims whose purpose was rescue, other or unknown*
‡ This figure excludes 77 other victims (55, 11, 11); decomposition rendered blood alcohol unreliable
§ Age unknown for 22 victims, presumed adult (8, 0, 14)

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

ALCOHOL Alcohol was present or suspected for at least 41% of boating drownings, including recreational 44%, daily living 50% and occupational 11%. When we exclude cases classified as unknown, alcohol was present or suspected for 57% of victims: recreational 59%, daily living 70%, and occupational 20% (Figure 5).

ETHNICITY Although aboriginals account for only about 4% of the Canadian population, at least 16% of boating victims were aboriginal. Ethnicity was unknown for 32% of victims.

EQUIPMENT FACTORS

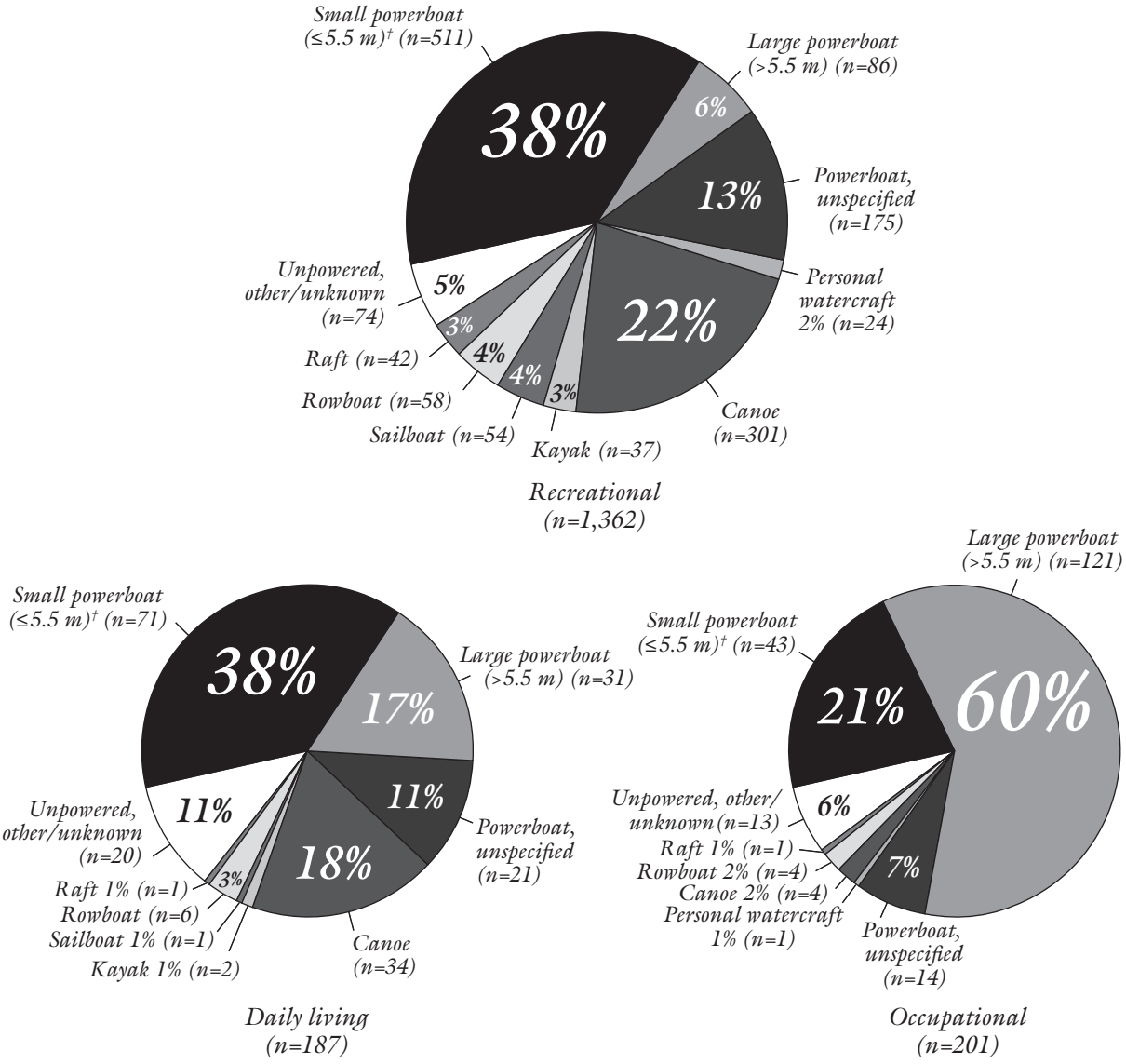
TYPE OF BOAT BY PURPOSE 62% of victims drowned while boating in a powerboat and 38% in an unpowered boat. Similar proportions prevailed for recreational (62% vs 38%) and daily living victims (66% vs 34%), while nearly all occupational victims were using a powerboat (89% vs 11%).

The specific type of boat varied by purpose of activity: recreational drownings occurred most often in small powerboats (≤5.5 m), followed by canoes; daily living drownings in small powerboats, followed by canoes and large powerboats (>5.5 m); and occupational drownings in large powerboats, followed by small powerboats. Most drownings in personal watercraft, kayaks, sailboats, rowboats and rafts occurred during recreational boating (Figure 6).

FLOTATION Only 10% of boating victims (180/1,803) were reported to be correctly wearing a flotation device, including 9% of powered boaters and 11% of unpowered boaters (Figure 7). For daily living drownings the proportion was even lower at 3% (Figure 8).

FLOTATION DEVICE BY SWIMMING ABILITY Non-swimmers were less likely to be properly wearing a flotation device (4%; 8/212) than weak (10%; 10/100), average (11%; 6/53), or strong swimmers (13%; 9/71).

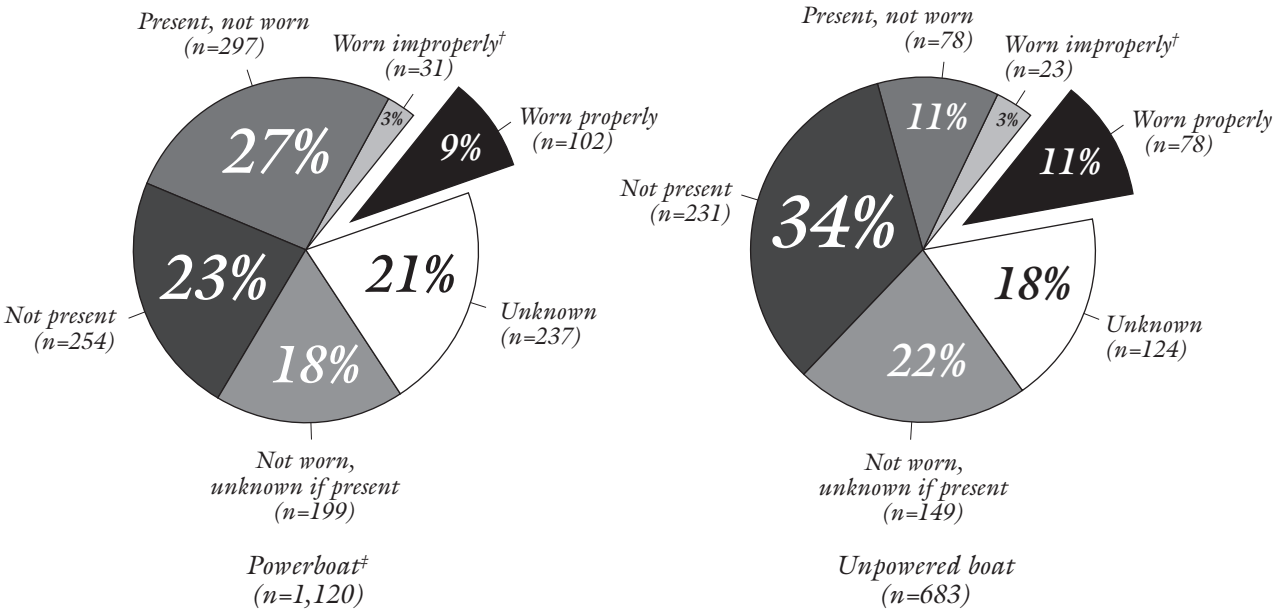
Figure 6 **BOATING DROWNINGS BY TYPE OF BOAT AND PURPOSE, CANADA 1991-2000 (n=1,803)***



** This figure excludes 53 victims whose purpose was rescue, other or unknown*
† Includes open outboard motorboats and other open powered boats such as inflatables

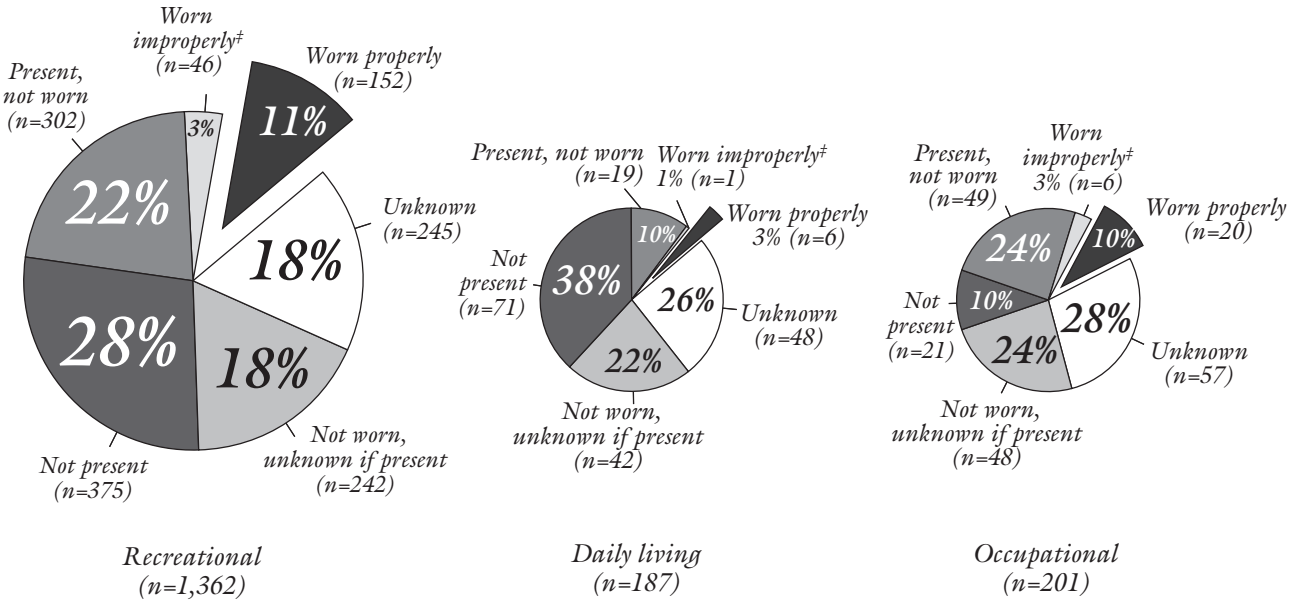
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 7 **BOATING DROWNINGS BY USE OF A FLOTATION DEVICE* AND BY TYPE OF BOAT, CANADA 1991-2000 (n=1,803)**



** Personal flotation device (PFD) or lifejacket † Not fastened or inappropriate size ‡ Includes personal watercraft*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 8 **BOATING DROWNINGS BY USE OF A FLOTATION DEVICE* & PURPOSE, CANADA 1991-2000 (n=1,803)†**



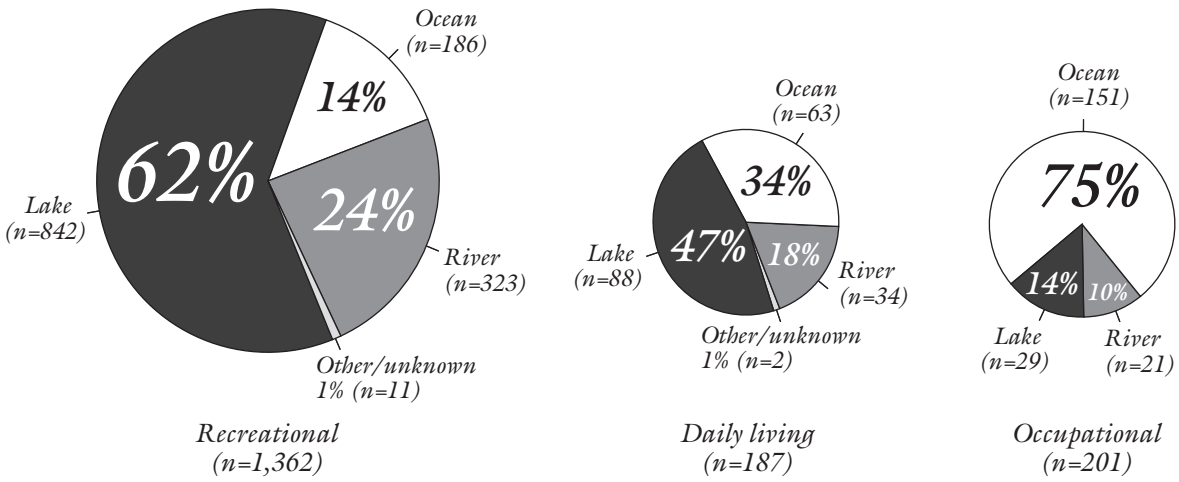
** Personal flotation device (PFD) or lifejacket † This figure excludes 53 victims whose purpose was rescue, other or unknown*
‡ Not fastened or inappropriate size

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

FLOTATION DEVICE BY ALCOHOL Use of alcohol was significantly lower among victims who were properly wearing a flotation device, with alcohol present or suspected in 16% of cases (28/173) as compared with 40% overall (676/1,748).

Figure 9

BOATING DROWNINGS BY TYPE OF BODY OF WATER* & PURPOSE, CANADA 1991-2000 (n=1,803)†



** "Lake" includes pond & reservoir † This figure excludes 53 victims whose purpose was rescue, other or unknown*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

ENVIRONMENTAL FACTORS

BODY OF WATER Overall, lakes were the body of water most frequently involved in boating drownings; however, the majority of occupational drownings occurred in the ocean (Figure 9).

CURRENT For incidents in rivers, current was unknown in 38% of cases. For the remainder, current was described as fast or strong 58%, rapids or whitewater 34%, dam spillway 3%, waterfall 2%, undertow 1%, tide <1% and other 2%.

WIND AND WAVES Wind conditions were unknown for 59% of victims. For the remainder, wind was described as strong for 56%, breezy for 25% and calm for 19%. Waves conditions were unknown for 52% of victims. For the remainder, it was stormy for 11%, rough for 49%, choppy for 19%, and calm for 21%.

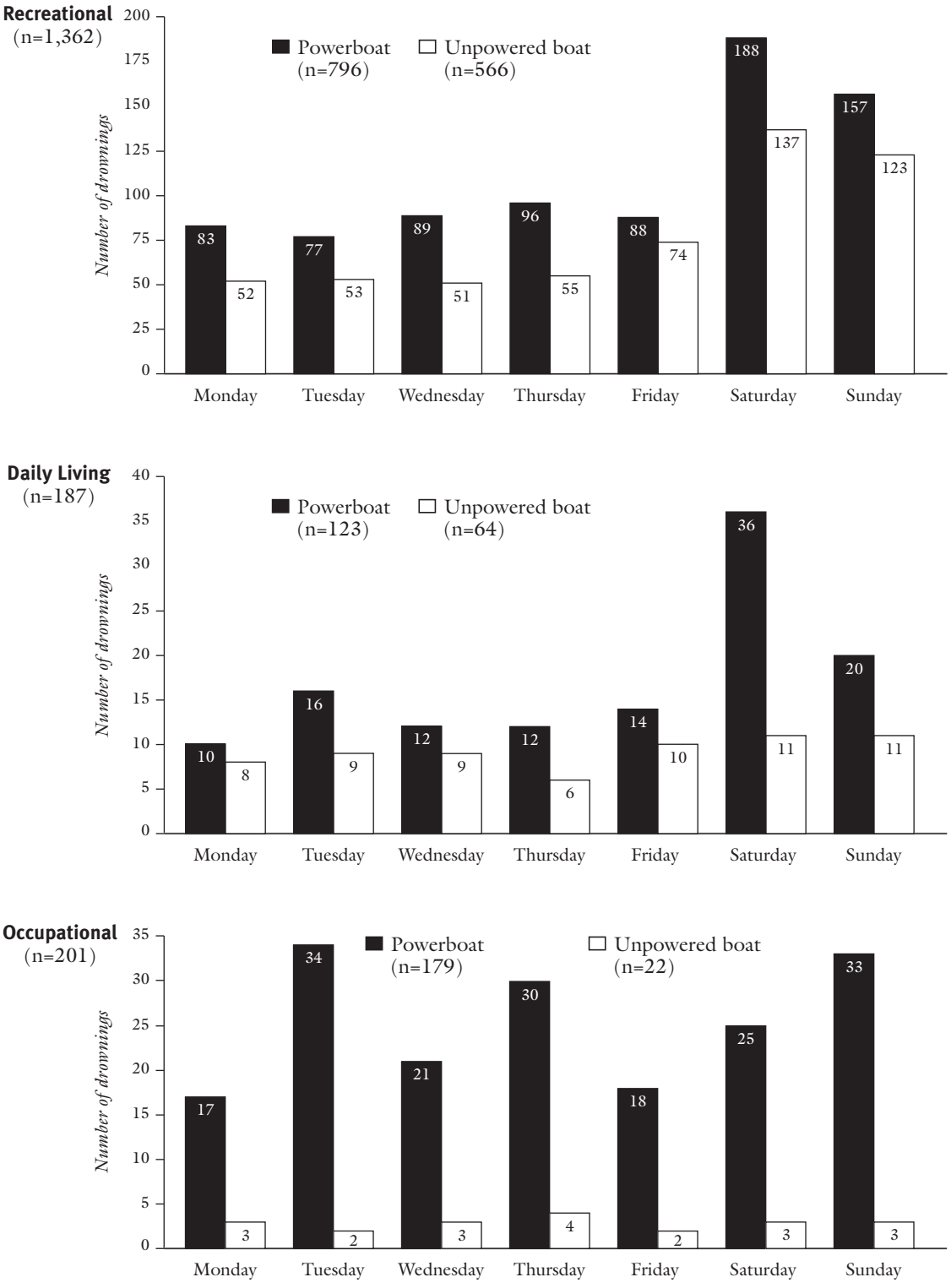
WATER TEMPERATURE Water temperature was unknown for 60% of boating drownings. For the remainder, it was reported to be extremely cold (<10°C) for 62%, cold or cool (10-20°C) for 36%, and warm or hot (>20°C) for 2%.

AIR TEMPERATURE Air temperature was unknown for 76% of boating drownings. For the remainder, it was extremely cold for 23%, cold for 44%, and warm or hot for 34%.

ICE AND COLD WATER Based on the criteria used in Module 2 of this series *(Ice & Cold Water)*, it is probable that cold water played a role in at least 40% of boating drownings, including 34% of recreational, 50% of daily living and 62% of occupational drownings.

LIGHT CONDITIONS Light conditions were unknown for 22% of boating victims. For the remainder, 63% occurred during daylight, 12% during twilight and 24% in the dark.

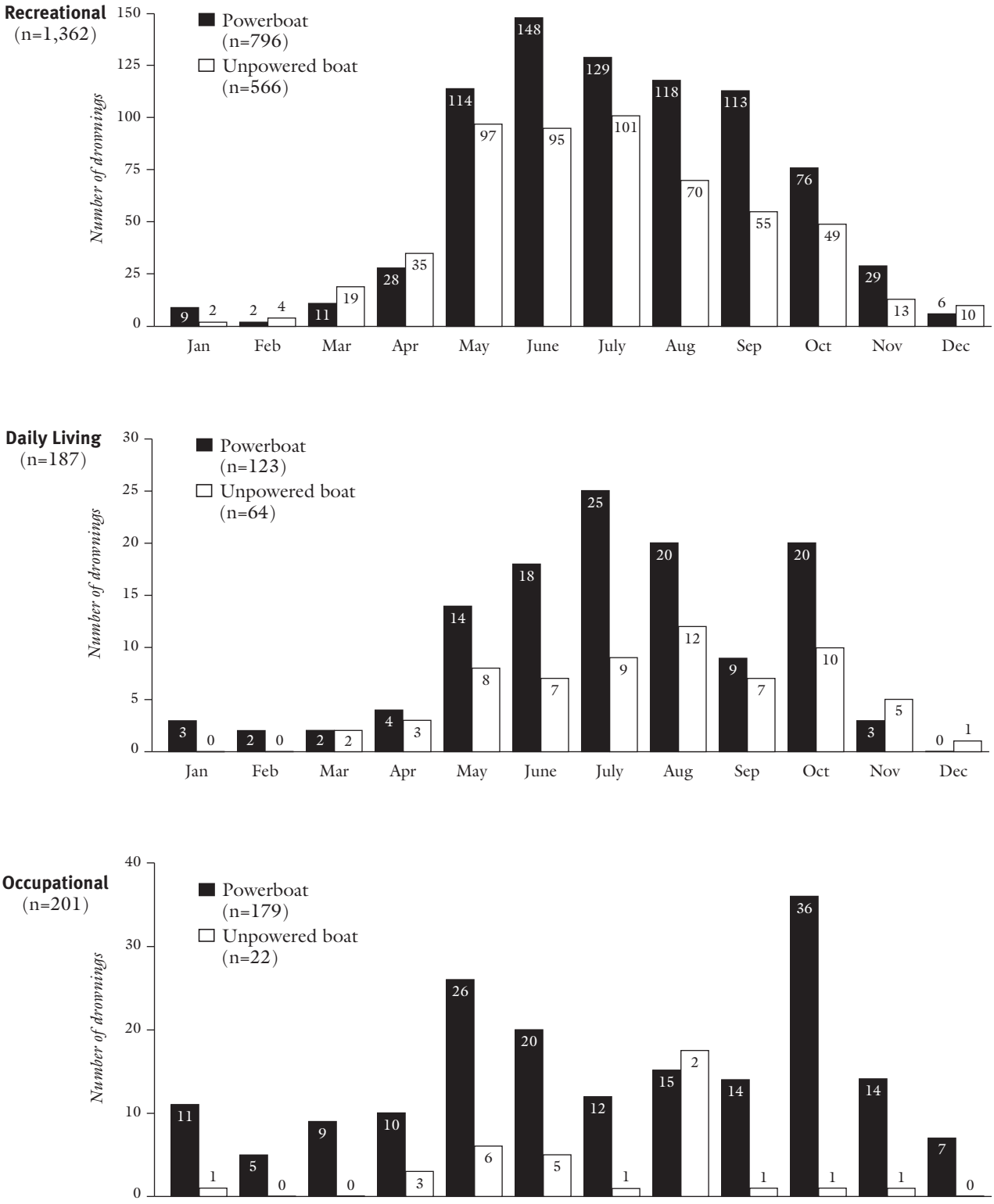
Figure 10 **BOATING DROWNINGS BY PURPOSE, DAY & TYPE OF BOAT, CANADA 1991-2000 (n=1,803)*†**



** This figure excludes 53 victims whose purpose was rescue, other or unknown*
† Day unspecified for 45 drownings: recreational 39 (powerboat 18, unpowered boat 21), daily living 3 (3, 0) and occupational 3 (1, 2)

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 11 **BOATING DROWNINGS BY PURPOSE, MONTH & TYPE OF BOAT, CANADA 1991-2000 (n=1,803)*†**



** This figure excludes 53 victims whose purpose was rescue, other or unknown*
† Month unspecified for 33 drownings: recreational 29 (powerboat 13, unpowered boat 16), daily living 3 (3, 0) and occupational 1 (0, 1)

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

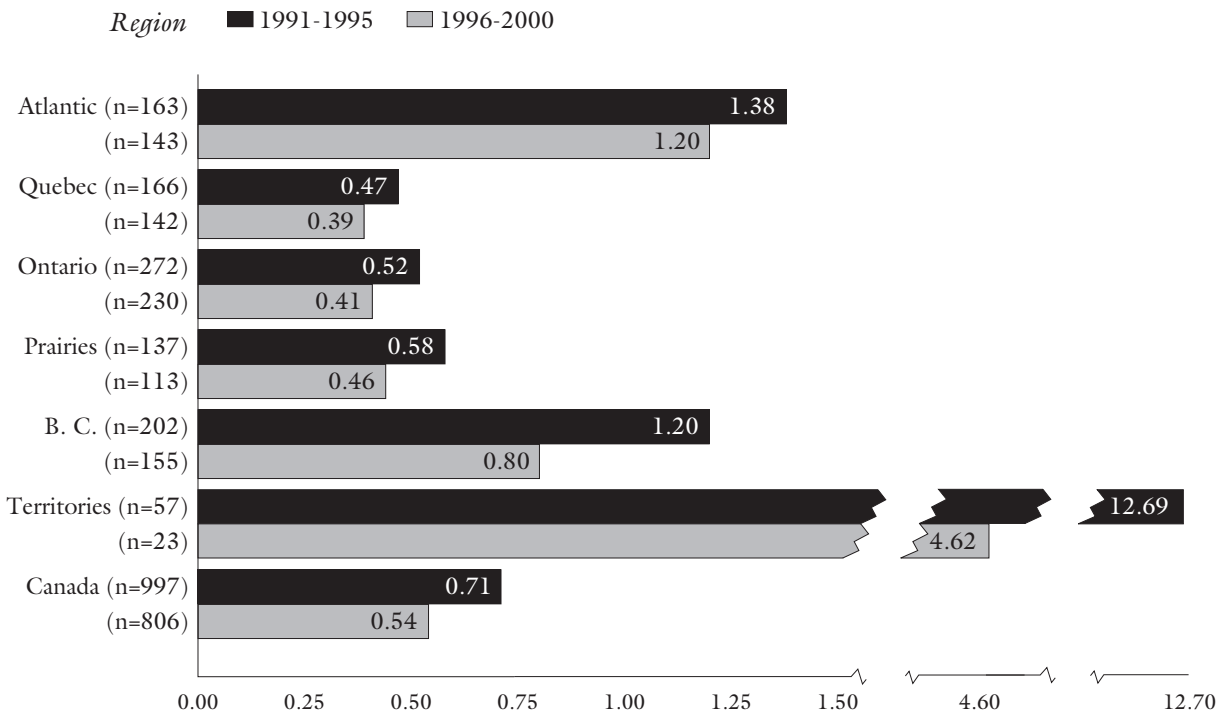
DAY OF THE WEEK AND TYPE OF BOAT Recreational drownings took place most often on the weekend, while occupational drownings occurred throughout the week. Daily living drownings involving powerboats occurred most often on the weekend (suggesting that some of these incidents may have been recreational), while those involving unpowered boats were spread throughout the week (Figure 10).

MONTH AND TYPE OF BOAT Overall, 85% of boating drownings took place between May and October. Recreational and daily living incidents were frequent throughout this period, whereas occupational drownings were likely to occur throughout the year, with peaks in May and October (Figure 11).

RATES AND TRENDS BY REGION The highest rates of boating drowning were seen in the northern territories, followed by the Atlantic region and British Columbia (Figure 12). Between 1991-1995 and 1996-2000 improvement was seen in all regions of Canada.

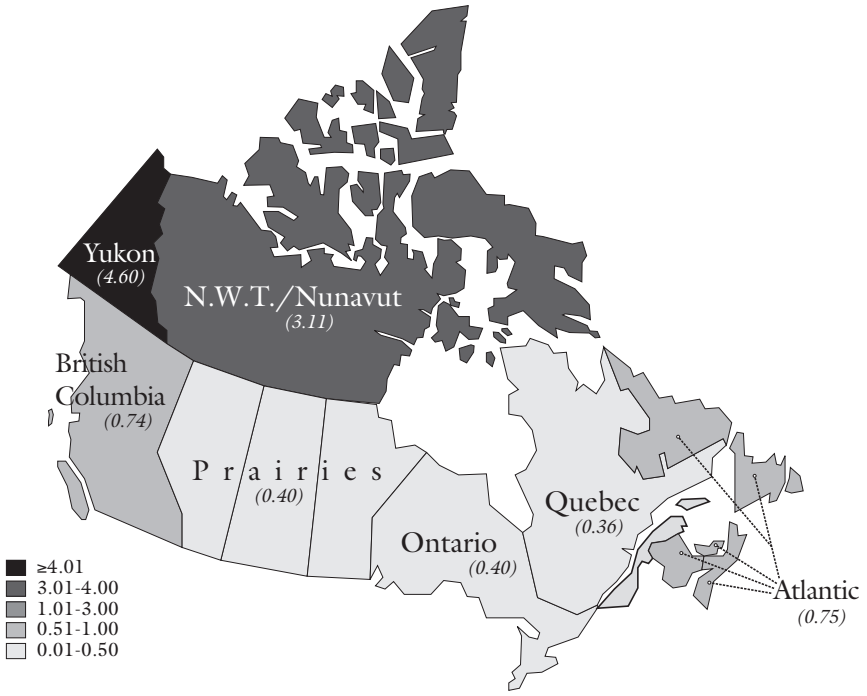
REGION BY PURPOSE Drowning rates for boating varied by purpose of activity. Recreational drownings were highest in the northern territories followed by the two coastal regions, daily living in the northern territories, and occupational drownings in the Atlantic region followed by the northern territories (Figures 13-15).

Figure 12 **RATE AND NUMBER OF BOATING DROWNINGS BY REGION, CANADA 1991-2000 (n=1,803)**



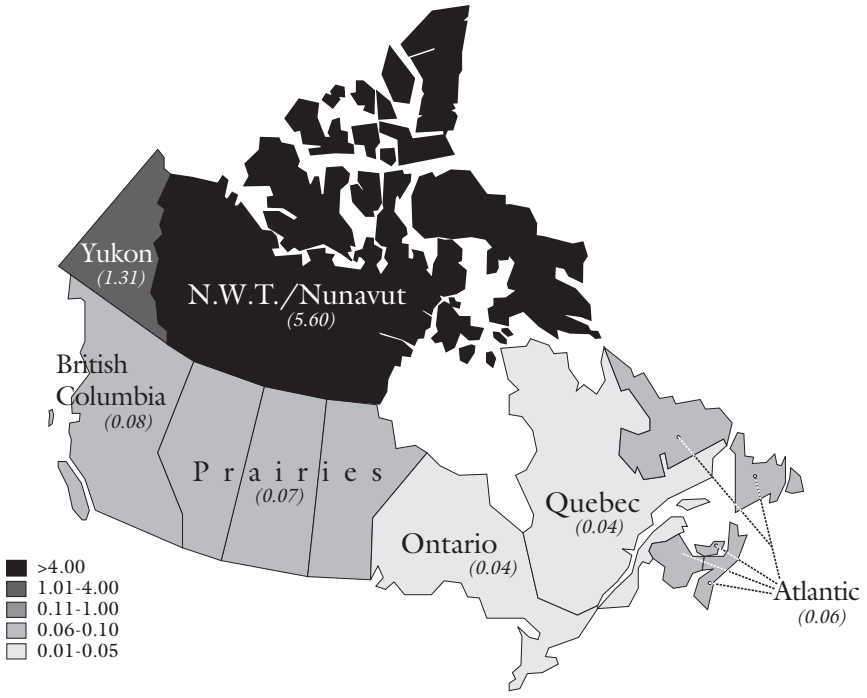
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 13 **RATE OF RECREATIONAL BOATING DROWNING BY REGION, CANADA 1991-2000 (n=1,362)**



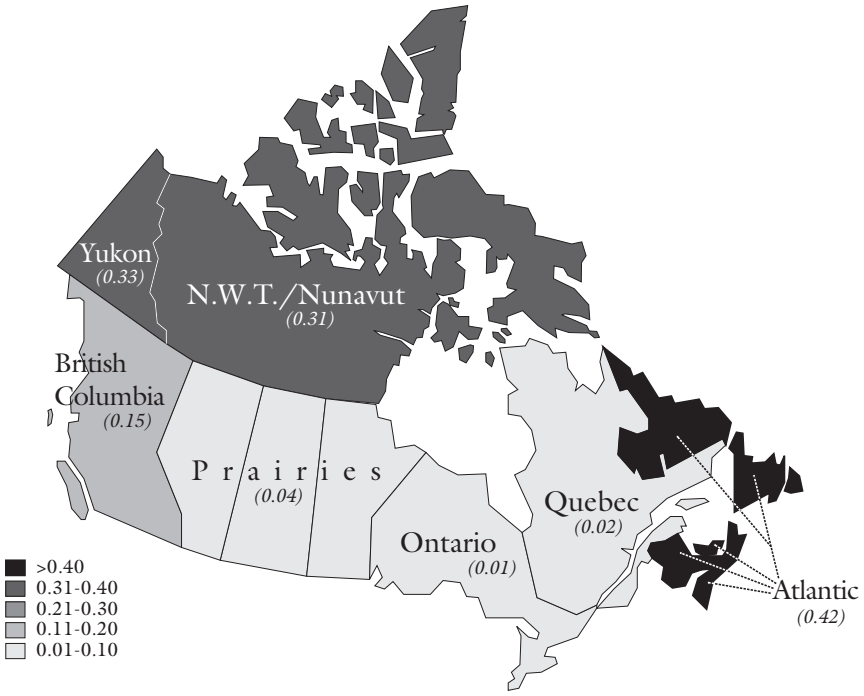
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 14 **RATE OF DAILY LIVING BOATING DROWNING BY REGION, CANADA 1991-2000 (n=187)**



Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 15 **RATE OF OCCUPATIONAL BOATING DROWNING BY REGION, CANADA 1991-2000 (n=201)**

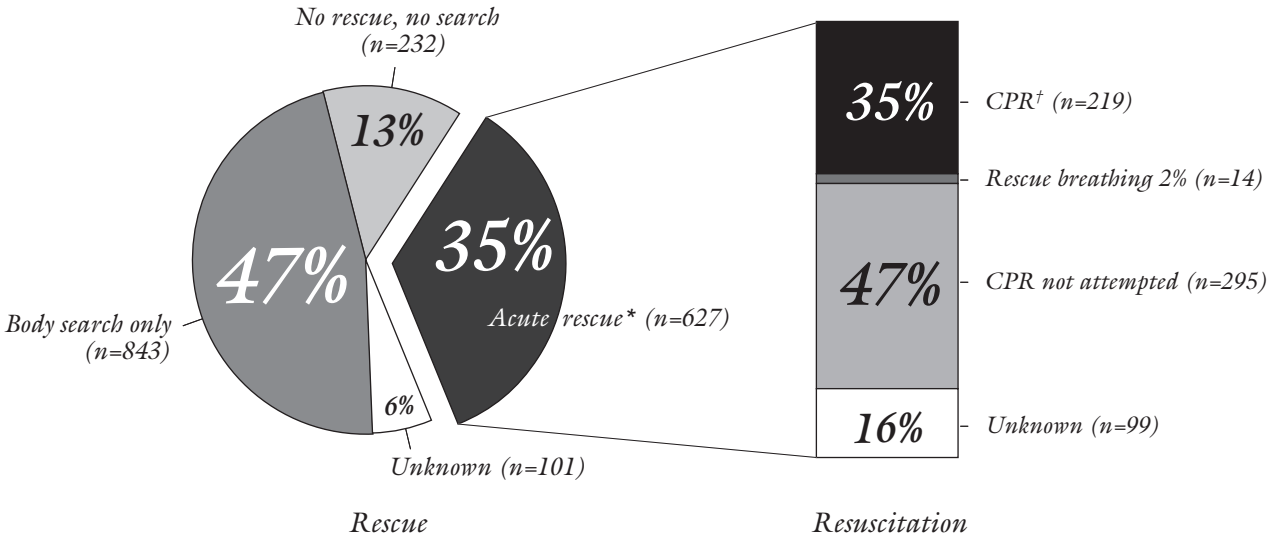


Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

ACCOMPANIMENT 68% of victims were accompanied by at least one adult, while 25% were alone, 3% were accompanied only by minor(s), and 2% had a companion whose age was not specified. Accompaniment was unknown for 1% of victims.

RESCUE An acute rescue for a potentially survivable victim was carried out in only about 35% of incidents (Figure 16). Of these, 37% underwent CPR and/or rescue breathing.

Figure 16 **BOATING DROWNINGS BY RESCUE & RESUSCITATION, CANADA 1991-2000 (n=1,803)**



** Including 339 cases with acute rescue for a potentially survivable victim & 288 with acute rescue followed by an extended body search*
† Cardiopulmonary resuscitation

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

NON DROWNINGS

There were 149 water-related fatalities other than drownings during boating in 1991-2000, including 116 recreational, 10 daily living, and 21 occupation deaths; purpose was unknown for the remaining 2 victims. 82% of victims (122/149) were in a powerboat and 18% (27/149) in an unpowered boat.

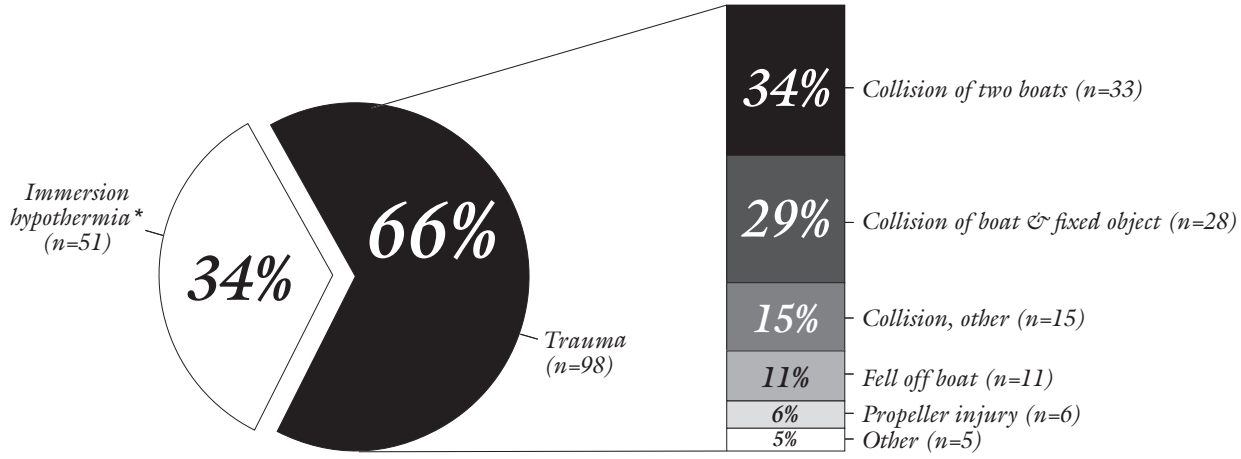
TYPE OF INCIDENT 51 victims (powerboat 34, unpowered boat 17) died as a result of immersion in cold water, while 98 (powerboat 88, unpowered boat 10) died following traumatic incidents such as collisions (Figure 17).

COLLISION Collisions were responsible for 51% of all non-drowning deaths (76/149) and 78% of trauma deaths (76/98), including 81% of powerboat incidents (71/88) and 50% ofunpowered incidents (5/10). (Collision also contributed to 7% (75/1,120) of powerboat drownings and 2% (13/683) of unpowered boating drownings.)

TYPE OF INJURY Immersion in cold water led to death by hypothermia. Traumatic incidents frequently resulted in head injury, which contributed to at least 57% of boating trauma deaths (56/98). Other injuries included multiple injury, spinal injury, and major lacerations (Table 1).

TYPE OF BOAT AND NATURE OF INJURY Powerboat fatalities were more likely to result from traumatic injury (88/122) than hypothermia (34/122), while the reverse was true for unpowered fatalities (trauma 10/27, hypothermia 17/27).

Figure 17 **NON-DROWNING DEATHS DURING BOATING BY NATURE OF INJURY & TYPE OF INCIDENT, CANADA 1991-2000 (n=149)**



** Excludes cases with drowning & hypothermia*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Table 1 **WATER-RELATED INJURY FATALITIES OTHER THAN DROWNINGS* DURING BOATING BY TYPE OF INCIDENT AND TYPE OF INJURY, CANADA 1991-2000 (n=149)**

NON DROWNINGS			
Type of incident	**Type of injury†**	**N°**	**%**
Immersion in cold water	Hypothermia	51	34
Collision			
Boat with another boat	Head 21, multiple 13, spine 6; major lacerations 3, abdominal 1, unknown 1	33	22
Boat with fixed object	Head 19, multiple 8, spine 3, hepatic rupture 1, blunt trauma 1, aortic transection 1, unknown 2	28	19
Other collision	Head 6, multiple 4, major lacerations 3, spine 2, blunt trauma 1, unknown 1	15	10
Fell out of boat	Head 8, multiple 1, blunt trauma 1, spine 1, abdominal 1, unknown 1	11	7
Propeller injury	Major lacerations 4, head 1, abdominal 1	6	4
Other	Multiple 2, spine 2, major lacerations 2, head 1, cardiac failure 1, chest 1, strangulation 1	5	3
Total		**149**	**100**

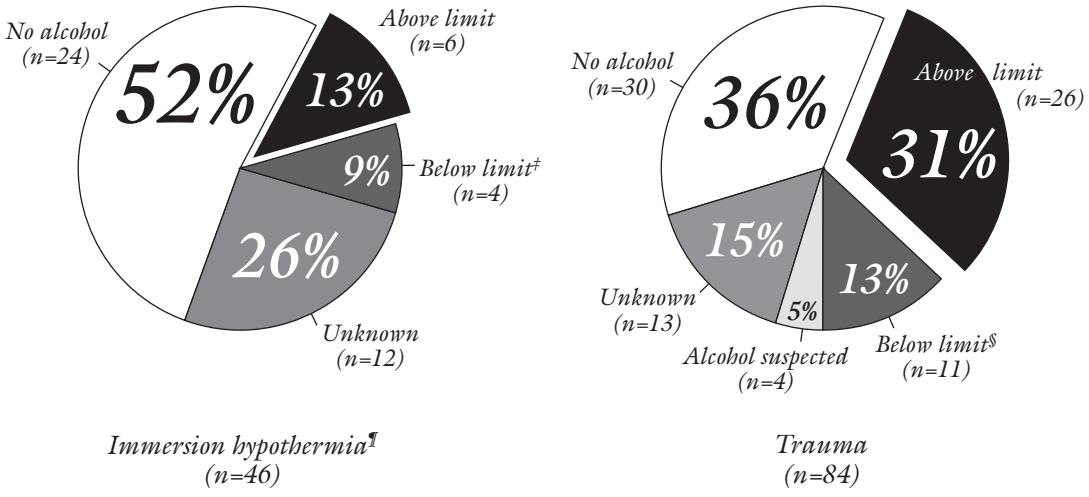
** Primary cause of death was injury other than drowning, although drowning may have complicated another injury; in case of hypothermia, only hypothermia deaths reportedly uncomplicated by drowning are included here*

† Victims may have sustained more than one type of injury

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

TRAUMA AND ALCOHOL Trauma-related fatalities during boating were often associated with alcohol, with alcohol present or suspected for 49% of victims, as compared with 22% for hypothermia and 41% for drowning (Figure 18; see also Figure 5).

Figure 18 **BLOOD ALCOHOL LEVELS* FOR NON-DROWNING DEATHS DURING BOATING BY NATURE OF INJURY, CANADA 1991-2000 (VICTIMS ≥15 YEARS OF AGE; n=135)†**



** Legal limit is 80 mg % † This figure excludes 5 victims (hypothermia 4, trauma 1); decomposition rendered blood alcohol unreliable ‡ 3 at 1-49 mg %, 1 at 50-80 mg % § 9 at 1-49 mg %, 2 at 50-80 mg % ¶ Excludes cases with drowning & hypothermia*

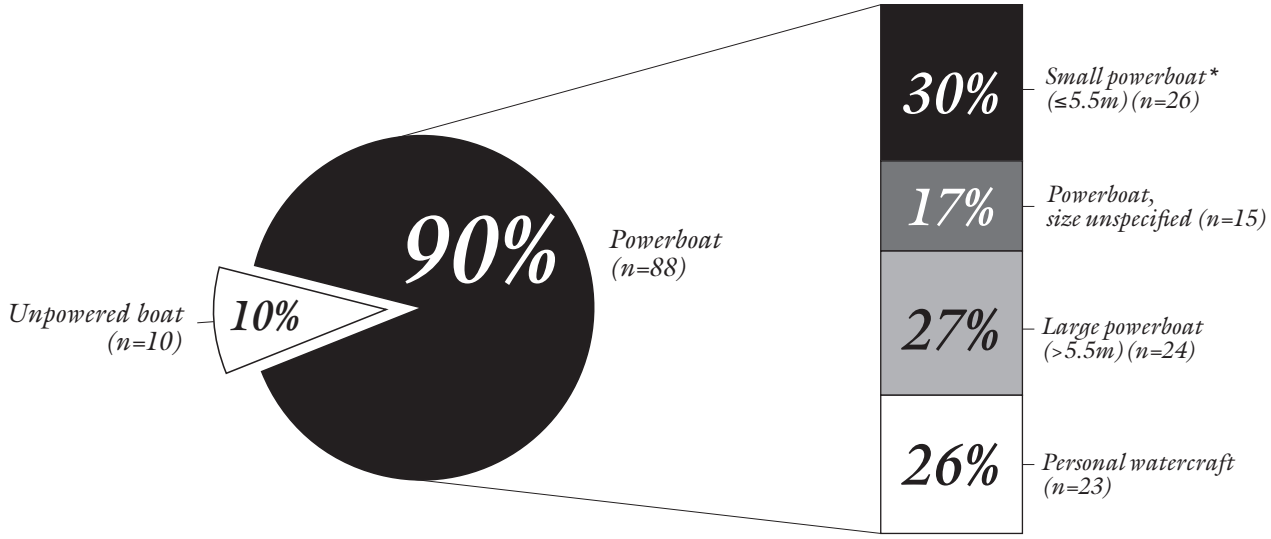
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

TRAUMA AND POWERBOATS 90% of trauma victims were boating in a powerboat (Figure 19). Large powerboats and personal watercraft were disproportionately associated with death by trauma as compared with death by drowning (Figures 19, 20).

TRAUMA AND PERSONAL WATERCRAFT While personal watercraft represented only 2% of powerboat drowning deaths, they accounted for 26% of powerboat trauma fatalities (Figures 19, 20). In addition, personal watercraft contributed to at least 30% (3/10) of unpowered trauma deaths: in one case, a canoeist was fatally injured after being struck by a personal watercraft, while in 2 other incidents a raft victim died of traumatic injuries incurred while being towed by a personal watercraft.

POWERBOAT TRAUMA & SWIMMERS Powerboats also pose a risk of traumatic injury — whether from blunt trauma or propeller laceration — to swimmers and others involved in aquatic activities such as diving and wading; at least one aquatic victim was fatally injured in this way.

Figure 19 **TRAUMA DEATHS DURING BOATING BY TYPE OF BOAT, CANADA 1991-2000 (n=98)**



** Includes open outboard motorboats and other open powered boats such as inflatables*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

DROWNINGS

There were a total of 1,120 powerboat drownings in Canada during 1991-2000, accounting for 62% of all boating drownings (Figure 20). At least 57% of these involved small open powerboats, while the remainder involved large powerboats and personal watercraft. The 683 drownings involving unpowered boats are discussed in Module 4 of this series.

TYPE OF INCIDENT 359 powerboat victims fell, jumped or were thrown overboard (32%), 329 capsized (29%), and 184 were swamped (16%). Another 75 drowned following a collision (7%); details were other or unknown for the remaining 173 victims (15%).

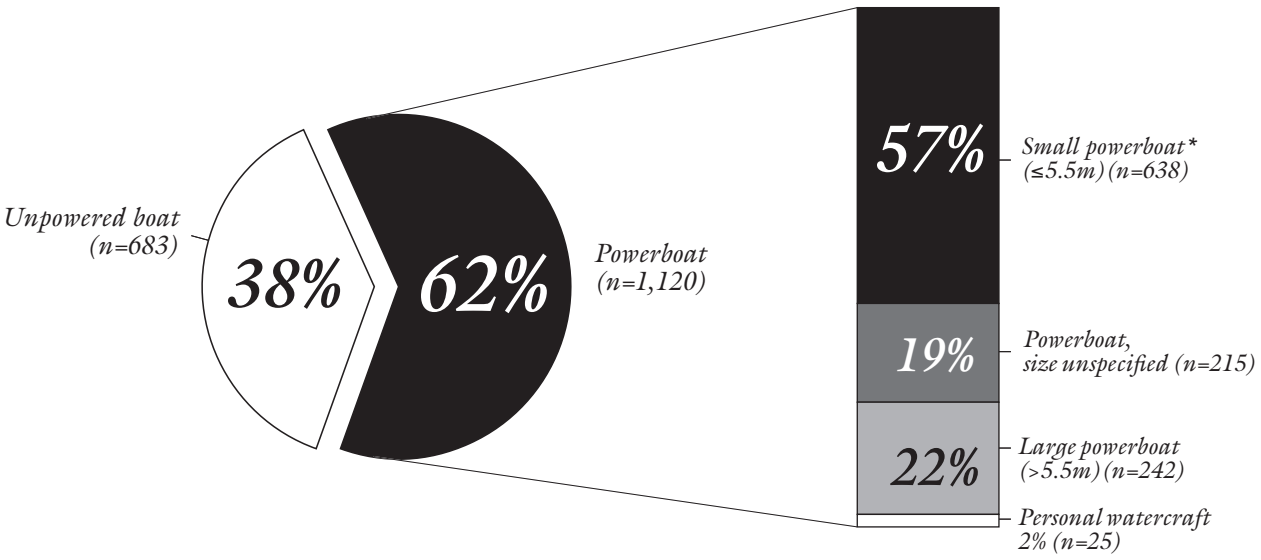
ACTIVITY Fishing was the activity most commonly associated with powerboat drownings, followed by powerboating, boat travel and hunting (Figure 21).

PURPOSE The majority of powerboat drownings occurred during recreational activities (Figure 22). Purpose of the activity varied by the type of boat (Figure 23).

PERSONAL FACTORS

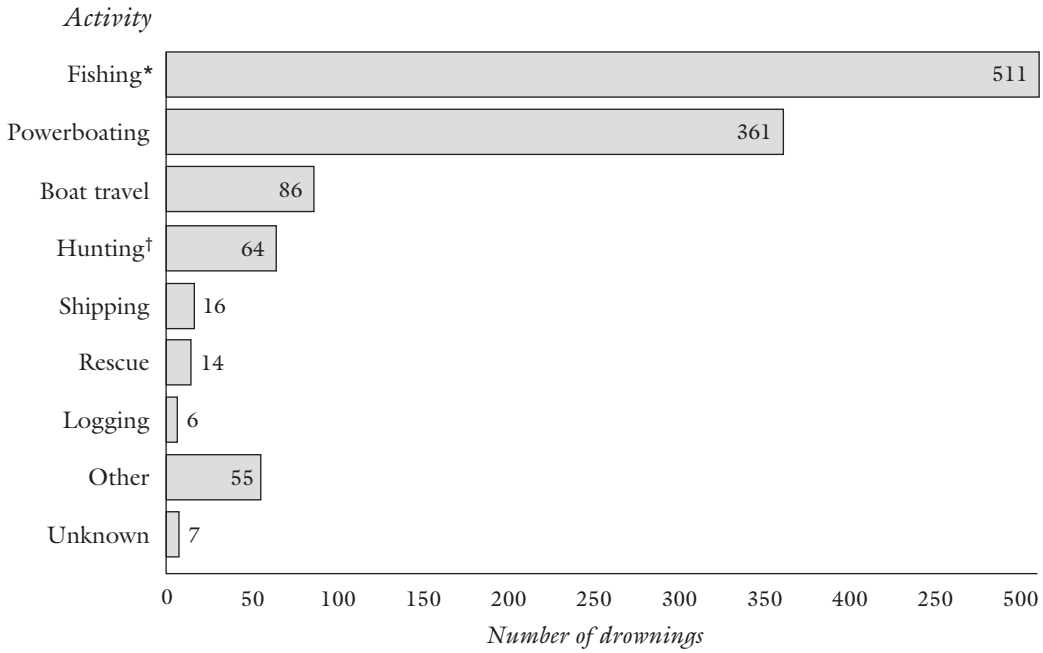
AGE & SEX Males 15 years and older accounted for 90% of powerboat drownings; those between 25 and 74 years were at highest risk (Figure 24). Between 1991-1995 and 1996-2000, the overall drowning rate decreased by 26%, with improvement in all age groups except males 55-64 and ≥75 years old.

Figure 20 **BOATING DROWNINGS BY TYPE OF BOAT, CANADA 1991-2000 (n=1,803)**



** Includes open outboard motorboats and other open powered boats such as inflatables; excludes personal watercraft*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

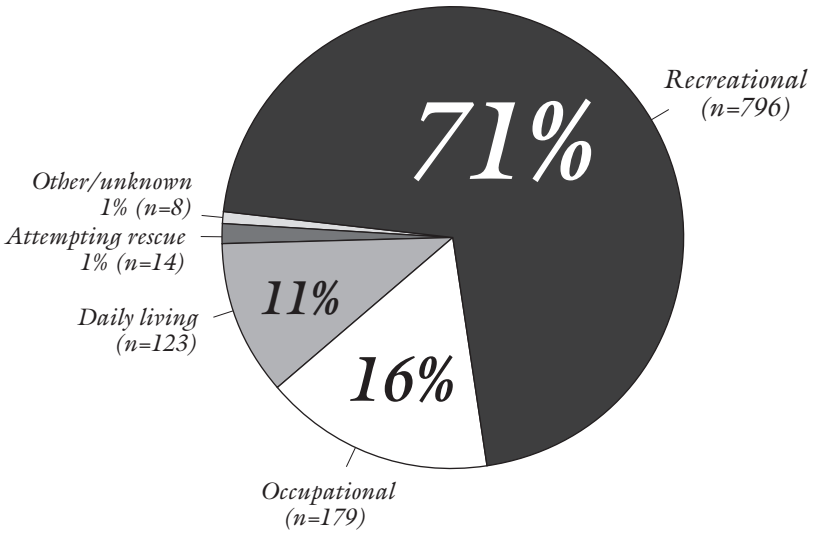
Figure 21 **POWERBOAT DROWNINGS BY ACTIVITY, CANADA 1991-2000 (n=1,120)**



** Recreational 357, occupational 139 (commercial 129, aquaculture 6, guiding 4) and daily living 15*
† Recreational 52, daily living 12

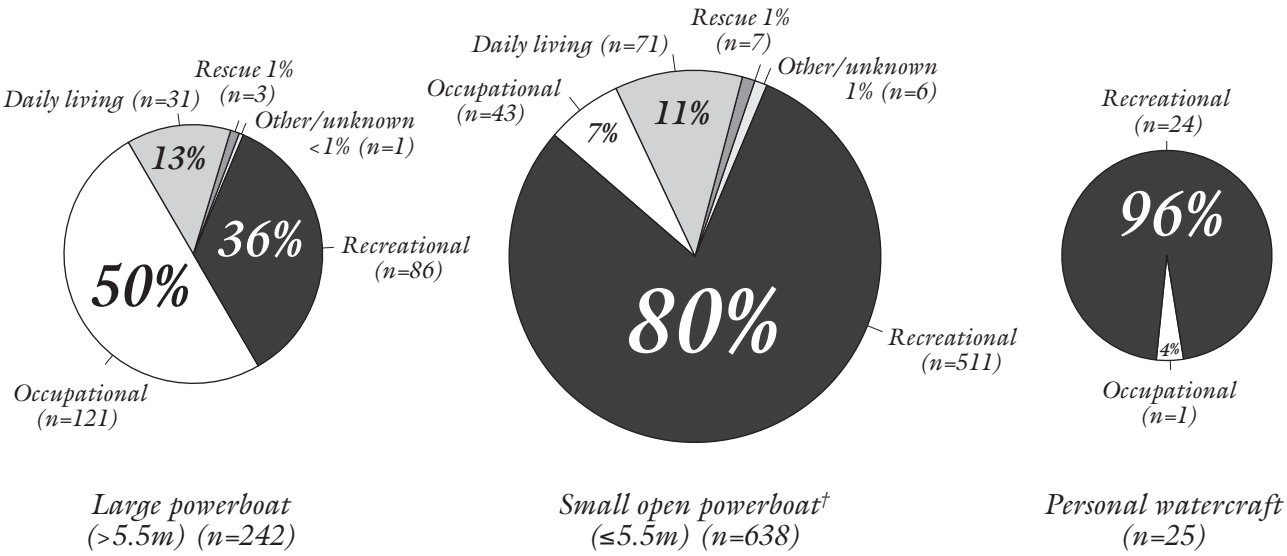
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 22 **POWERBOAT DROWNINGS BY PURPOSE, CANADA 1991-2000 (n=1,120)**



Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

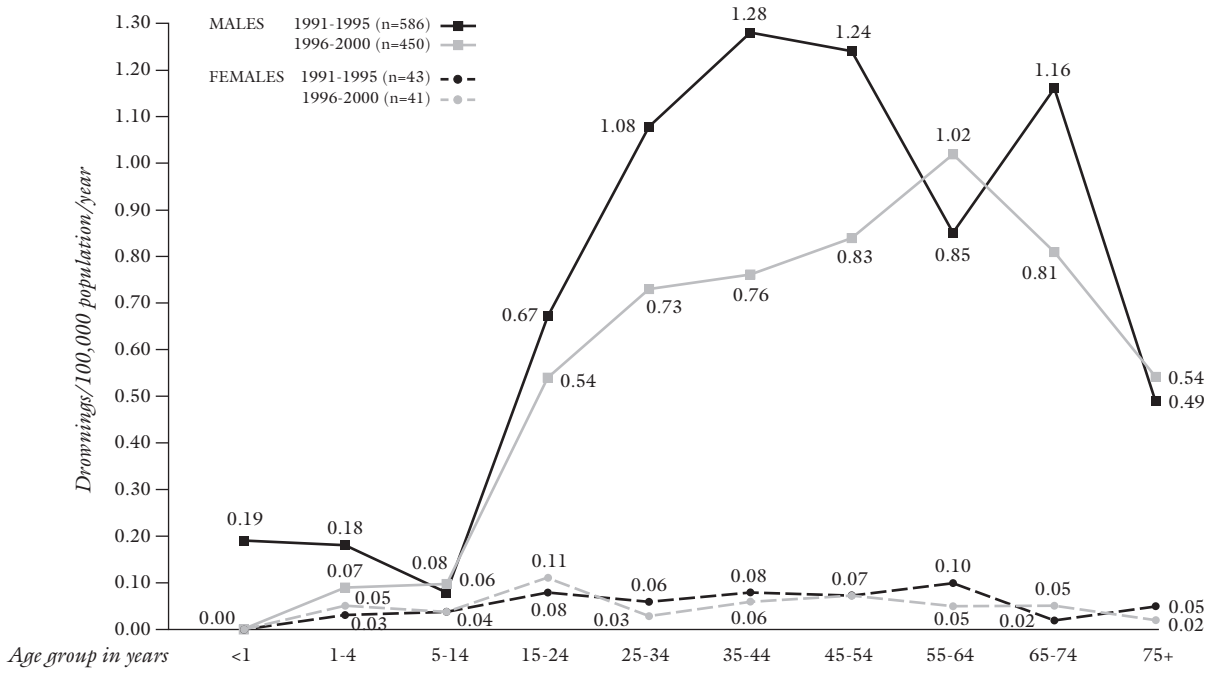
Figure 23 **POWERBOAT DROWNINGS BY TYPE OF BOAT AND PURPOSE, CANADA 1991-2000 (n=1,120)***



** This figure excludes powerboats of unspecified size (n=215)*
† Includes open outboard motorboats and other open powered boats such as inflatables

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 24 **RATE AND NUMBER OF POWERBOAT DROWNINGS BY AGE & SEX, CANADA 1991-2000 (n=1,120)***



MALES	1991-1995	2	7	6	69	139	143	94	51	50	12
	1996-2000	0	3	8	56	87	95	78	64	39	15
FEMALES	1991-1995	0	1	4	8	7	9	5	6	1	2
	1996-2000	0	2	4	11	3	7	7	3	3	1

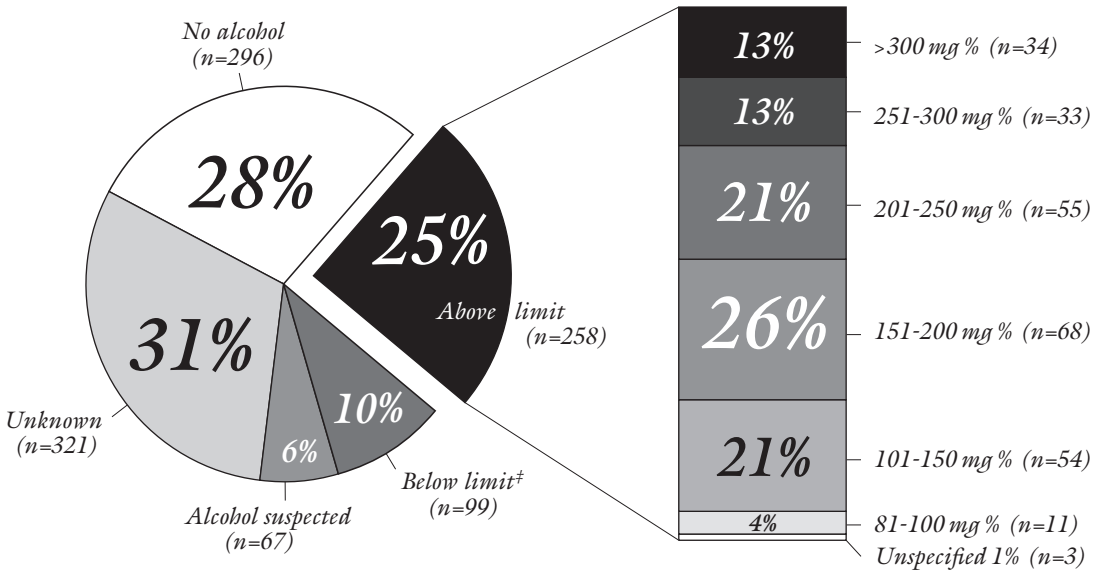
** Age unknown for 18 victims (males 13, 4; sex unknown, imputed male 0, 1)*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

ALCOHOL Alcohol was present or suspected for at least 41% of powerboat drownings (Figure 25).

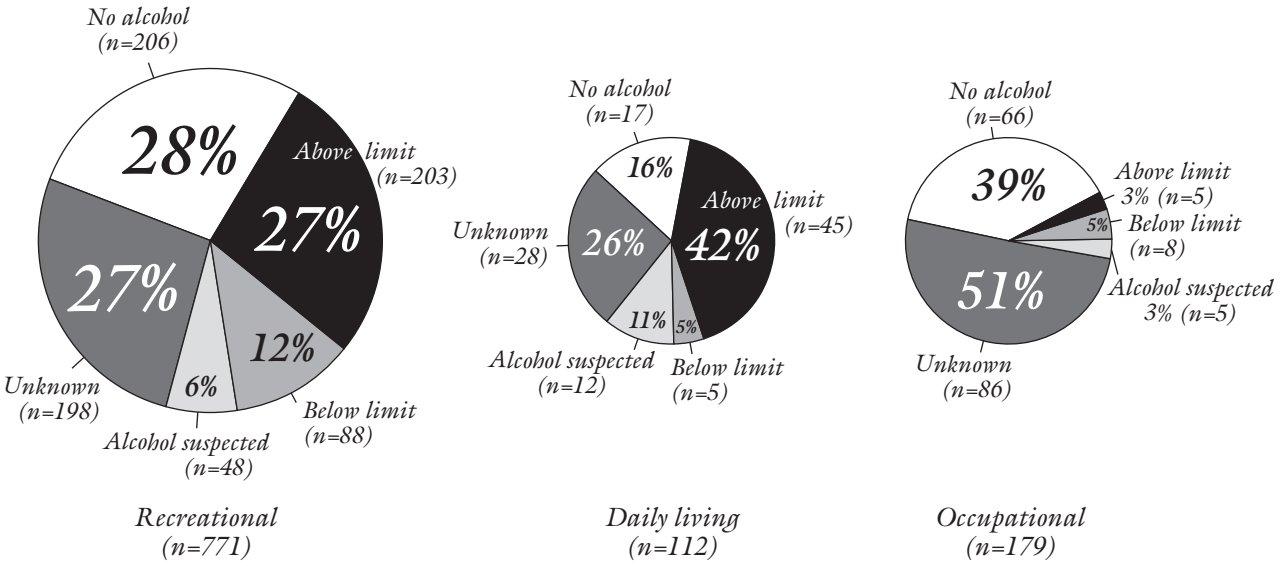
ALCOHOL BY PURPOSE Alcohol varied significantly by purpose: it was present or suspected for 46% of recreational and 58% of daily living victims, but only 11% of occupational victims (Figure 26).

Figure 25 **BLOOD ALCOHOL LEVELS* FOR POWERBOAT DROWNINGS, CANADA 1991-2000 (VICTIMS ≥15 YEARS OF AGE; n=1,083)†**



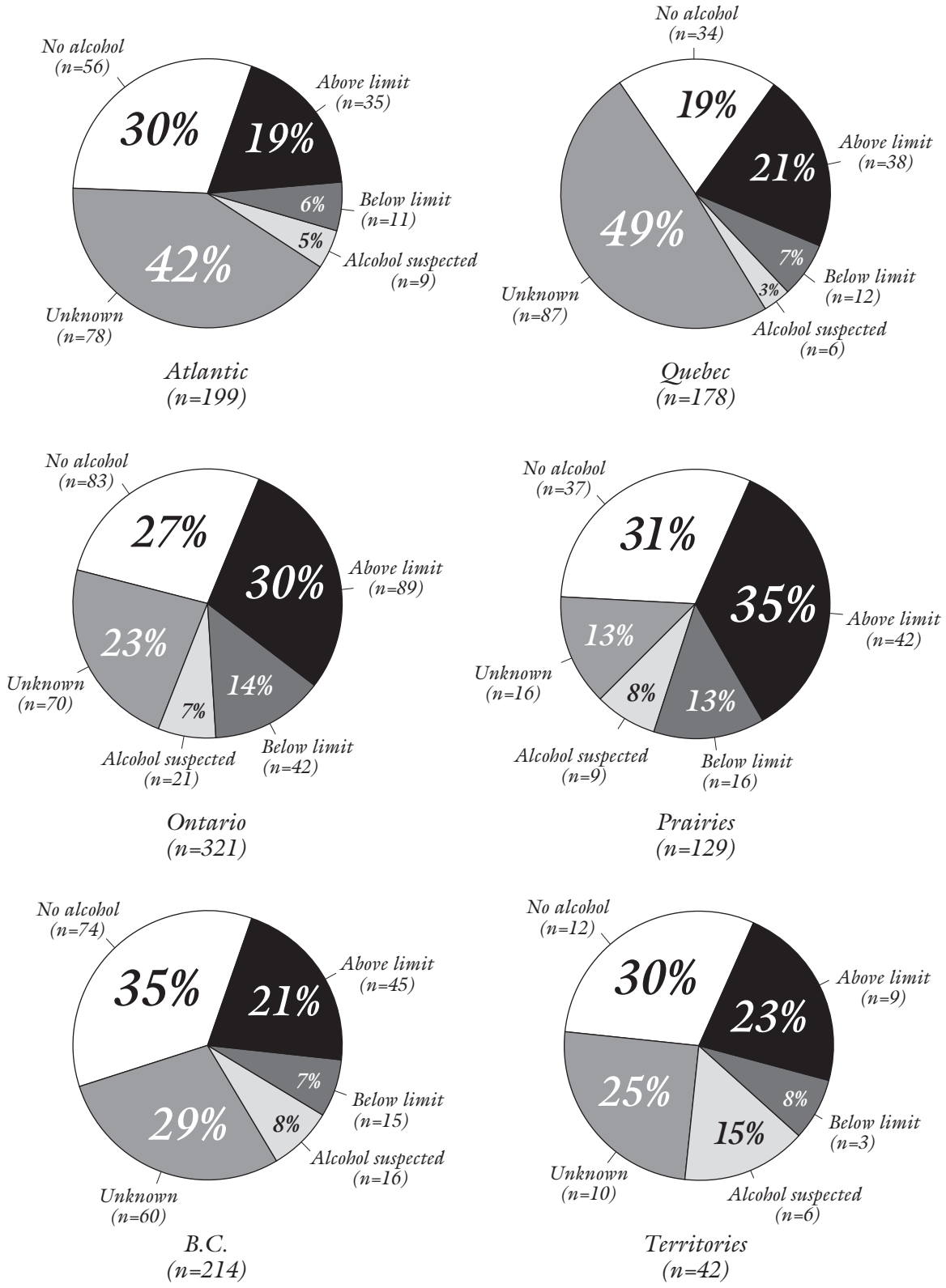
** Legal limit is 80 mg % † This figure excludes 42 victims; decomposition rendered blood alcohol unreliable*
‡ 57 at 1-49 mg %, 33 at 50-80 mg %, & 9 unspecified
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 26 **BLOOD ALCOHOL LEVELS* FOR POWERBOAT DROWNINGS BY PURPOSE, CANADA 1991-2000 (VICTIMS ≥15 YEARS OF AGE; n=1,083)†‡**



** Legal limit is 80 mg % † This figure excludes 21 victims whose purpose was rescue, other or unknown*
‡ This figure excludes 42 other victims (28, 9, 5); decomposition rendered blood alcohol unreliable
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 27 **BLOOD ALCOHOL LEVELS* FOR POWERBOAT DROWNINGS BY REGION, CANADA 1991-2000 (VICTIMS ≥15 YEARS OF AGE; n=1,083)†**



** Legal limit is 80 mg% † This figure excludes 42 victims (Atlantic 10, Quebec 1, Ontario 16, Prairies 9, B.C. 4, Territories 2); decomposition rendered blood alcohol unreliable*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

ALCOHOL BY REGION The involvement of alcohol was highest in the Prairies and Ontario. However, the true proportions in Quebec and Atlantic Canada may have been higher, since alcohol was unknown for 49% and 42% of victims respectively (Figure 27).

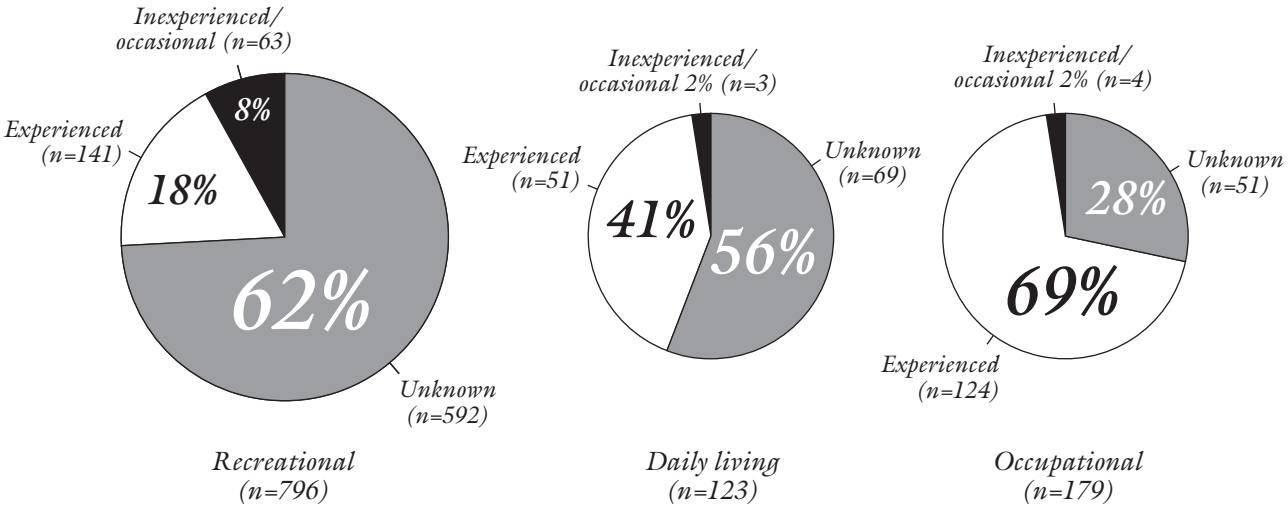
ETHNICITY Although aboriginals account for only about 4% of the Canadian population, at least 17% of powerboat victims were aboriginal. Ethnicity was unknown for 33% of victims.

SWIMMING ABILITY Swimming ability was unknown for 70% of victims. For the remainder, 41% were non swimmers, 16% were weak swimmers, 10% were average swimmers, 9% were strong swimmers, and 25% were swimmers of unspecified ability.

ALCOHOL BY SWIMMING ABILITY Where swimming ability was known, alcohol was present or suspected for 40% of non swimmers (53/131), 32% of weak swimmers (16/50), 41% of average swimmers (12/29) and 45% of strong swimmers (13/29).

BOATING EXPERIENCE Boating experience varied by purpose of activity, with occupational victims most likely and recreational victims least likely to be experienced boaters (Figure 28).

Figure 28 **POWERBOAT* DROWNINGS BY PURPOSE AND BOATING EXPERIENCE, CANADA 1991-2000 (n=1,120)**



** This figure excludes 22 victims whose purpose was rescue, other, or unknown*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

EQUIPMENT FACTORS

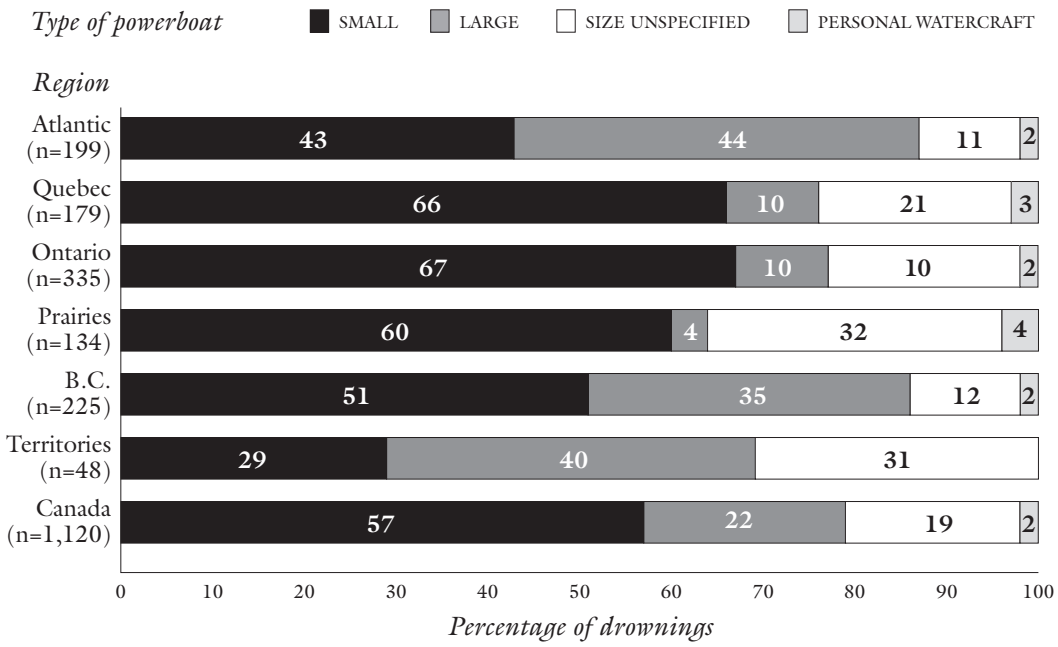
FLOTATION As seen in Figure 8, only 9% of powerboat victims were properly wearing a flotation device. Use of flotation varied by purpose; with occupational (11%, 19/179) and recreational victims (10%, 78/796) more likely to be correctly wearing flotation than daily living victims (2%, 3/123).

FLOTATION BY SWIMMING ABILITY Where swimming ability was known, 6% of non swimmers (8/136), 13% of weak swimmers (7/53), 9% of average swimmers (3/33) and 3% of strong swimmers (1/29)were properly wearing a flotation device.

FLOTATION BY ALCOHOL Use of alcohol was significantly lower among victims who were properly wearing a flotation device, with alcohol present or suspected in 20% of cases (19/97) as compared with 41% overall (424/1,083).

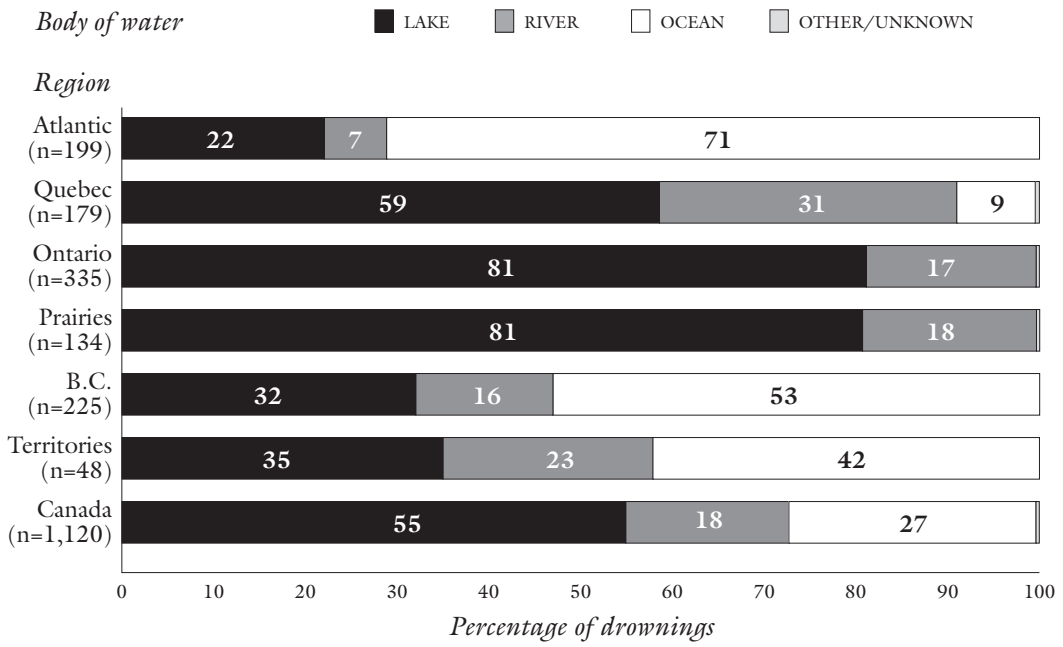
TYPE OF BOAT BY REGION Type of powerboat varied by region, with small powerboats predominating overall. However, due to greater numbers of occupational incidents in coastal regions, large powerboat drownings were more prevalent in Atlantic Canada, British Columbia and the northern territories (Figure 29).

Figure 29 **POWERBOAT DROWNINGS BY TYPE OF BOAT AND REGION, CANADA 1991-2000 (n=1,120)**



Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 30 **POWERBOAT DROWNINGS BY BODY OF WATER* AND REGION, CANADA 1991-2000 (n=1,120)**



** "Lake" includes pond & reservoir*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

ENVIRONMENT FACTORS

BODY OF WATER Lakes were the most frequent body of water, followed by rivers and oceans. Body of water naturally varied greatly by region, with the ocean most frequent in coastal regions, particularly the Atlantic region (Figure 30).

CURRENT For incidents in rivers, current was unknown in 46% of cases. For the remainder, current was described as fast or strong 66%, rapids or whitewater 21%, dam spillway 4%, waterfall 4%, undertow 2% and tide 1%.

WIND AND WAVES Wind conditions were unknown for 55% of victims. For the remainder, wind was described as strong for 59%, breezy for 24% and calm for 17%. Waves conditions were unknown for 50% of victims. For the remainder, it was stormy for 14%, rough for 48%, choppy for 19%, and calm for 19%.

WATER TEMPERATURE Water temperature was unknown for 60% of powerboat drownings. For the remainder, it was reported to be extremely cold (<10°C) for 65%, cold or cool (10-20°C) for 34%, and warm or hot (>20°C) for 1%.

AIR TEMPERATURE Air temperature was unknown for 76% of powerboat drownings. For the remainder, it was extremely cold for 26%, cold for 44%, and warm or hot for 30%.

ICE AND COLD WATER Based on the criteria used in Module 2 of this series *(Ice & Cold Water)*, it is probable that cold water played a role in at least 40% of powerboat drownings.

LIGHT CONDITIONS 50% of powerboat drownings occurred during daylight, 10% during twilight and 19% in the dark. Light conditions were unknown for 21% of victims.

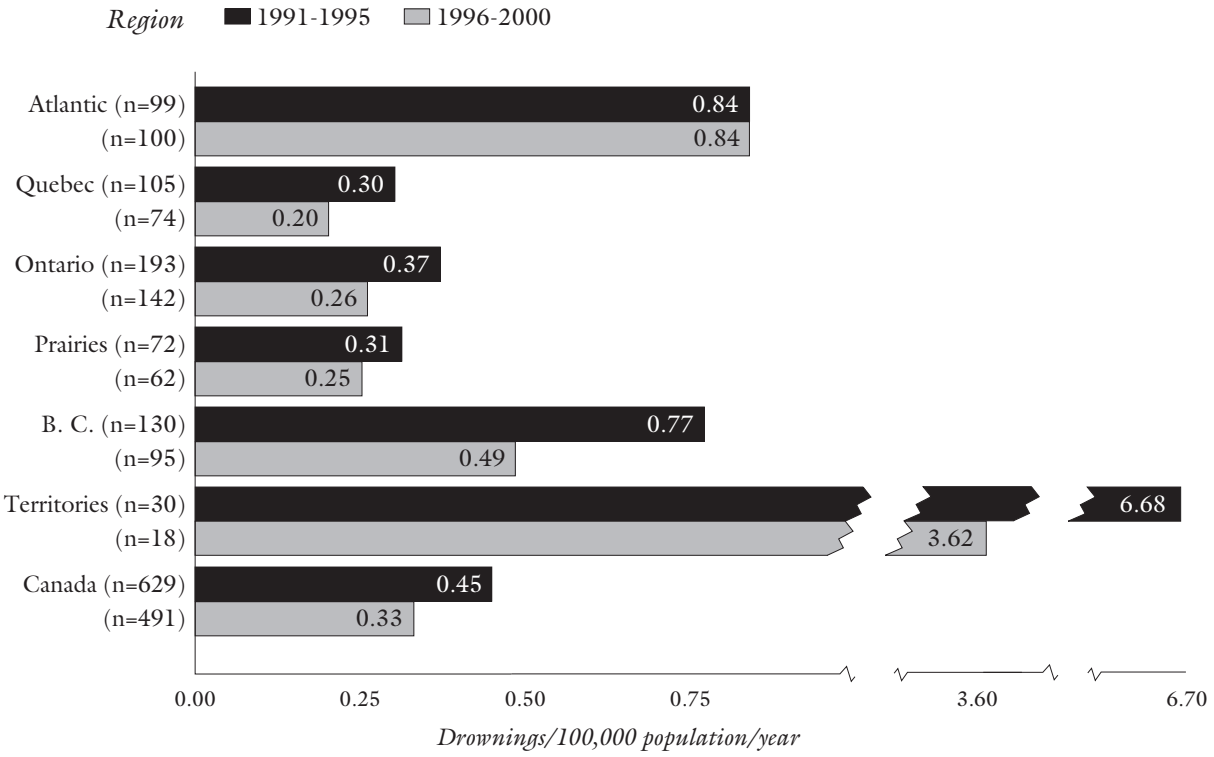
MONTH AND DAY OF THE WEEK 86% of victims drowned between May and October. Although drownings took place throughout the week, 43% took place on Saturday or Sunday.

RATES AND TRENDS BY REGION The highest rates of powerboat drowning were seen in the northern territories, followed by the Atlantic region and British Columbia (Figure 31). Between 1991-1995 and 1996-2000 improvement was seen in all parts of Canada except for the Atlantic region, where the rate remained constant.

RATES AND TRENDS BY REGION AND PURPOSE The highest rates of **recreational** and **daily living** drowning during powered boating occurred in the northern territories, followed by British Columbia and the Atlantic region. Between 1991-1995 and 1996-2000 significant improvement was seen in British Columbia, Ontario and Quebec (Figure 32).

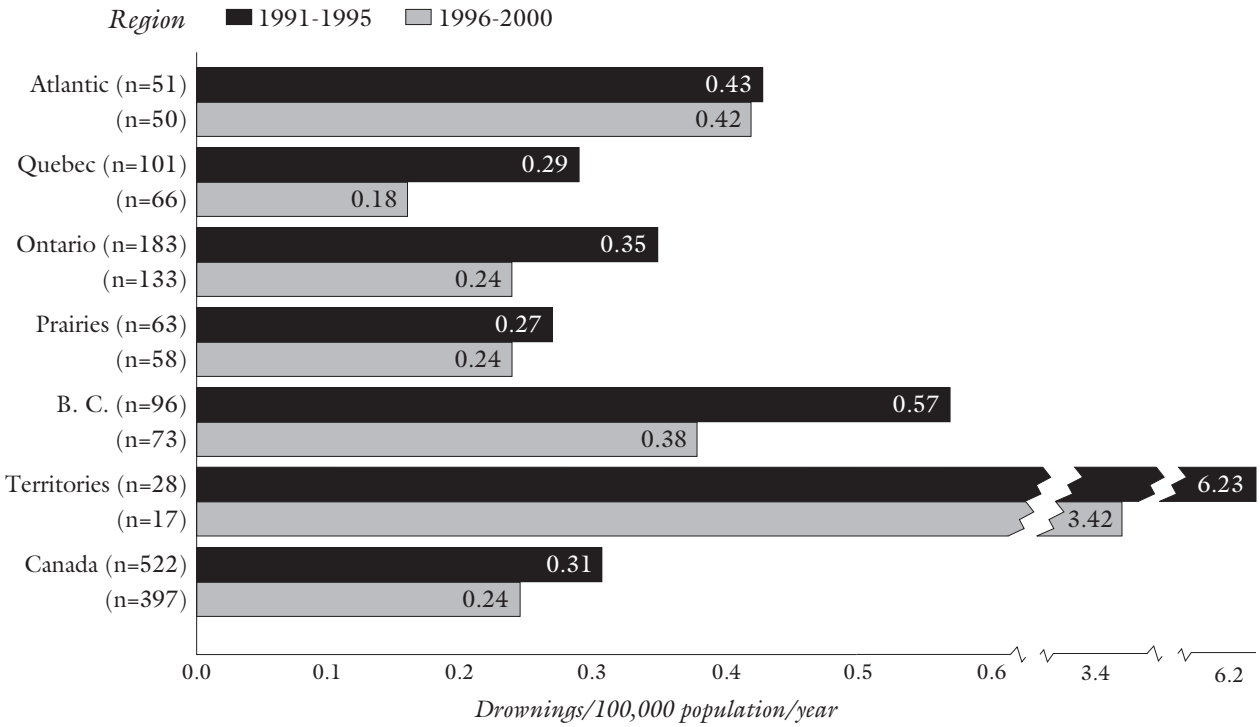
The discrepancy in rates by region was much more dramatic for **occupational** drownings. The highest rates occurred in Atlantic Canada, followed by the northern territories and British Columbia; rates in other regions were very low in comparison. There was considerable improvement in British Columbia between 1991-1995 and 1996-2000, whereas there was a slight increase in the Atlantic region (Figure 33).

Figure 31 **RATE AND NUMBER OF POWERBOAT DROWNINGS BY REGION, CANADA 1991-2000 (n=1,120)**



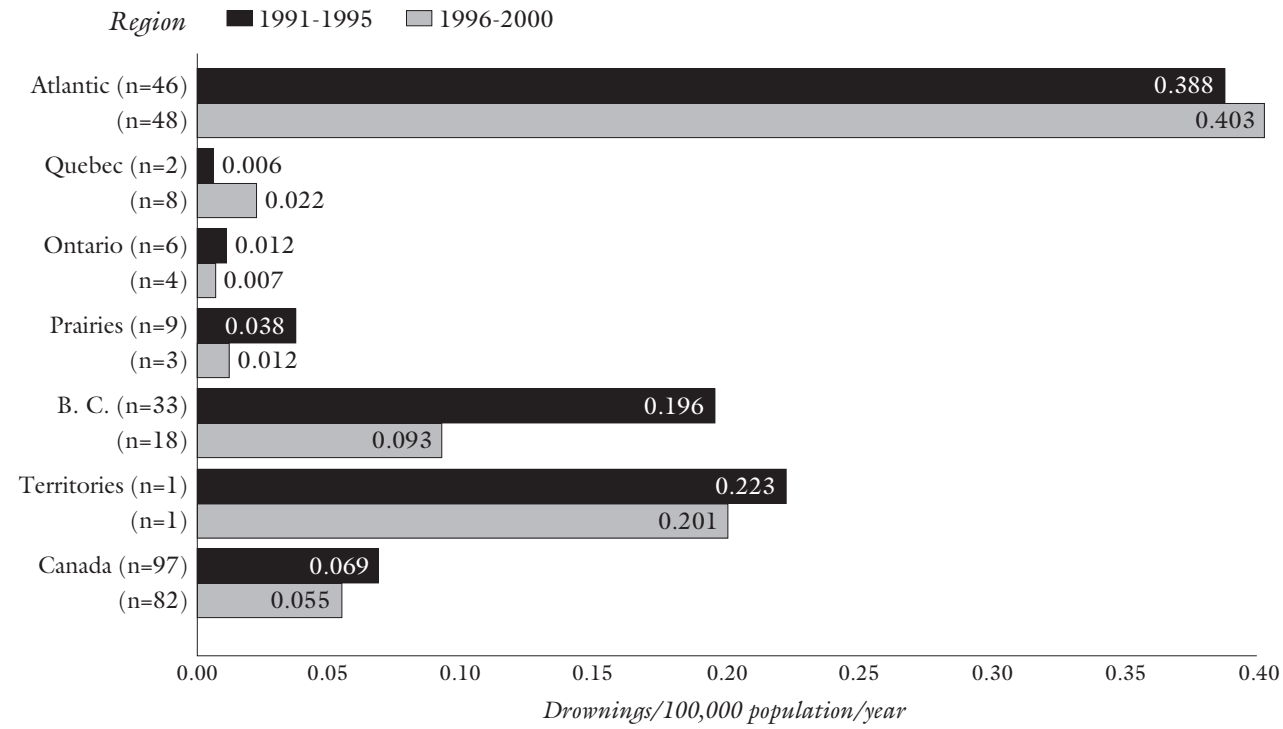
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 32 **RATE AND NUMBER OF RECREATIONAL AND DAILY LIVING POWERBOAT DROWNINGS BY REGION, CANADA 1991-2000 (n=919)**



Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 33 **RATE AND NUMBER OF OCCUPATIONAL POWERBOAT DROWNINGS BY REGION, CANADA 1991-2000 (n=179)**



Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

ACCOMPANIMENT 70% of victims were accompanied by at least one adult, while 25% were alone, 2% were accompanied only by minor(s), and 2% had a companion whose age was not specified. Accompaniment was unknown for 1% of victims.

RESCUE An acute rescue for a potentially survivable victim was carried out in only about 33% of cases. Of these, 34% underwent CPR and/or rescue breathing.

NON DROWNINGS

There were 122 water-related fatalities other than drownings involving powerboats in 1991-2000, including 88 deaths by trauma and 34 deaths by immersion hypothermia.

PURPOSE 76% of non-drowning fatalities occurred during recreational activities, 16% during occupational activities, 7% during daily living activities and 1% during other/unknown activities.

DROWNINGS

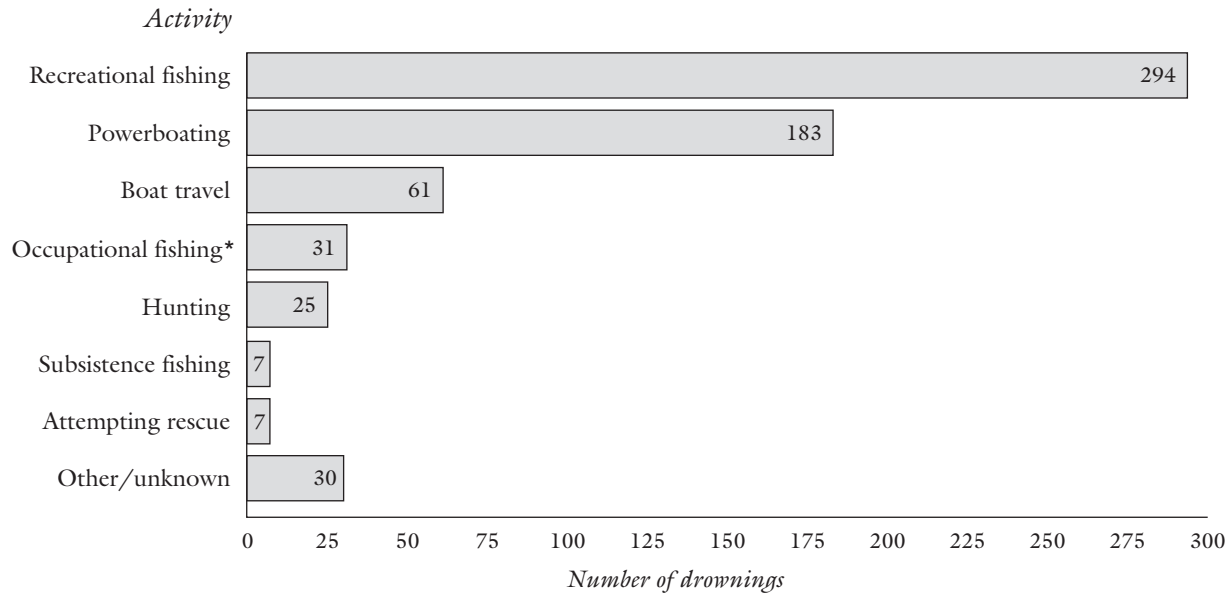
There were 638 small powerboat (≤5.5 m)* drownings in Canada during 1991-2000, accounting for 57% of all powerboat drownings; the true proportion is probably higher since boat size was not reported for 19% of powerboat victims.

TYPE OF INCIDENT The boat capsized in 33% of cases and was swamped in 19%, while 29% of victims fell, jumped or were thrown overboard. Another 5% drowned following a collision; details were unknown or other for the remaining 14% of victims.

ACTIVITY Recreational fishing was the activity most commonly associated with small powerboat drownings, followed by powerboating, boat travel, occupational fishing, and hunting (Figure 34).

PURPOSE As seen in Figure 21, 80% of small powerboat drownings occurred during recreation, 11% during daily life, 7% during occupational activities, and 1% while attempting rescue. Purpose was unknown for the remaining 1% of victims.

Figure 34 **SMALL POWERBOAT DROWNINGS BY ACTIVITY, CANADA 1991-2000 (n=638)**



** Commercial fishing 27, aquaculture 2, fishing guiding 2*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

** Includes open outboard motorboats and other open powered boats such as inflatables; excludes personal watercraft.*

PERSONAL FACTORS

AGE & SEX Males 15 years and older accounted for 91% of small powerboat drownings (Figure 35). Between 1991-1995 and 1996-2000 the overall drowning rate for these boats decreased by 36%, with significant improvement for males 25-54 years.

ALCOHOL Alcohol was present or suspected for at least 44% of drownings. Most victims who tested over the limit had very high blood alcohol levels (Figure 36).

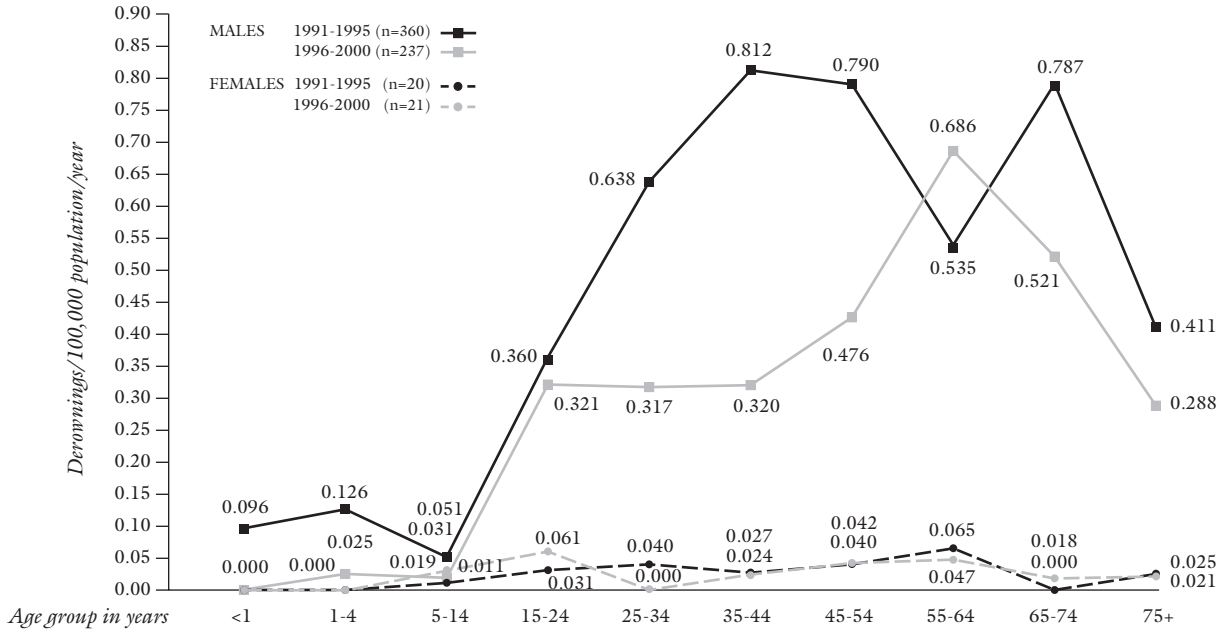
ALCOHOL BY REGION There was a strong association between alcohol and small powerboat drownings in all regions of Canada, with alcohol suspected or known to be present for 32 – 50% of victims 15 and over. Since alcohol was unknown for a mean of 28% of victims ranging from 8% in the northern territories to 50% in Quebec, the true level of association may have been much higher. Figure 37 shows the possible range of involvement by region.

ETHNICITY At least 15% of small powerboat victims were aboriginal; ethnicity was unknown for 36% of victims.

SWIMMING ABILITY Swimming ability was unknown for 66% of victims. For the remainder, 59% were weak or non swimmers, 17% were average or strong swimmers and 23% were swimmers of unspecified ability.

BOATING EXPERIENCE Boating experience was unknown for 69% of small powerboat victims. For the remainder, 74% were experienced and 26% were inexperienced or occasional boaters. Experience varied by purpose; when experience was reported, 100% of occupational and 96% of daily living victims were experienced boaters, compared with only 66% of recreational victims.

Figure 35 **RATE AND NUMBER OF SMALL POWERBOAT DROWNINGS BY AGE & SEX, CANADA 1991-2000 (n=638)***



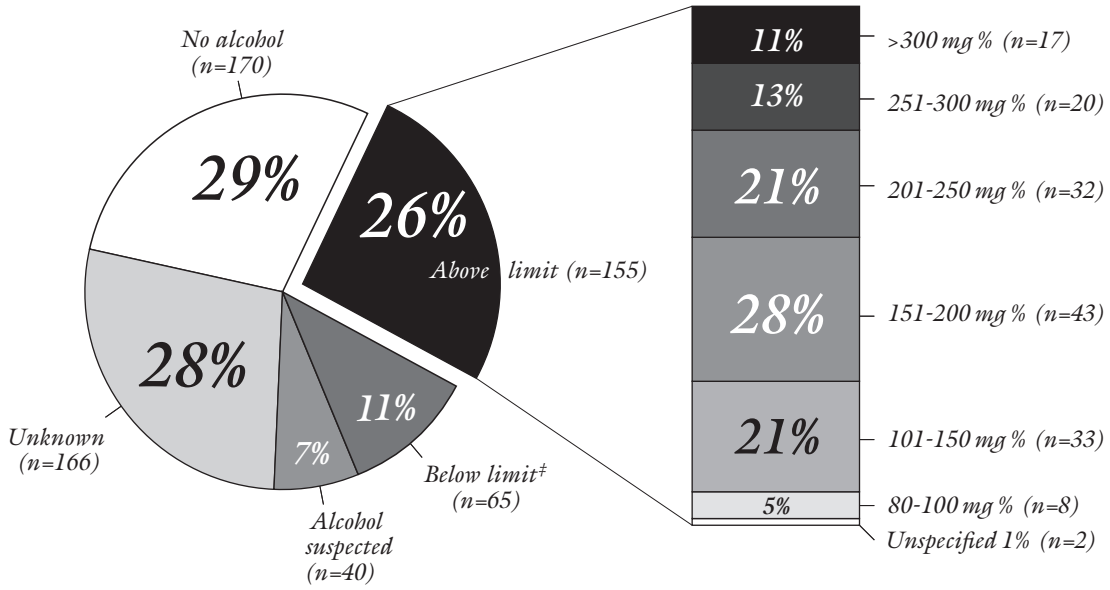
Number of drownings in age group

MALES	1991-1995	1	5	5	37	82	91	60	32	34	10
	1996-2000	0	1	2	33	38	40	45	43	25	8
FEMALES	1991-1995	0	0	1	3	5	3	3	4	0	1
	1996-2000	0	0	3	6	0	3	4	3	1	1

** Age unknown for 5 male victims (3, 2)*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

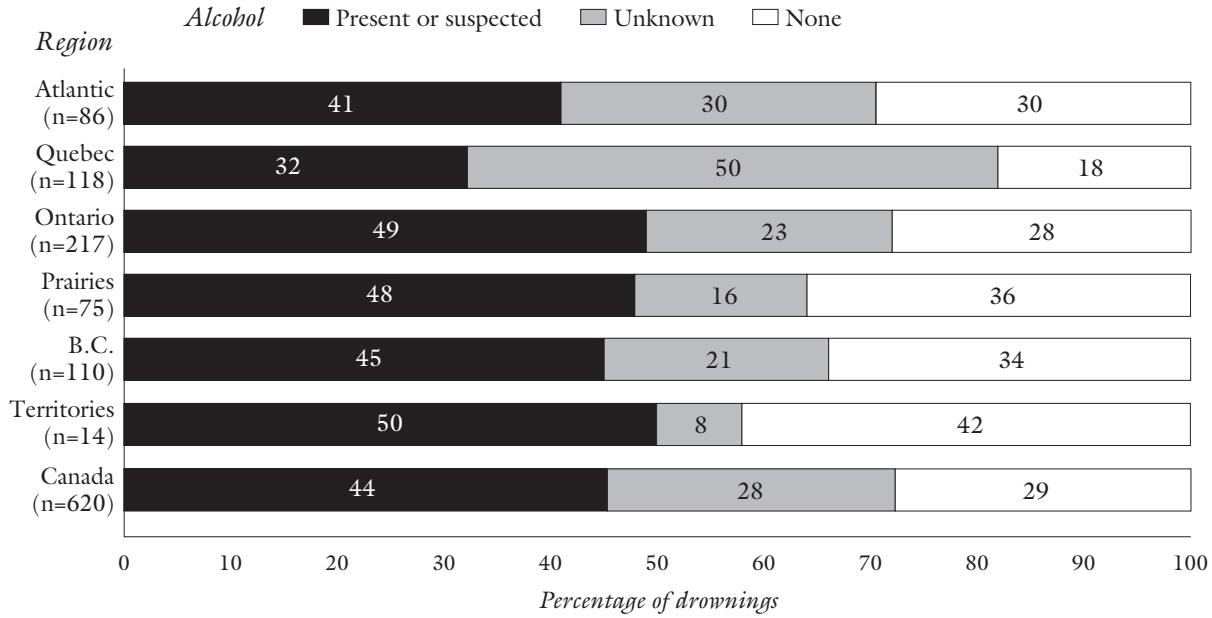
Figure 36 **BLOOD ALCOHOL LEVELS* FOR SMALL POWERBOAT DROWNINGS, CANADA 1991-2000 (VICTIMS ≥15 YEARS OF AGE; n=620)†**



** Legal limit is 80 mg % † This figure excludes 24 victims; decomposition rendered blood alcohol unreliable*
‡ 37 at 1-49 mg %, 24 at 50-80 mg %, & 4 unspecified

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 37 **SMALL POWERBOAT DROWNINGS BY PRESENCE OF ALCOHOL AND REGION, CANADA 1991-2000 (VICTIMS ≥15 YEARS OF AGE; n=620)**



Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

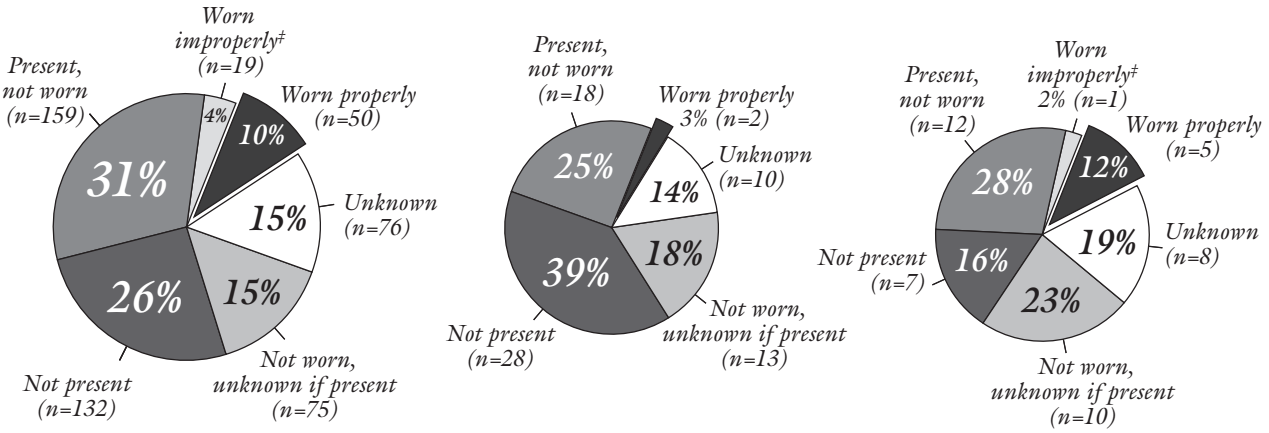
EQUIPMENT FACTORS

FLOTATION BY PURPOSE Overall only 9% of small powerboat victims were properly wearing a flotation device (57/638). Use of flotation varied by purpose, with daily living victims least likely to be correctly wearing flotation (Figure 38).

FLOTATION BY ALCOHOL Alcohol was present or suspected for 20% of victims properly wearing a flotation device (11/56), 28% of those improperly wearing flotation (5/18), and 47% of those not wearing flotation (205/433), suggesting an inverse association between alcohol consumption and use of flotation.

FLOTATION BY SWIMMING ABILITY Where swimming ability was known, a flotation device was properly worn by 8% of non swimmers (7/85), 17% of weak swimmers (7/41), 7% of average swimmers (1/15) and 5% of strong swimmers (1/22).

Figure 38 **SMALL POWERBOAT DROWNINGS BY USE OF A FLOTATION DEVICE* & PURPOSE, CANADA 1991-2000 (n=638)†**



** Personal flotation device (PFD) or lifejacket † This figure excludes 13 victims whose purpose was rescue, other or unknown*
‡ Not fastened or inappropriate size

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

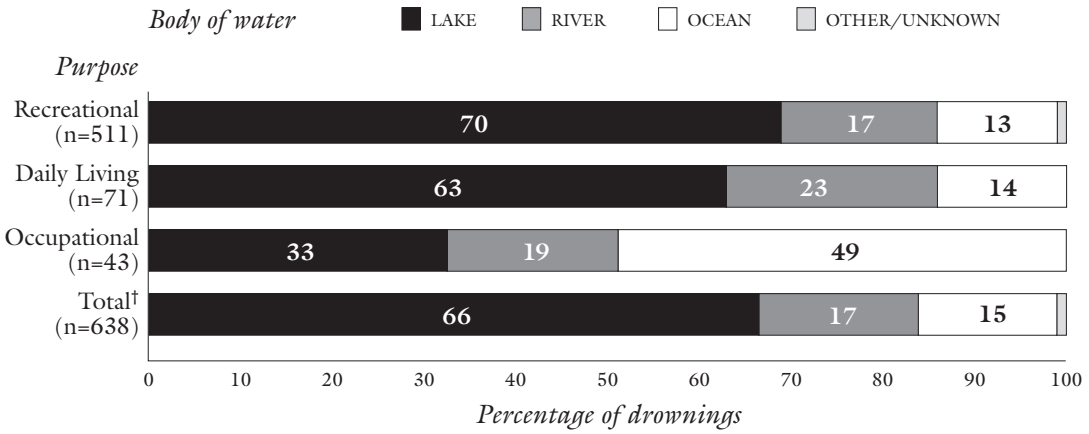
ENVIRONMENT FACTORS

BODY OF WATER 66% of small powerboat drownings occurred in lakes, 17% in rivers and 15% in the ocean; body of water was other (canal 2, dam 1) or unknown (1) for 1%. Body of water varied by purpose, with occupational drownings most likely to occur in the ocean (Figure 39). Body of water also varied by region (Figure 40).

CURRENT For incidents in rivers, current was unknown in 42% of cases. For the remainder, current was described as fast or strong 65%, rapids or whitewater 22%, dam spillway 2%, waterfall 5%, undertow 2%, tide 2% and other 3%.

WIND AND WAVES Wind conditions were unknown for 50% of drownings. For the remainder, wind was described as strong for 58%, breezy for 22% and calm for 20%. Waves conditions were unknown for 50% of victims. For the remainder, it was stormy for 7%, rough for 52%, choppy for 20%, and calm for 21%.

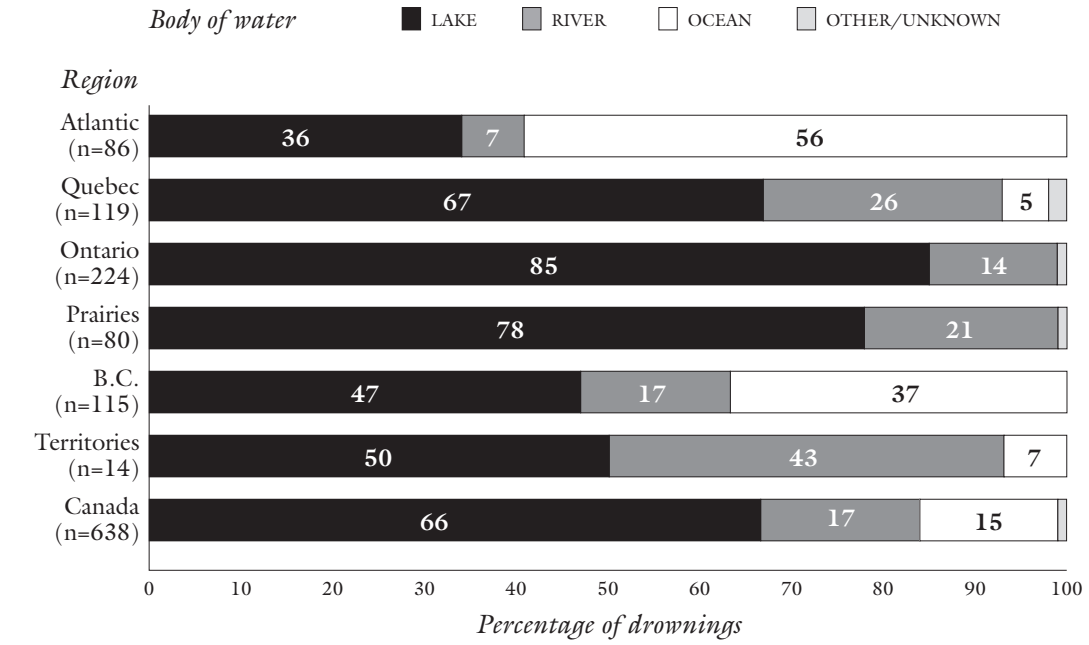
Figure 39 **SMALL POWERBOAT DROWNINGS BY BODY OF WATER* AND PURPOSE, CANADA 1991-2000 (n=638)†**



** "Lake" includes pond & reservoir † Total includes 13 victims whose purpose was rescue, other or unknown*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 40 **SMALL POWERBOAT DROWNINGS BY BODY OF WATER* AND REGION, CANADA 1991-2000 (n=638)**



** "Lake" includes pond & reservoir*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

WATER TEMPERATURE Water temperature was unknown for 63% of small powerboat drownings. For the remainder, it was reported to be extremely cold (<10°C) for 58%, cold or cool (10-20°C) for 41%, and warm or hot (>20°C) for 1%.

AIR TEMPERATURE Air temperature was unknown for 78% of drownings. For the remainder, it was extremely cold for 22%, cold for 46%, and warm or hot for 32%.

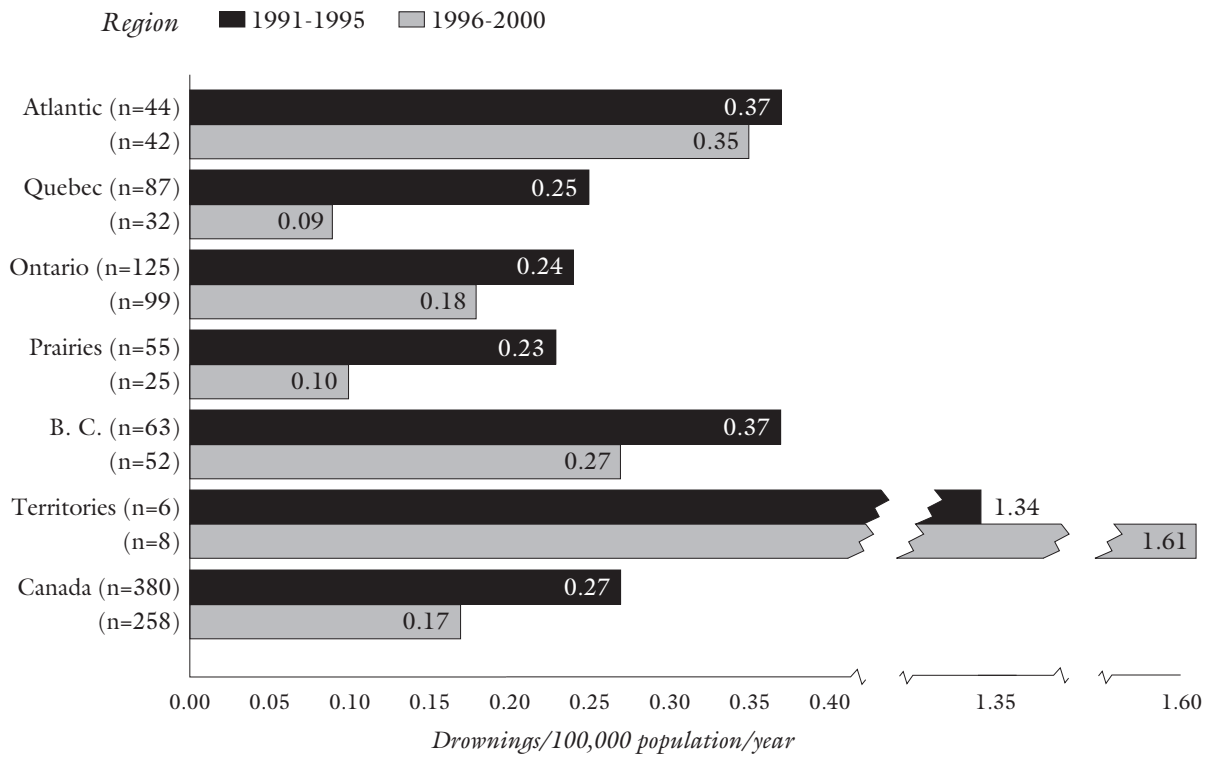
ICE AND COLD WATER Based on the criteria used in Module 2 of this series *(Ice & Cold Water)*, it is probable that cold water played a role in at least 35% of small powerboat drownings.

LIGHT CONDITIONS Light conditions were unknown for 21% of small powerboat drownings For the remainder, 66% occurred during daylight, 15% at twilight and 19% in darkness.

MONTH AND DAY 88% of small powerboat drownings occurred between May and October; 8% in April or November and 4% between December and March. Drownings took place throughout the week but were more frequent on Saturday and Sunday (43%).

RATES AND TRENDS BY REGION The highest rates of small powerboat drowning were seen in the northern territories, followed by the Atlantic region and British Columbia. Overall there was a 36% reduction in drowning rate between 1991-1995 and 1996-2000. There was significant improvement in all regions except the Atlantic region and the northern territories, where there was little change (Figure 41).

Figure 41 **RATE AND NUMBER OF SMALL POWERBOAT DROWNINGS BY REGION, CANADA 1991-2000 (n=638)**



Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

ACCOMPANIMENT 70% of victims were accompanied by at least one adult, while 25% were alone, 2% were accompanied only by minor(s), and 2% had a companion whose age was not specified. Accompaniment was unknown for 1% of victims.

RESCUE An acute rescue for a potentially survivable victim was carried out in only about 32% of cases. Of these, 31% underwent CPR and/or rescue breathing.

NON DROWNINGS

There were 51 water-related fatalities other than drownings involving small powerboats in 1991-2000, including 26 deaths by trauma and 25 deaths by immersion hypothermia.

There were 48 water-related fatalities involving personal watercraft in Canada during 1991-2000, including 25 drownings and 23 non drownings, all of which were trauma deaths from causes such as head injury, multiple injuries, major lacerations, and spinal injury (Table 2).

Table 2 **PERSONAL WATERCRAFT FATALITIES OTHER THAN DROWNINGS* BY TYPE OF INCIDENT AND TYPE OF INJURY, CANADA 1991-2000 (n=23)**

Type of incident	Type of injury†	N°	%
Collision			
Boat with another boat‡	Head 6, multiple 7, spine 3, major lacerations 2, unknown 1	14	61
Boat with fixed object	Head 4, multiple 2, spine 1, unknown 1	5	22
Other collision	Head 1	1	4
Propeller injury¶	Major lacerations 3	3	13
Total		**23**	**100**

** Primary cause of death was injury other than drowning, although drowning may have complicated another injury*
† Victims may have sustained more than one type of injury ‡ 1 case is classified with propeller injury ¶ Fell overboard 2, collision between boats 1

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Personal watercraft accounted for 2% of drownings and 26% of non-drowning deaths during powered boating; in addition, they were implicated in at least 3 incidents resulting in the death of an unpowered boater (see **TRAUMA AND PERSONAL WATERCRAFT**, page 20).

DROWNINGS & NON DROWNINGS

Given the small number of fatalities and the large proportion of non-drowning victims, this section will combine discussion of drownings and non drownings.

TYPE OF INCIDENT Overall, 25 victims died following a collision (52%), 16 fell or jumped overboard (33%), 1 capsized (2%) and 1 was swamped (2%); circumstances were unknown for the remaining 5 victims (10%). Drownings most often resulted from falling or jumping overboard, while nearly all trauma deaths resulted from collision (Figure 42).

PURPOSE Overall, 47 victims (98%) died during recreational activities, while 1 victim (2%) died during occupational activities.

PERSONAL FACTORS

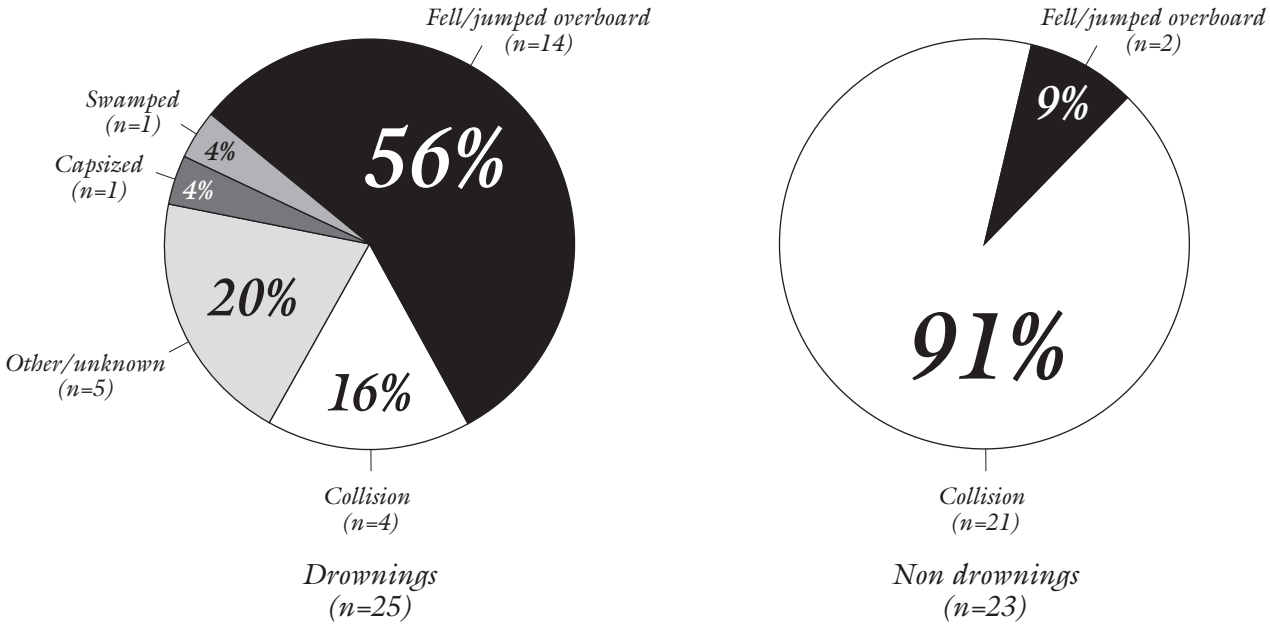
AGE & SEX Males accounted for 88% of personal watercraft fatalities during 1991-2000, with those 15 to 24 years at highest risk for both drowning and trauma. There were no female drownings, but females accounted for 26% of trauma deaths. 8% of victims were children under 15 (Figure 43).

ALCOHOL Alcohol was present or suspected for 52% of personal watercraft victims, possibly more since alcohol was unknown in 29% of cases (Figure 44).

ETHNICITY Although aboriginals are over-represented in most categories of water-related fatality, they accounted for only 4% of personal watercraft fatalities, roughly equivalent to the proportion they represent of the Canadian population.

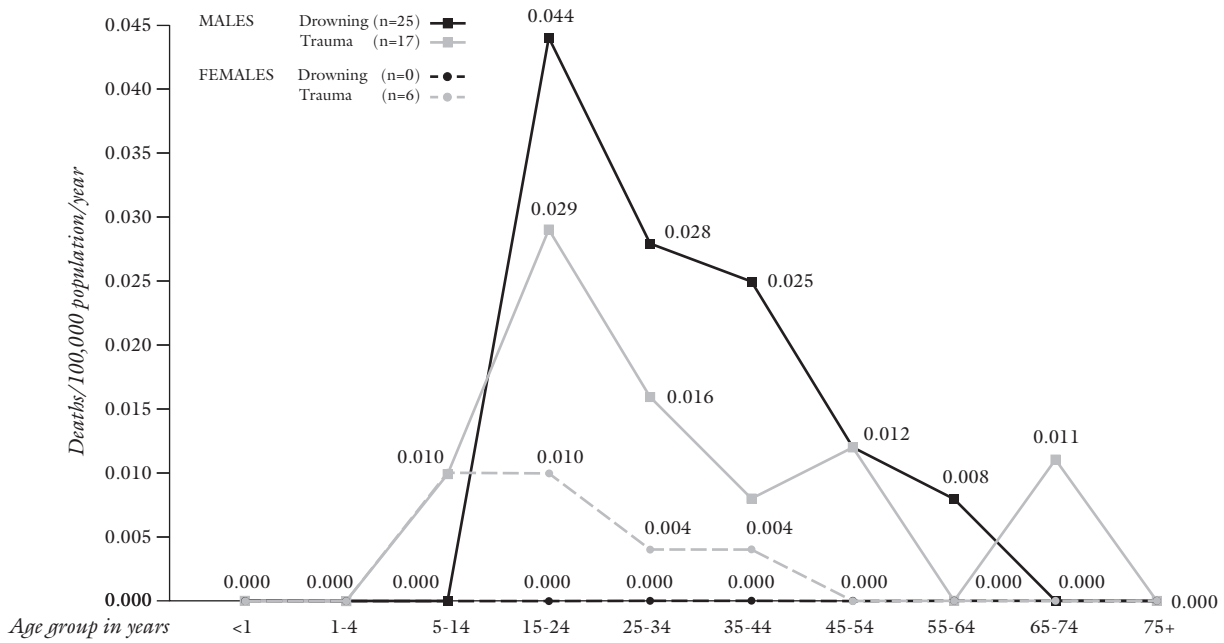
SWIMMING ABILITY Swimming ability was unknown for 75% of personal watercraft victims. For the remainder, 33% were weak or non swimmers, 17% were average or strong swimmers and 50% were swimmers of unspecified ability.

Figure 42 **PERSONAL WATERCRAFT FATALITIES BY CAUSE OF DEATH AND TYPE OF INCIDENT, CANADA 1991-2000 (n=48)**



Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

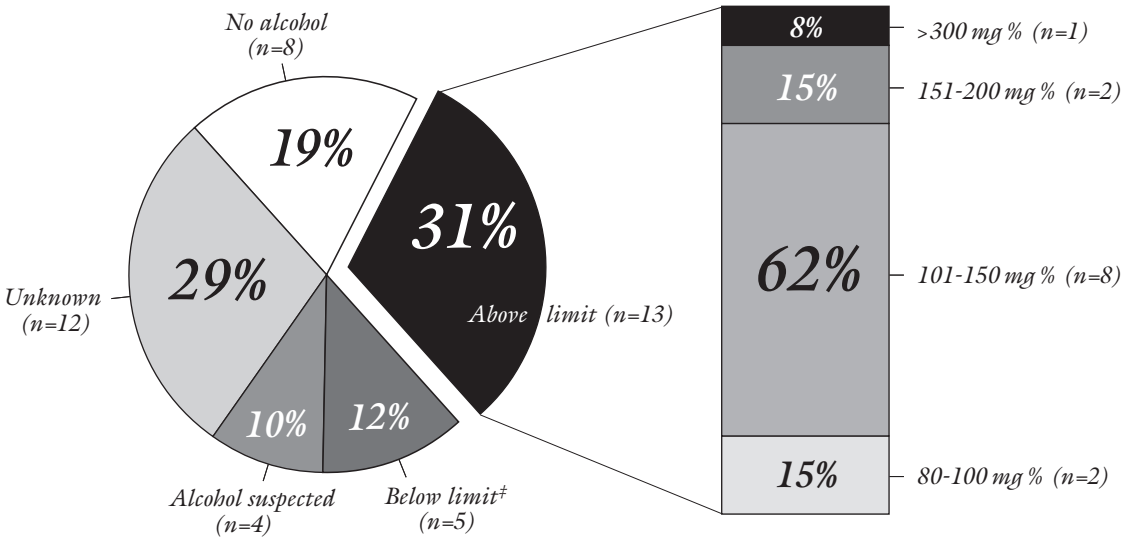
Figure 43 **RATE AND NUMBER OF PERSONAL WATERCRAFT FATALITIES BY CAUSE OF DEATH AND BY AGE & SEX, CANADA 1991-2000 (n=48)**



MALES	Drowning	0	0	0	9	7	6	2	1	0	0
	Trauma	0	0	2	6	4	2	2	0	1	0
FEMALES	Drowning	0	0	0	0	0	0	0	0	0	0
	Trauma	0	0	2	2	1	1	0	0	0	0

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 44 **BLOOD ALCOHOL LEVELS* FOR PERSONAL WATERCRAFT FATALITIES, CANADA 1991-2000 (VICTIMS ≥15 YEARS OF AGE; n=44)†**



** Legal limit is 80 mg % † This figure excludes 2 victims; decomposition rendered blood alcohol unreliable*
‡ 4 at 1-49 mg %, 1 at 50-80 mg %

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

BOATING EXPERIENCE Boating experience was unknown for 56% of personal watercraft victims. For the remainder, only 33% were experienced boaters, while 62% were inexperienced and 5% were occasional boaters.

EQUIPMENT FACTORS

FLOTATION 20% of personal watercraft drowning victims were properly wearing a flotation device (Figure 45); although higher than for powerboat drownings overall, this proportion is still low. 44% of trauma victims (not included in this figure) were properly wearing flotation.

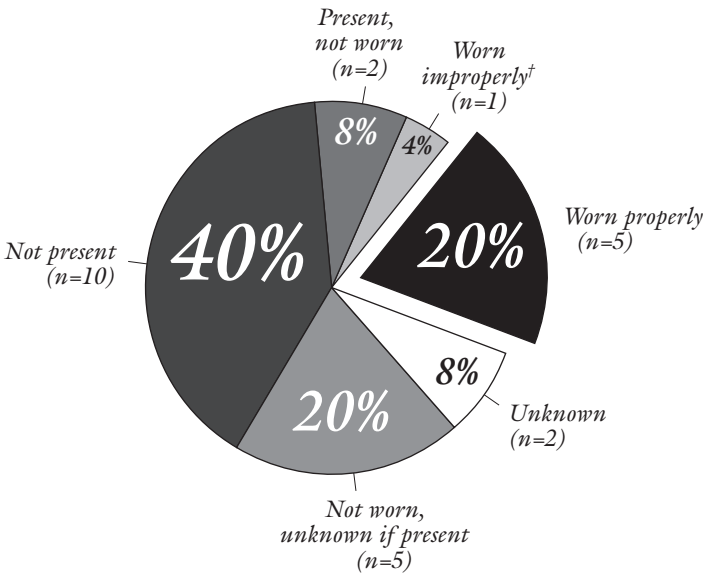
ENVIRONMENT FACTORS

BODY OF WATER 69% of personal watercraft fatalities occurred in lakes, 19% in rivers, 10% in the ocean and 2% in canals (Figure 46).

WIND AND WAVES Wind conditions were unknown for 83% of deaths. For the remainder, wind was described as breezy for 62% and calm for 38%; no strong winds were reported. Waves conditions were unknown for 75% of victims. For the remainder, it was calm for 45%, choppy for 45% and rough for 9%; no stormy weather was reported.

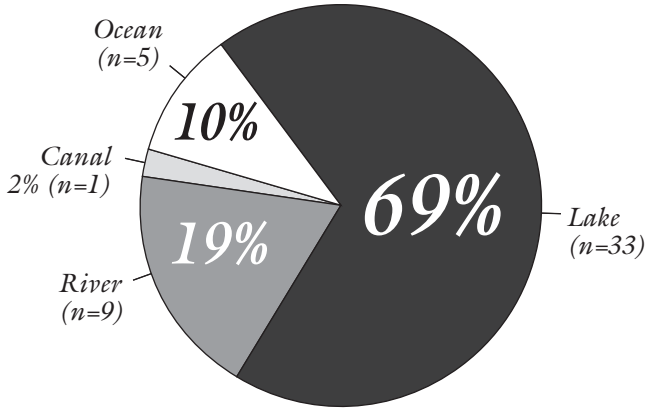
WATER TEMPERATURE Water temperature was unknown for 73% of personal watercraft fatalities. For the remainder, it was reported to be extremely cold (<10°C) for 31% (all were drowning victims), cold or cool (10-20°C) for 62%, and warm or hot (>20°C) for 8%.

Figure 45 **PERSONAL WATERCRAFT DROWNINGS BY USE OF A FLOTATION DEVICE,* CANADA 1991-2000 (n=25)**



** 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, 2009

Figure 46 **PERSONAL WATERCRAFT FATALITIES BY TYPE OF BODY OF WATER,* CANADA 1991-2000 (n=48)**



** "Lake" includes pond & reservoir*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

AIR TEMPERATURE Air temperature was unknown for 75% of deaths. For the remainder, it was cold for 17%, warm for 67% and hot for 17%; no extremely cold air temperatures were reported.

ICE AND COLD WATER Based on the criteria used in Module 2 of this series *(Ice & Cold Water)*, it is probable that cold water was a factor in 20% of personal watercraft drownings; none of the non-drowning fatalities were due to hypothermia.

LIGHT CONDITIONS Light conditions were unknown for 10% of victims. For the remainder 77% of deaths occurred during daylight, 14% at twilight and 9% in darkness.

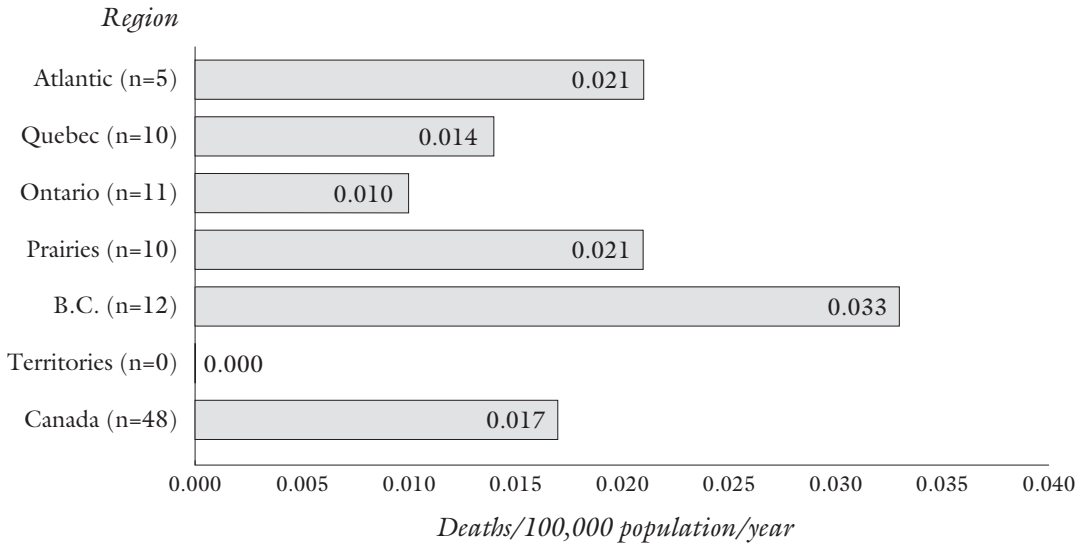
MONTH AND DAY All personal watercraft fatalities occurred between May and October, 90% between May and August. 75% of deaths took place between Friday and Sunday.

REGION The highest rate of fatality was seen in British Columbia, followed by the Atlantic region and the Prairies. There were no personal watercraft deaths in the northern territories during 1991-2000 (Figure 47).

ACCOMPANIMENT 69% of victims were accompanied by at least one adult, while 12% were alone and 8% were accompanied only by minor(s). Accompaniment was unknown for 10% of victims.

RESCUE An acute rescue for a potentially survivable victim was carried out in 62% of cases (the proportion was higher for trauma victims, 83%, than for drowning victims, 44%). Of these, 30% underwent CPR and/or rescue breathing.

Figure 47 **RATE AND NUMBER OF PERSONAL WATERCRAFT FATALITIES BY REGION, CANADA 1991-2000 (n=48)**



Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

DROWNINGS

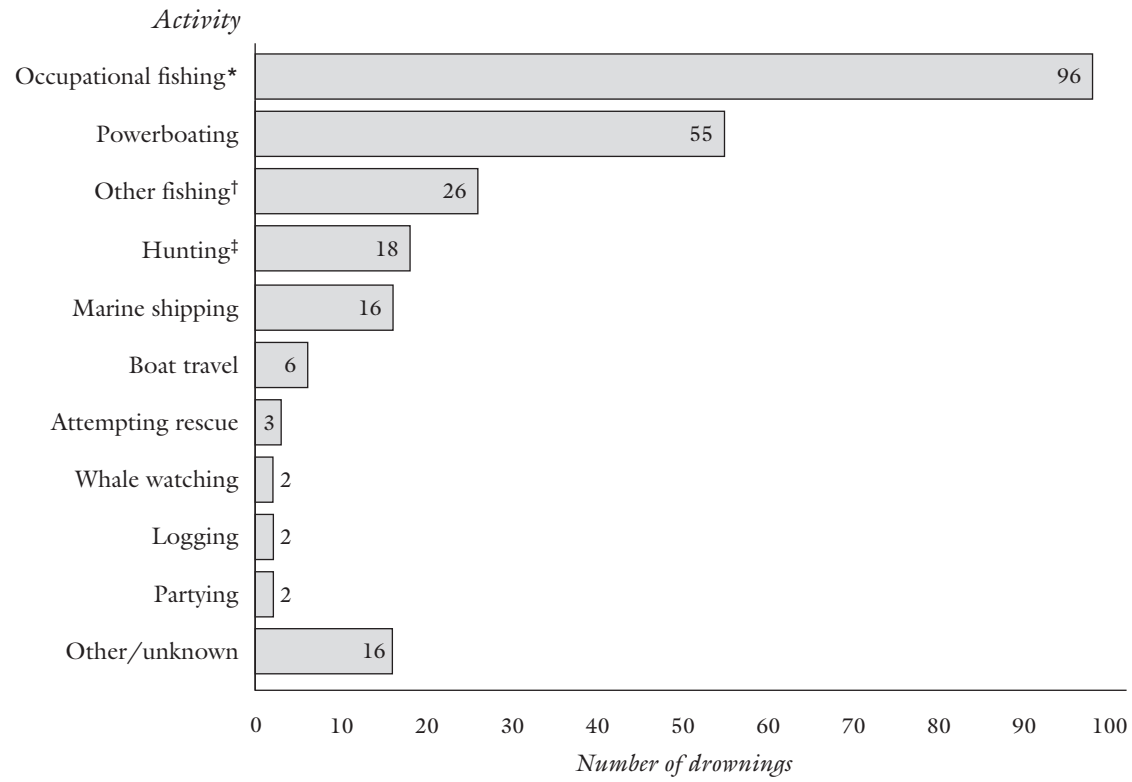
There were 242 large powerboat (>5.5 m) drownings in Canada during 1991-2000, accounting for 22% of powerboat drownings; the true proportion may be higher since the size of boat was unknown for 19% of victims.

TYPE OF INCIDENT 28% of victims fell, jumped or were thrown overboard, 25% capsized and 21% were swamped. Another 10% drowned following a collision; details were unknown or other for the remaining 17% of victims.

ACTIVITY Occupational fishing was the activity most commonly associated with large powerboat drownings, followed by powerboating, other fishing, hunting and shipping (Figure 48).

PURPOSE As seen in Figure 21, 50% of large powerboat drownings occurred during occupational activities, 36% during recreation, 13% during daily life, and 1% while attempting rescue.

Figure 48 **LARGE POWERBOAT DROWNINGS BY ACTIVITY, CANADA 1991-2000 (n=242)**



** Commercial fishing 92, aquaculture 3, fishing guiding 1 † Recreational 18, daily living 8 ‡ Recreational 7, daily living 11*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

PERSONAL FACTORS

AGE & SEX Males 15 years and older accounted for 84% of large powerboat drownings; those between 25 and 74 years were at highest risk (Figure 49). Between 1991-1995 and 1996-2000, the overall drowning rate decreased by 24%; the greatest reduction was seen for victims 55-74 years.

AGE & SEX BY PURPOSE Where age was known, 96% of occupational victims were males between 15 and 64 years; 59% were between 25 and 44 years. For recreational and daily living activities, males between 35 and 74 years had the highest rates of drowning. 88% of female victims drowned during recreational or daily living activities (Figure 50).

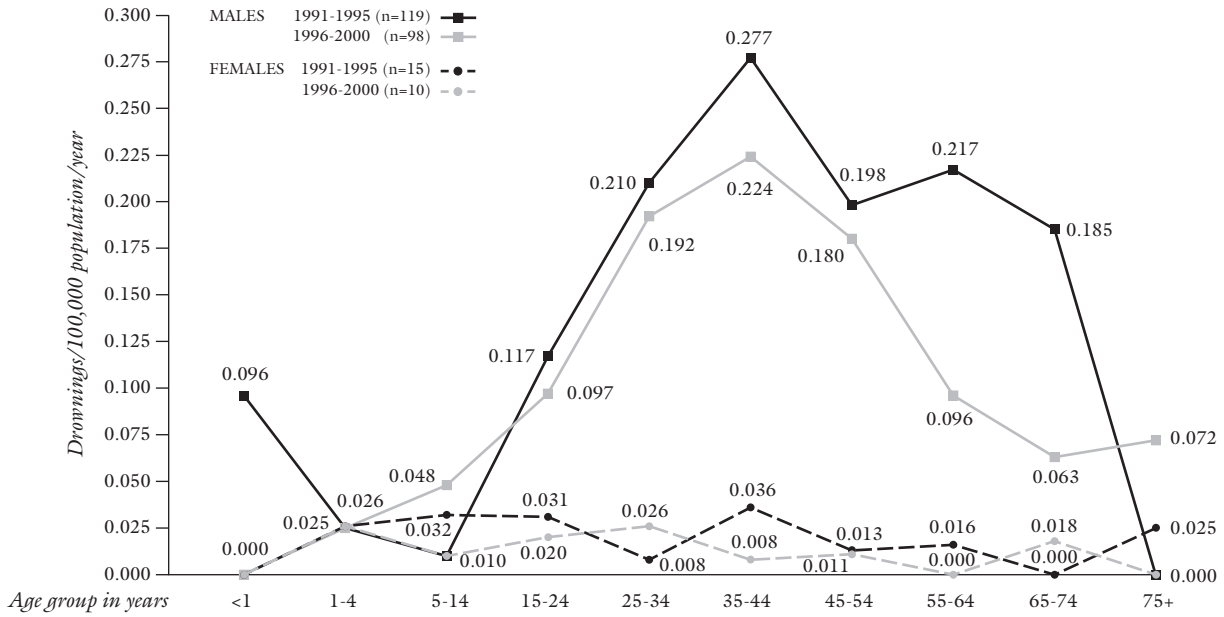
ALCOHOL BY PURPOSE Overall, alcohol was present or suspected for 23% of large powerboat drownings, possibly more as it was unknown for 48% of victims. Alcohol consumption (known or suspected) was much lower for occupational victims than for recreational or daily living victims (Figure 51).

ETHNICITY At least 18% of large powerboat victims were aboriginal; ethnicity was unknown for 23% of victims.

SWIMMING ABILITY Swimming ability was unknown for 81% of victims. For the remainder, 51% were non swimmers and the rest were swimmers of varying ability.

BOATING EXPERIENCE Boating experience was unknown for 41% of large powerboat victims. For the remainder, 92% were experienced and 7% were inexperienced or occasional boaters.

Figure 49 **RATE AND NUMBER OF LARGE POWERBOAT DROWNINGS BY AGE & SEX, CANADA 1991-2000 (n=242)***



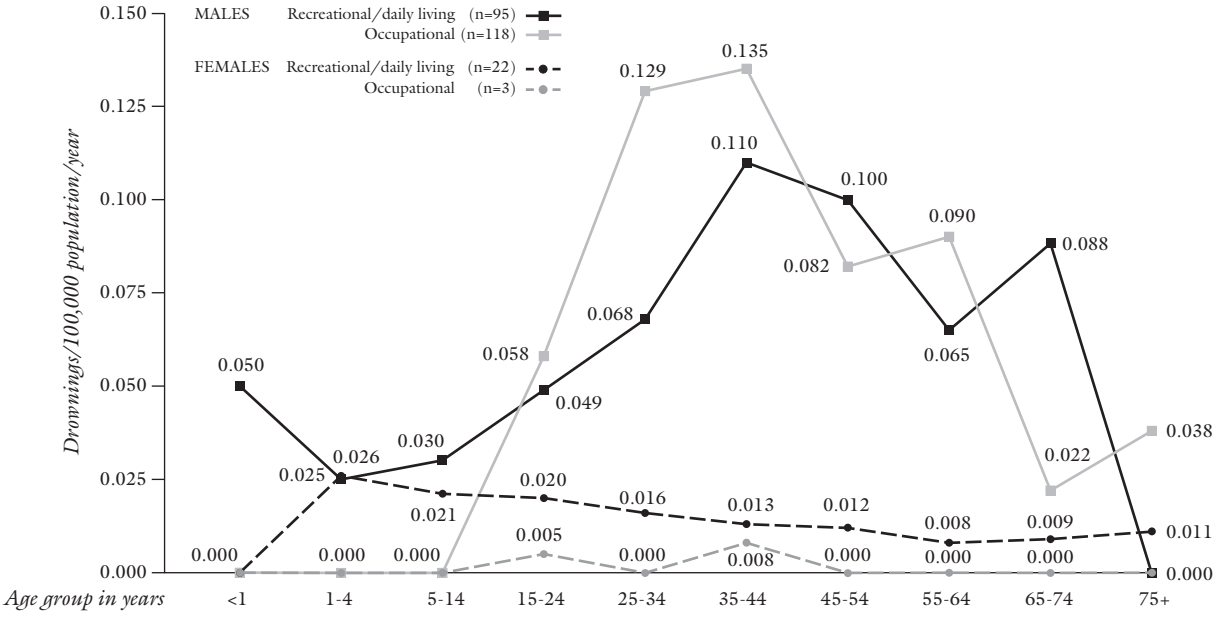
Number of drownings in age group

MALES	1991-1995	1	1	1	12	27	31	15	13	8	0
	1996-2000	0	1	5	10	23	28	17	6	3	2
FEMALES	1991-1995	0	1	3	3	1	4	1	1	0	1
	1996-2000	0	1	1	2	3	1	1	0	1	0

** Age unknown for 13 male victims (10, 3)*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 50 **RATE AND NUMBER OF LARGE POWERBOAT DROWNINGS BY AGE & SEX AND BY PURPOSE, CANADA 1991-2000 (n=242)***



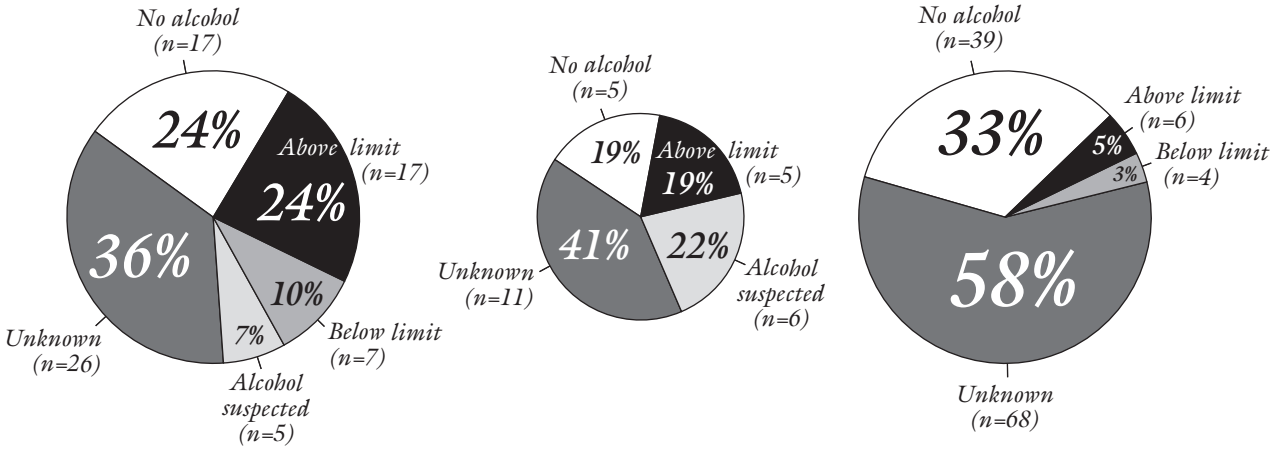
Number of drownings in age group

MALES	REC/DL	1	2	6	10	17	26	17	8	8	0
	OCC	0	0	0	12	32	32	14	11	2	2
FEMALES	REC/DL	0	2	4	4	4	3	2	1	1	1
	OCC	0	0	0	1	0	2	0	0	0	0

** Age unknown for 13 male occupational victims*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 51 **BLOOD ALCOHOL LEVELS* FOR LARGE POWERBOAT DROWNINGS BY PURPOSE, CANADA 1991-2000 (VICTIMS ≥15 YEARS OF AGE; n=227)†‡**



** Legal limit is 80 mg % † This figure excludes 4 victims whose purpose was rescue, other or unknown*
‡ This figure excludes 7 other victims (3, 0, 4); decomposition rendered blood alcohol unreliable

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

EQUIPMENT FACTORS

FLOTATION 11% of large powerboat victims were properly wearing a flotation device. Use of flotation varied by purpose; none of the daily living victims was correctly wearing a flotation device, as compared with 12% for occupational and 14% for recreational victims (Figure 52).

FLOTATION BY ALCOHOL Alcohol was present or suspected for 4% of victims properly wearing a flotation device (1/25), 20% of those improperly wearing flotation (1/5), and 28% of those not wearing flotation (34/120), compared with 23% overall (51/220).

ENVIRONMENT FACTORS

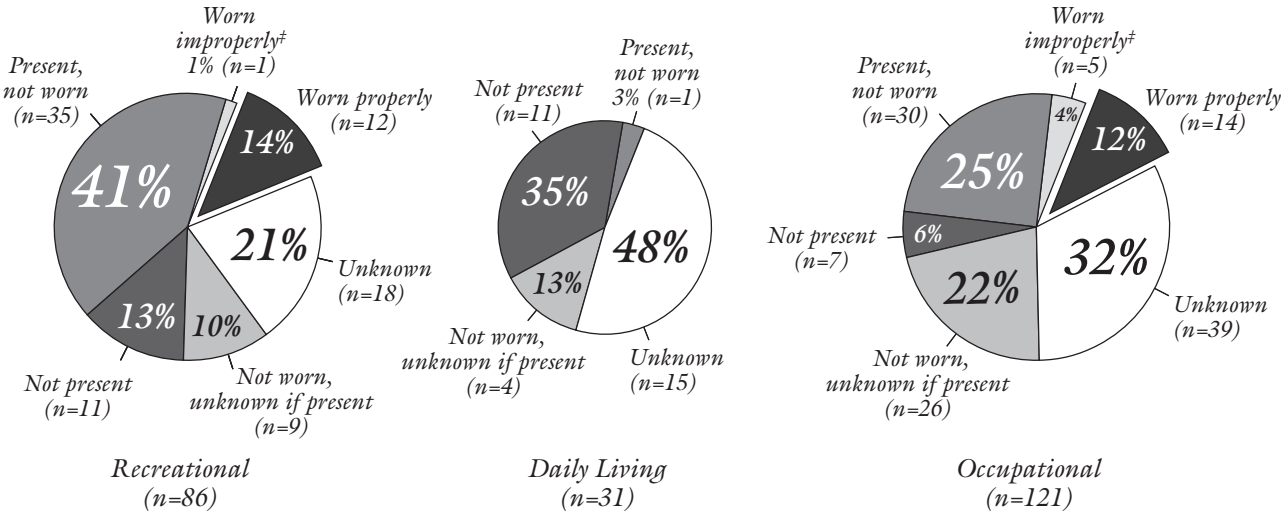
BODY OF WATER Most large powerboat drownings occurred in the ocean (68%); lakes and rivers accounted for 19% and 12% respectively. Body of water varied by purpose; recreational drownings were more likely to occur in lakes, although oceans and rivers were also frequent locations (Figure 53).

ENVIRONMENTAL RISK FACTORS Many large powerboat incidents involved cold weather, cold or extremely cold water, strong winds and rough water (Figure 54).

ICE AND COLD WATER Based on the criteria used in Module 2 of this series *(Ice & Cold Water)*, it is probable that cold water played a role in at least 68% of large powerboat drownings.

LIGHT CONDITIONS Light conditions were unknown for 19% of powerboat drownings. For the remainder, 55% of large powerboat drownings occurred during daylight, 7% at twilight and 38% in darkness.

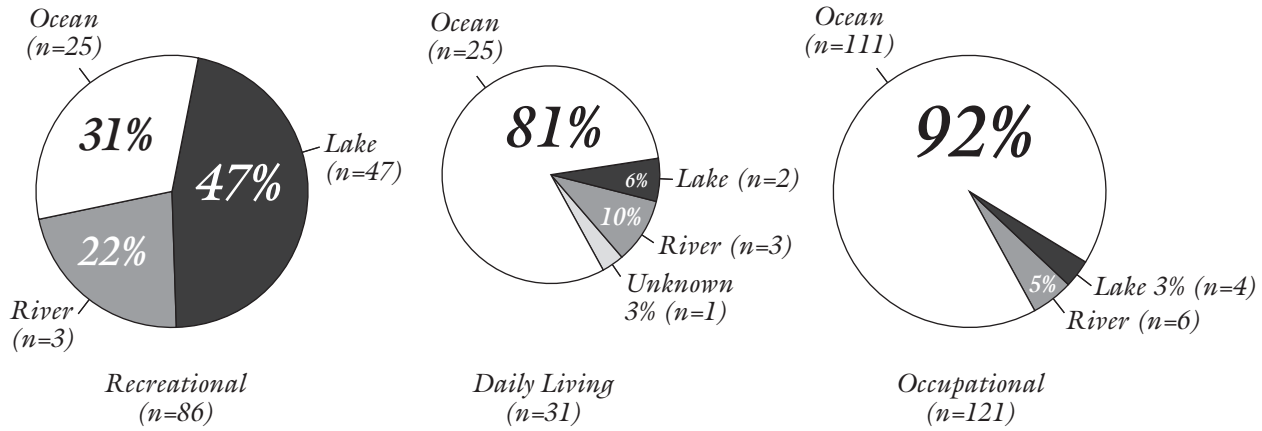
Figure 52 **LARGE POWERBOAT DROWNINGS BY USE OF A FLOTATION DEVICE* & PURPOSE, CANADA 1991-2000 (n=242)†**



** Personal flotation device (PFD) or lifejacket † This figure excludes 4 victims whose purpose was rescue or other/unknown (3, 1)*
‡ Not fastened or inappropriate size

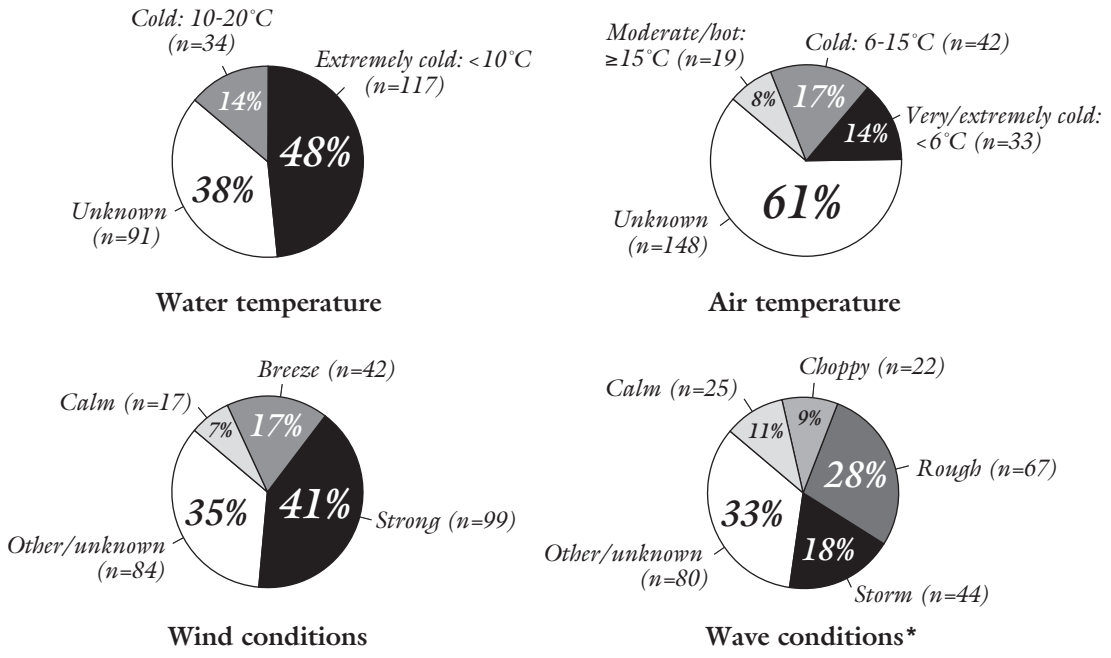
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 53 **LARGE POWERBOAT DROWNINGS BY BODY OF WATER AND PURPOSE, CANADA 1991-2000 (n=242)†**



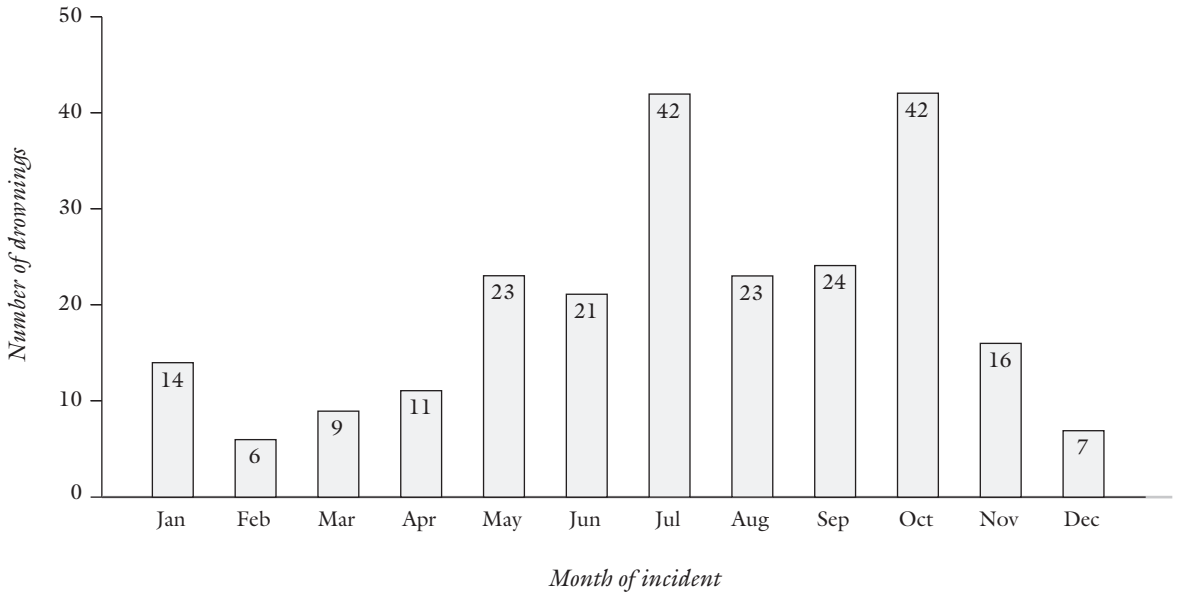
** "Lake" includes pond & reservoir † This figure excludes 4 victims whose purpose was rescue or other/unknown (3, 1)*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 54 **LARGE POWERBOAT DROWNINGS BY ENVIRONMENTAL RISK FACTORS, CANADA 1991-2000 (n=242)**



**Wave conditions were considered irrelevant for 4 drownings*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Figure 55 **LARGE POWERBOAT DROWNINGS BY MONTH OF INCIDENT, CANADA 1991-2000 (n=242)***



** Month unspecified for 4 drownings*
Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

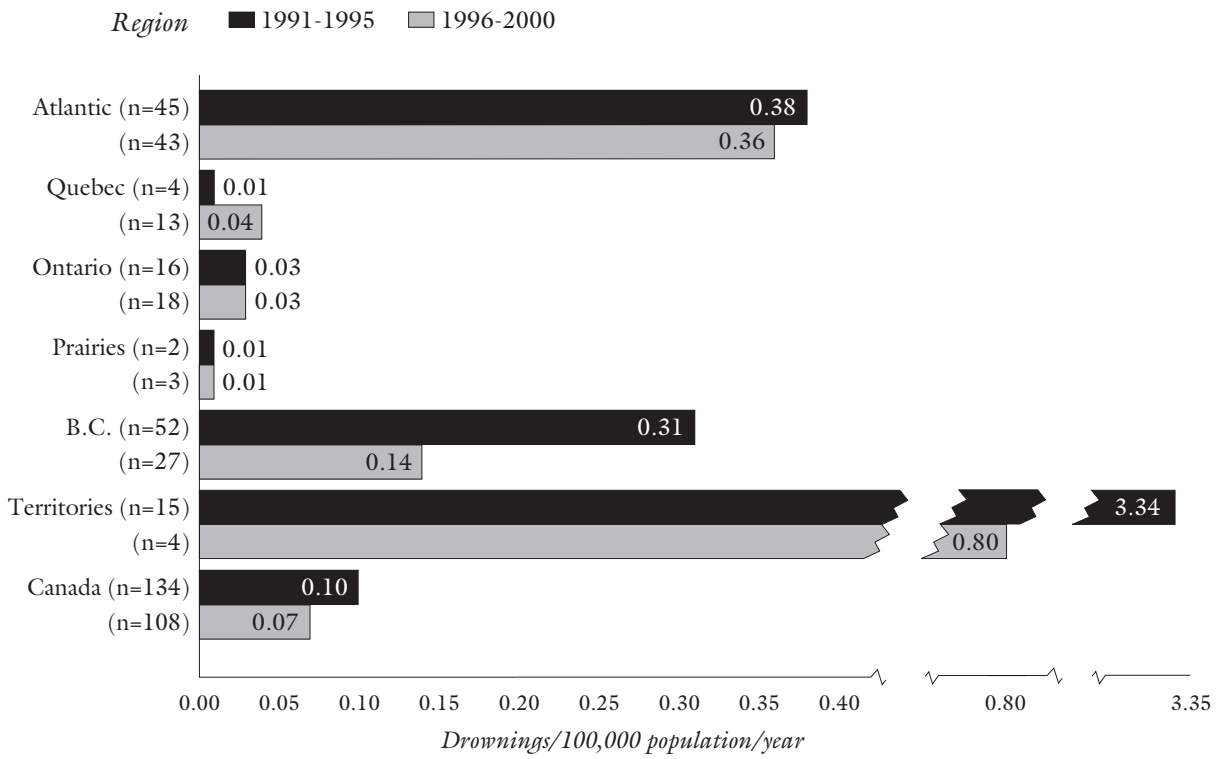
MONTH 72% of large powerboat drownings occurred between May and October, with peaks in July and October, although there were drownings throughout the year (Figure 55).

RATES AND TRENDS BY REGION The highest rates of large powerboat drowning were seen in the northern territories, followed by the Atlantic region and British Columbia. Overall there was a 24% reduction between 1991-1995 and 1996-2000, largely accounted for by improvements in the territories and British Columbia. An increase was seen in Quebec (Figure 56).

ACCOMPANIMENT 69% of victims were accompanied by at least one adult, while 19% were alone, 12% were accompanied only by minor(s), and 1% had a companion whose age was not specified.

RESCUE An acute rescue for a potentially survivable victim was carried out in only 36% of cases. Of these, 30% underwent CPR and/or rescue breathing.

Figure 56 **RATE AND NUMBER OF LARGE POWERBOAT DROWNINGS BY REGION, CANADA 1991-2000 (n=242)**



Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

NON DROWNINGS

There were 33 water-related fatalities other than drownings involving large powerboats in 1991-2000, including 24 deaths by trauma and 9 deaths by immersion hypothermia.

And you know that it is useless and that your voice does not carry the length of the boat and that even if you knew the original spot, the relentless waves would carry such a burden perhaps a mile or so by the time you could return.

And you know also, the final irony, that your father, like your uncles and all the men that form your past, cannot swim a stroke.

– Alistair MacLeod, "The Boat," 1968

OVERVIEW OF ACTIVITIES & RISK FACTORS FOR ALL BOATS

Boating accounted for 1,952 injury deaths in Canada during 1991-2000, of which 92% were caused by drowning with or without hypothermia, 3% by immersion hypothermia without drowning, and 5% by trauma from incidents such as collisions, falls, and propeller injuries. 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, for a total loss of $4 billion during the decade.

Boating was associated with 39% of drownings and 50% of other water-related injury deaths (excluding land and air transport), making boating by far the most frequent type of activity leading to water-related injury fatality in Canada. Powered boating accounted for 62% of boating drownings and 83% of other boating injury deaths, and unpowered boating for the remainder.

The most frequent boating ***activity*** was fishing, including recreational, occupational and subsistence fishing, which accounted for 39% of boating drownings. Other activities included powerboating, canoeing, travel, hunting, sailing, kayaking, rafting and rowing. Between 1991-1995 and 1991-2000, the rate of death declined for many activities, but increases were noted for hunting, sailing, rafting, and rowing.

As for the ***purpose*** of the activity, a majority of boating drownings occurred during recreational activities, 76%, followed by occupational 11%, daily life 10%, and rescue 2%.

The ***type of incident*** leading to drowning varied between powered and unpowered boating. Type of incident during powered boating included falling overboard 32%, capsizing 29%, swamping 16% and collision 7%, while for unpowered boating it included capsizing 52%, falling overboard 20%, swamping 8% and collision 2%. Type of incident also varied between drowning and non-drowning fatalities; while collision accounted for only 5% of drowning deaths, it contributed to 51% of non-drowning deaths, including hypothermia 35% and trauma 78%. A disproportionate number of collision deaths involved personal watercraft.

Considering ***personal risk factors*** such as age, sex, and alcohol consumption, the peak of risk for powerboating ***drownings*** was actually 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 drownings during boating, females 15 and older for only 6%. Hence males 15 and older accounted for over 90% of victims, making them the key target group for prevention. Alcohol was associated with 50% of recreational and daily living drownings — possibly more, since alcohol was unknown for about 30% of victims. Alcohol was less frequently reported for occupational deaths, 11%, although alcohol was unknown for more of these victims.

As for ***equipment factors***, small powerboats and canoes predominated in recreational incidents, accounting for 60%; small powerboats, canoes, and large powerboats in daily living incidents, 73%; and large powerboats in occupational incidents, 60%.

Clearly the most fundamental item of safety equipment is a properly worn ***flotation device***; this was borne out by the fact that only 9% of powered and 11% of unpowered boating

drowning victims were reported to have been properly wearing one, with another 3% improperly wearing one. A flotation device was reported to be properly worn by 11% of recreational victims, 3% of daily living victims and 10% of occupational victims. Only 4% of reported non-swimmers wore flotation.

A key ***environmental factor*** for boating immersion deaths in Canada is cold water, which was associated with 34% of recreational, 50% of daily living and 62% of occupational drownings. Most recreational incidents occurred on lakes, followed by rivers; daily living incidents occurred on lakes, oceans, and rivers; and occupational incidents mainly on oceans. For lakes and oceans, strong winds and waves were frequent environmental risk factors, while current was a frequent factor for rivers. 85% of deaths occurred between May and October, although occupational incidents were spread throughout the year. About a third of incidents occurred when visibility was reduced during darkness or twilight. Coastal regions and the northern territories had the highest rates of boating drowning per unit of population; rates in the remainder of the country were relatively similar.

With respect to ***rescue***, boaters should reflect upon the sobering fact that an acute rescue for a potential survivor was carried out for only about a third of victims, and resuscitation such as CPR and/or rescue breathing for only about a third of these. Hence even the possibility of rescue plus resuscitation was available for only about one in 8 victims, emphasizing the importance of personal knowledge and preparedness for pre-event and event phases of potential injury incidents.

As for ***trends***, there was a 24% decrease in the rate of boating drowning between 1991-1995 and 1996-2000, including 27% for powerboats and 19% for unpowered boats. The greatest improvement in powerboat drownings occurred in British Columbia and the northern territories, although rate reductions were seen in all parts of the country except the Atlantic region. For unpowered boats, rates in the Atlantic region, British Columbia, and the Territories showed the most improvement; conversely, Quebec and Ontario showed slight increases.

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 POWERED BOATS

90% of powerboat fatalities resulted from drowning with or without hypothermia, 3% from immersion hypothermia without drowning, and 7% from traumatic injury. Powerboats were mainly used for recreational fishing, powerboating, travel, and hunting. Falling, capsizing, and swamping were the most frequent types of incident.

As for ***personal risk factors***, the main risk group was males 25 to 74 years old. Alcohol and limited swimming ability were frequent factors. Although daily living victims were more often described as experienced boaters than recreational victims, they were less likely to have worn flotation, so “experience” was not associated with proper use of flotation equipment. Furthermore, use of alcohol was twice as frequent for victims not properly wearing flotation as for those who were. This indicates the association of more than one type of risk-taking behaviour, which could have resulted from insufficient water safety knowledge, unsafe attitudes, or both.

Concerning ***equipment factors,*** only 9% of powerboat drowning victims were wearing flotation; the proportion was even lower among non-swimmers at 6%. Small open powerboats predominated except in coastal regions, especially Atlantic Canada where numbers of small and large powerboat deaths were almost equal.

As for ***environmental factors***, cold water was associated with 40% of deaths. Strong winds and rough to stormy wave conditions were reported in more than half the cases where information was available, although no information was provided for about half the victims. Darkness or twilight was reported for about a third of deaths, with low visibility a probable factor in these cases.

Rescue of a potentially survivable victim was carried out for 33% of victims, and CPR or rescue breathing for 34% of these. The situation was somewhat worse than for unpowered boating drownings, where rescue of a potentially survivable victim was done in 37% of cases and, of these, CPR or rescue breathing for 42%.

In summary, the main personal risk factors for powerboat deaths included ages 25 years and older, male gender, and alcohol; very few women or children less than 15 years old were involved. Failure to wear a flotation device was an equipment risk factor for up to 91% of all victims and up to 94% of non-swimmers. Those not wearing flotation were often multiple risk takers, with at least 41% alcohol involvement, as compared with 20% among those correctly wearing flotation. Environmental factors were important, including extremely cold water, wind, waves, current, and darkness. Fishing was the most frequent activity associated with powerboat fatalities.

ACTIVITIES & RISK FACTORS FOR SMALL POWERBOATS

93% of small powerboat fatalities resulted from drowning with or without hypothermia, 4% from immersion hypothermia without drowning, and 4% from traumatic injury. The type of incident included capsizing, falling overboard, and swamping. Fishing, powerboating and boat travel were the most frequent activities; 80% of deaths occurred during recreational boating.

As for ***personal risk factors***, 91% of victims were males 15 years and older, and the highest death rates occurred among males 25 years and older. Only 3% of victims were children under 15 years of age; the remaining 6% were women 15 years and older. Alcohol was associated with at least 44% of deaths; many victims had very high levels of blood alcohol. Many victims were weak or non-swimmers; however, despite this finding, many were also reported to be experienced boaters.

The most essential item of safety ***equipment***, a flotation device, was reported to have been worn correctly by only 9% of victims. Use of alcohol was more frequent in those not wearing flotation. Weak swimmers were most likely to have correctly worn flotation, 17%, compared with only 8% of non-swimmers and 5% of strong swimmers.

Environmental factors were frequently reported, including strong wind and waves on open water such as lakes, and strong current in rivers. Cold water was a factor in at least 35% of incidents.

An acute ***rescue*** for a potential survivor was carried out for about a third of victims; of these only one third underwent CPR and/or rescue breathing.

As for ***trends***, there was a 50% decrease in death rates among 25-44-year-old males between 1991-1995 and 1995-2000; however, there was no improvement for males 15-24 or 55 years and older.

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 personal watercraft, where immersion accounted for 52% and trauma for 48%. A very high proportion of drownings, 56%, resulted from falling off the personal watercraft, while 16% followed a collision, whereas 91% of trauma deaths were due to collision and 9% to falling off. Collisions accounted for 54% of all personal watercraft deaths, suggesting that even

when death was attributed to drowning, victims may have incurred traumatic injuries such as concussion.

Considering ***personal risk factors***, the age profile was young, with a sharp peak for 15-24 year-olds and 79% of victims between 15 and 44 years old. Although the numbers were small, 8% of victims were children 5-14 years old and 8% were women; all died of trauma.

Alcohol was associated with more than half of incidents. Levels above the limit of 80 mg% were lower than for small open powerboats, with 77% between 80 and 150 mg%, as contrasted with only 26% for small open powerboats. This finding suggests that for personal watercraft, 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***, personal watercraft 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 personal watercraft fatalities resulted from collisions.

Personal watercraft 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 also probable factors in many incidents, although such details are not routinely recorded by police and coroners.

Flotation devices were worn by 20% of drowning victims, about double that for other boaters; however, these data are based on small numbers. Furthermore, since 72% of personal watercraft drownings resulted from falling off or collisions, it's likely that some drownings resulted from loss of consciousness due to concussion that was unapparent to the investigating police and coroner. This possibility is supported by the fact that wearing of flotation was 44% among victims of trauma from collisions and falling off.

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. Wearing of helmets was also not routinely mentioned in the death reports.

Environment factors such as wind, waves, cold water, current and darkness were rarely associated with deaths involving personal watercraft, compared with other types of boat. Fatality rates were highest in British Columbia, possibly due to the fact that the warmer Pacific coastal climate is more conducive to use of such boats.

Acute ***rescue*** for a potentially survivable victim was carried out for about two-thirds of personal watercraft victims, about double that for other powerboats. However, CPR and/or rescue breathing were applied for less than a third of these.

ACTIVITIES & RISK FACTORS FOR LARGE POWERBOATS

Large powerboat incidents mainly occurred during occupational activities, 50%, especially fishing, followed by recreational, 36%, most of which were powerboating.

Personal risk factor analysis showed peak incidence among all age groups between 25 to 74-year-old males; however the situation differed between recreational/daily living and occupational deaths, with occupational victims generally younger and recreational older. Alcohol was associated with at least 40% of recreational and daily living incidents, and 8% of occupational incidents. Where swimming ability was known, 51% were reported to be non-swimmers. Most victims were reported to be experienced boaters.

As for ***equipment factors***, only 11% of victims were reported to have properly worn a flotation device. Alcohol consumption was much more frequent among those not wearing flotation.

Environment factors were frequently reported. Nearly all occupational and daily living incidents occurred on the ocean, while about half of recreational incidents occurred on lakes. Extremely cold water, strong winds, and rough or stormy wave conditions were reported for at least half of incidents, and cold was a probable factor for at least 68% of deaths. More than a third of incidents occurred during darkness or twilight.

Trends between 1991-1995 and 1995-2000 showed large reductions in drowning rates in British Columbia and the northern territories, an increase in Quebec, and no change in other regions.

UNPOWERED BOATS

Details of unpowered boating deaths are reported in detail in Module 4 of this series; however, for comparison with powerboating and for completeness, a brief summary for each type of unpowered boat, and for unpowered boating incidents on rivers, is included here.

Canoe deaths were attributed to young age; alcohol consumption; non-use of flotation devices among the vast majority of victims, including many weak and non-swimmers; extremely cold water; wind; waves; strong current; and darkness. Use of unstable boats by persons of limited swimming ability suggests a lack of awareness of basic water and boating safety.

For ***kayak*** deaths, environmental determinants predominated as causal factors, although only a third of victims were known to be wearing a flotation device.

For ***rafts,*** about half the deaths occurred in river rapids and current, often in extremely cold water. Considering the hazards of such conditions, it is surprising that so many rafters did not wear a flotation device.

For ***rowboats,*** non-wearing of a flotation device, cold immersion, alcohol, and poor swimming ability were the main factors leading to death.

For ***sailboats,*** non-wearing of a flotation device, cold immersion, and darkness were important factors.

River drownings in small unpowered boats including canoes, kayaks, and rafts primarily involved young males who capsized in strong current, often in extremely cold water. Non-wearing of a flotation device was reported for a majority of victims.

HOW TO AVOID BOATING INJURIES

Ten 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.

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 simple basic principles with which every boater should be familiar. Most deaths described in this report could have been averted by respect for the following fundamentals:

- 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 and 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;
- 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.

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. Hence 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.

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 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.

For traumatic injuries, even momentary 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 personal watercraft 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. Most fatalities involving personal watercraft, including drowning and trauma, resulted from collisions. Most passengers on high speed boats, as on motorcycles and snowmobiles, do not wear safety restraints; therefore, helmets should be mandatory as on other high-speed transport where passengers are unrestrained. Head injury could occur from falling off, and a brief concussion accompanied by immersion could be fatal. Hence powerboaters who travel at high speed need helmets as well as lifejackets that will keep the head out of the water in the event of a concussion. Hospital studies of trauma among personal watercraft users in the United States found that about half of victims sustained head injury; mandatory helmet use was recommended (Rubin et al., 2003, Jones 2000).

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 shows that non swimmers were even less likely than other boating victims to correctly wear flotation, at only 4% overall and only 2% for unpowered boaters

— 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 10% of boaters who drowned during 1991-2000 were wearing a flotation device. This is a major opportunity for prevention by good legislation and enforcement, and of course individual safety practices. Taking time in advance to choose and purchase an appropriate flotation device for the activity that is planned ensures 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. The greatest improvement during the 1990's was seen in the northern territories, where the rate was reduced by half. 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 this series, 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 *loss 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. Hence 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 they have an 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 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.

Hence 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 shore 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 21% of incidents, including 18% of powered and 28% of unpowered incidents, resulting in 386 deaths over 10 years. 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 help *avert about 20% of boating drownings per year, saving nearly 400 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 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 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, represents 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. The total potential savings would be about $4 billion during 10 years, i.e., about $400 million per year. While all of these 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 for an annual cost savings of about $330 million.

1 – Knowledge and **Safety Equipment** for Pre-event Phase Since many incidents involved neglect of elemental boating safety measures, knowledge and attitudes need to be improved; this is particularly important for powerboats which pose a risk to unpowered boaters and swimmers as well as to users. As of September 15, 2009, all recreational boaters must carry proof of competency when they operate any kind of powerboat; this requirement should be supported by appropriate training programs that are regularly evaluated and improved. Boat-specific issues — such the problem of off-throttle steering for personal watercraft — should be addressed. Flotation devices, cold immersion, the hazards of wind and waves on large lakes and current in rivers, and the use of a weather radio are other key issues that need mastery by at least one and preferably every occupant of the boat.

For unpowered boats, which are relatively harmless to other boaters and swimmers, training programs should emphasize the development — by both users and passengers — of specific water competencies for the most frequent activities, environments and hazards associated with unpowered boating.

2 – Safety Equipment for Event Phase Since a flotation device was properly worn by only 10% of victims, interventions mandating and enforcing flotation wearing by all boaters could have potentially averted up to 90%, or 1,623 of 1,803 drownings. This could be achieved by regulation and enforcement, together with research-based education and marketing. Policy makers should take note of recent research showing the critical need to keep the nose and mouth above the water surface in the immediate post-immersion phase, which strongly supports mandatory wearing. Powered boaters who travel at high speeds, especially personal watercraft users, should be protected by helmets, since many collisions are fatal. Even a brief loss of consciousness can lead to rapid drowning. High speed boaters should also use flotation devices that keep the nose and mouth out of water during temporary unconsciousness. At a cost saving of about $2 million per life saved, effective legislation and enforcement of appropriate flotation for the specific boating activity could have averted about $3.3 billion of economic losses in Canada during the decade, i.e., about $330 million per year.

3 – Safety Equipment for Post-event Phase Environment Factors – **Extremely Cold Water** Extremely cold water was associated with at least 40% of all drowning incidents — including about 34% of recreational, 50% of daily living, and 62% of occupational incidents — and with all deaths from immersion hypothermia without drowning. The use of appropriate protective equipment against cold immersion, including an appropriate flotation device as well as more specialized devices such as coats, wetsuits, dry suits, and immersion suits, could have averted most of these fatalities. Use of such equipment could be achieved by education, training, regulations, and enforcement.

4 – Personal Behaviour and **Marketing Factors** for Pre-event Phase – **Alcohol** Avoidance of alcohol could have averted at least 40% of deaths among boaters 15 years and older. Alcohol consumption could be discouraged through education, regulations, and enforcement, as well as restrictions on marketing.

5 – River Current, an Environment Risk Factor for Pre-Event, Event, and Post-event Phases of **Boating** Incidents – Protection by Enhancing Personal Knowledge, Attitude & Ability Boaters who choose to fish, paddle or travel in current need to be fully aware of the enormous kinetic energy of moving water, and how to use this energy to manoeuvre their boat and themselves safely at all times and avoid being trapped by this energy. Theory and practice in the boat to be used and in the water, under skilled supervision and controlled conditions, is essential prior to undertaking unsupervised boating activities in current, as is knowledge of specific river hazards such as dams, bridge pilings, and strainers.

CONCLUSION

From the above, it is clear that by an appropriate combination of preventive measures, the vast majority of boating deaths could be prevented, saving nearly 2,000 lives during a decade. Since most victims are young adult wage-earners, human capital costs of such losses are high. Conservatively estimating an economic loss of $2 million per life, losses total nearly $4 billion for the 10-year period of this research, about $2.5 billion for powered and $1.4 billion for unpowered. 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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Annex 1a

ANNUAL SUMMARY OF NUMBERS AND PERCENTS* FOR INJURY FATALITIES DURING BOATING, CANADA 1991-2000 (n=1,952)

	1991		1992		1993		1994		1995		1996		1997		1998		1999		2000		1991-2000	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
DROWNINGS	209	95	214	95	191	91	186	93	197	93	185	90	176	92	171	92	145	92	129	88	1.803	92
Recreational	**165**	**79**	**145**	**68**	**143**	**75**	**122**	**66**	**153**	**78**	**156**	**84**	**138**	**78**	**120**	**70**	**122**	**84**	**98**	**76**	**1,362**	**76**
Powerboat	89	54	98	68	93	65	65	53	89	58	76	49	81	59	70	58	78	64	57	58	796	58
♦ Small powerboat† (≤5.5m)	65		71		53		45		64		45		53		34		41		40		511	
♦ Large powerboat (>5.5m)	5		13		16		6		4		4		9		8		15		6		86	
♦ Personal watercraft	1		4		4		0		2		1		3		4		2		3		24	
♦ Powerboat, size unspecified	18		10		20		14		19		26		16		24		20		8		175	
Unpowered boat	76	46	47	32	50	35	57	47	64	42	80	51	57	41	50	42	44	36	41	42	566	42
♦ Canoe	40		33		21		37		39		39		27		25		16		24		301	
♦ Kayak	6		4		5		3		1		4		3		4		2		5		37	
♦ Rowboat	7		0		6		3		9		10		8		5		4		6		58	
♦ Raft/inflatable	3		2		3		5		4		6		8		4		5		2		42	
♦ Sailboat/sailboard	10		4		6		1		2		12		3		6		10		0		54	
♦ Other/unknown	10		4		9		8		9		9		8		6		7		4		74	
Daily living	**17**	**8**	**45**	**21**	**19**	**10**	**29**	**16**	**15**	**8**	**10**	**5**	**11**	**6**	**21**	**12**	**11**	**8**	**9**	**7**	**187**	**10**
Powerboat	14	82	34	76	11	58	21	72	8	53	8	80	8	73	14	67	3	27	2	22	123	66
♦ Small powerboat† (≤5.5m)	6		24		3		10		7		4		8		4		3		2		71	
♦ Large powerboat (>5.5m)	8		4		3		8		0		1		0		7		0		0		31	
♦ Powerboat, size unspecified	0		6		5		3		1		3		0		3		0		0		21	
Unpowered boat	3	18	11	24	8	42	8	28	7	47	2	20	3	27	7	33	8	73	7	78	64	34
♦ Canoe	2		6		6		1		5		0		2		5		5		2		34	
♦ Kayak	1		0		0		1		0		0		0		0		0		0		2	
♦ Rowboat	0		0		1		1		0		1		1		1		1		0		6	
♦ Raft/inflatable	0		1		0		0		0		0		0		0		0		0		1	
♦ Sailboat/sailboard	0		1		0		0		0		0		0		0		0		0		1	
♦ Other/unknown	0		3		1		5		2		1		0		1		2		5		20	
Occupational	**23**	**11**	**15**	**7**	**22**	**12**	**32**	**17**	**22**	**11**	**14**	**8**	**23**	**13**	**26**	**15**	**9**	**6**	**15**	**12**	**201**	**11**
Powerboat	19	83	11	73	17	77	29	91	21	95	14	100	21	91	23	88	9	100	15	100	179	89
♦ Small powerboat† (≤5.5m)	7		7		2		5		4		4		6		4		1		3		43	
♦ Large powerboat (>5.5m)	12		4		12		23		16		7		12		18		6		11		121	
♦ Personal watercraft	0		0		0		0		1		0		0		0		0		0		1	
♦ Powerboat, size unspecified	0		0		3		1		0		3		3		1		2		1		14	
Unpowered boat	4	17	4	27	5	23	3	9	1	5	0	0	2	9	3	12	0	0	0	0	22	11
♦ Canoe	0		1		0		1		1		0		0		1		0		0		4	
♦ Rowboat	1		0		1		1		0		0		1		0		0		0		4	
♦ Raft/inflatable	0		0		0		0		0		0		1		0		0		0		1	
♦ Other/unknown	3		3		4		1		0		0		0		2		0		0		13	
Attempting rescue	**0**	**0**	**2**	**1**	**6**	**3**	**1**	**1**	**5**	**3**	**1**	**1**	**2**	**1**	**2**	**1**	**3**	**2**	**6**	**5**	**28**	**2**
Other/unknown	**4**	**2**	**7**	**3**	**1**	**1**	**2**	**1**	**2**	**1**	**4**	**2**	**2**	**1**	**2**	**1**	**0**	**0**	**1**	**1**	**25**	**1**
NON-DROWNING FATALITIES‡	11	5	11	5	18	9	13	7	15	7	20	10	16	8	15	8	12	8	18	12	149	8
TOTAL	220	11	225	12	209	11	199	10	212	11	205	11	192	10	186	10	157	8	147	8	1,952	100

** Values in unshaded areas refer to shaded totals above; values in lighter shaded areas refer to darker shaded totals above; drowning and non drowning percents refer to bottom row totals; bottom row percents refer to 10-year total at right*
† Includes open outboard motorboats & other open powered boats such as inflatables; excludes personal watercraft
‡ Primary cause of death was injury other than drowning, although drowning may have complicated another injury; in case of hypothermia, only hypothermia deaths reportedly uncomplicated by drowning are included here

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Annex 1b

ANNUAL SUMMARY OF NUMBERS AND PERCENTS* FOR NON-DROWNING† INJURY FATALITIES DURING BOATING, CANADA 1991-2000 (n=149)

	1991		1992		1993		1994		1995		1996		1997		1998		1999		2000		1991-2000	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
NON-DROWNINGS	12	8	11	7	17	11	13	9	15	10	20	13	16	11	16	11	11	7	18	12	149	100
Hypothermia	**2**	**17**	**6**	**55**	**6**	**35**	**2**	**15**	**5**	**33**	**6**	**30**	**5**	**31**	**6**	**38**	**6**	**55**	**7**	**39**	**51**	**34**
Powerboat	0	0	5	83	5	83	2	100	3	60	4	67	4	80	1	17	6	100	4	57	34	67
♦ Small powerboat‡ (≤5.5m)	0		4		5		2		3		4		1		1		5		0		25	
♦ Large powerboat (>5.5m)	0		1		0		0		0		0		3		0		1		4		9	
Unpowered boat	2	100	1	17	1	17	0	0	2	40	2	33	1	20	5	83	0	0	3	43	17	33
♦ Canoe	0		1		0		0		2		2		1		2		0		3		11	
♦ Kayak	0		0		0		0		0		0		0		2		0		0		2	
♦ Raft/inflatable	1		0		0		0		0		0		0		0		0		0		1	
♦ Sailboat/sailboard	0		0		0		0		0		0		0		1		0		0		1	
♦ Other/unknown	1		0		1		0		0		0		0		0		0		0		2	
Collision	**7**	**58**	**3**	**27**	**9**	**53**	**10**	**77**	**8**	**53**	**11**	**55**	**9**	**56**	**6**	**38**	**4**	**36**	**9**	**50**	**76**	**51**
Powerboat	6	86	3	100	9	100	10	100	8	100	9	82	9	100	5	83	4	100	8	89	71	93
♦ Small powerboat‡ (≤5.5m)	0		2		4		7		1		2		3		1		0		3		23	
♦ Large powerboat (>5.5m)	2		0		1		1		5		1		2		0		1		3		16	
♦ Personal watercraft	3		0		0		1		2		5		4		3		2		1		21	
♦ Powerboat, size unspecified	1		1		4		1		0		1		0		1		1		1		11	
Unpowered boat	1	14	0	0	0	0	0	0	0	0	2	18	0	0	1	17	0	0	1	11	5	7
♦ Canoe	1		0		0		0		0		0		0		0		0		0		1	
♦ Sailboat/sailboard	0		0		0		0		0		1		0		1		0		0		2	
♦ Other/unknown	0		0		0		0		0		1		0		0		0		1		2	
Propeller injury	**1**	**8**	**0**	**0**	**1**	**6**	**0**	**0**	**1**	**7**	**1**	**5**	**1**	**6**	**1**	**6**	**0**	**0**	**0**	**0**	**6**	**4**
Powerboat	1	100	0		1	100	0		1	100	1	100	1	100	1	100	0		0		6	100
♦ Small powerboat‡ (≤5.5m)	0		0		0		0		0		0		0		1		0		0		1	
♦ Large powerboat (>5.5m)	1		0		0		0		1		0		0		0		0		0		2	
♦ Personal watercraft	0		0		1		0		0		0		1		0		0		0		2	
♦ Powerboat, size unspecified	0		0		0		0		0		1		0		0		0		0		1	
Fell/thrown overboard	**1**	**8**	**1**	**9**	**1**	**6**	**1**	**8**	**0**	**0**	**2**	**10**	**1**	**6**	**3**	**19**	**1**	**9**	**0**	**0**	**11**	**7**
Powerboat	0	0	1	100	1	100	0	0	0		1	50	1	100	3	100	0	0	0		7	64
♦ Small powerboat‡ (≤5.5m)	0		0		0		0		0		1		1		0		0		0		2	
♦ Large powerboat (>5.5m)	0		0		1		0		0		0		0		2		0		0		3	
♦ Powerboat, size unspecified	0		1		0		0		0		0		0		1		0		0		2	
Unpowered boat	1	100	0	0	0	0	1	100	0		1	50	0	0	0	0	1	100	0		4	36
♦ Raft/inflatable	1		0		0		0		0		0		0		0		1		0		2	
♦ Other/unknown	0		0		0		1		0		1		0		0		0		0		2	
Other/unknown	**1**	**8**	**1**	**9**	**0**	**0**	**0**	**0**	**1**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**11**	**5**	**3**
Powerboat	0	0	1	100	0		0		1	100	0		0		0		0		2	100	4	80
♦ Large powerboat (>5.5m)	0		0		0		0		1		0		0		0		0		2		3	
♦ Powerboat, size unspecified	0		1		0		0		0		0		0		0		0		0		1	
Unpowered boat	1	100	0	0	0		0		0	0	0		0		0		0		0	0	1	20
♦ Raft/inflatable	1		0		0		0		0		0		0		0		0		0		1	

** Values in unshaded areas refer to shaded totals above; values in lighter shaded areas refer to darker shaded totals above; top row percents refer to 10-year total at right*

† Primary cause of death was injury other than drowning, although drowning may have complicated another injury; in case of hypothermia, only hypothermia deaths reportedly uncomplicated by drowning are included here

‡ Includes open outboard motorboats & other open powered boats such as inflatables; excludes personal watercraft

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Annex 2a

REGIONAL SUMMARY OF NUMBERS AND PERCENTS* FOR INJURY FATALITIES DURING BOATING, CANADA 1991-2000 (n=1,952)

	NL		NS		PE		NB		QC		ON		MB		SK		AB		BC		NU/NT†		YT		CANADA	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
DROWNINGS	114	93	115	97	20	100	57	93	308	92	502	93	91	99	78	94	81	92	357	88	61	94	19	95	1,803	92
Recreational	61	54	67	58	11	55	38	67	260	84	433	86	62	68	55	71	74	91	267	75	20	33	14	74	1,362	76
Powerboat	25	41	37	55	7	64	22	58	151	58	279	64	37	60	33	60	36	49	150	56	14	70	5	36	796	58
♦ Small powerboat‡ (≤5.5m)	20		24		3		13		103		187		22		21		18		94		1		5		511	
♦ Large powerboat (>5.5m)	4		4		3		2		9		29		1		0		2		30		2		0		86	
♦ Personal watercraft	0		2		0		1		6		5		0		0		6		4		0		0		24	
♦ Powerboat, size unspecified	1		7		1		6		33		58		14		12		10		22		11		0		175	
Unpowered boat	36	59	30	45	4	36	16	42	109	42	154	36	25	40	22	40	38	51	117	44	6	30	9	64	566	42
♦ Canoe	9		13		1		10		62		99		15		12		22		46		3		9		301	
♦ Kayak	3		4		0		1		4		5		1		1		0		16		2		0		37	
♦ Rowboat	17		4		2		3		9		11		2		0		5		5		0		0		58	
♦ Raft/inflatable	1		1		0		0		4		7		0		3		4		22		0		0		42	
♦ Sailboat/sailboard	0		3		0		1		9		14		6		1		2		18		0		0		54	
♦ Other/unknown	6		3		1		1		21		18		1		5		5		10		1		0		74	
Daily living	6	5	6	5	0	0	2	4	27	9	42	8	19	21	13	17	3	4	29	8	36	59	4	21	187	10
Powerboat	5	83	4	67	0		1	50	16	59	37	88	11	58	4	31	0	0	19	66	26	72	0	0	123	66
♦ Small powerboat‡ (≤5.5m)	5		1		0		0		11		24		6		4		0		13		7		0		71	
♦ Large powerboat (>5.5m)	0		3		0		1		2		2		1		0		0		5		17		0		31	
♦ Powerboat, size unspecified	0		0		0		0		3		11		4		0		0		1		2		0		21	
Unpowered boat	1	17	2	33	0		1	50	11	41	5	12	8	42	9	69	3	100	10	34	10	28	4	100	64	34
♦ Canoe	0		0		0		0		6		2		7		8		1		3		3		4		34	
♦ Kayak	0		0		0		0		1		0		0		0		1		0		0		0		2	
♦ Rowboat	0		0		0		0		1		1		0		0		1		1		2		0		6	
♦ Raft/inflatable	0		0		0		0		0		1		0		0		0		0		0		0		1	
♦ Sailboat/sailboard	0		0		0		0		0		0		0		0		0		1		0		0		1	
♦ Other/unknown	1		2		0		1		3		1		1		1		0		5		5		0		20	
Occupational	43	38	36	31	7	35	14	25	13	4	13	3	9	10	6	8	3	4	54	15	2	3	1	5	201	11
Powerboat	40	93	35	97	6	86	13	93	10	77	10	77	6	67	5	83	1	33	51	94	1	50	1	100	179	89
♦ Small powerboat‡ (≤5.5m)	9		6		0		3		3		7		4		4		1		5		0		1		43	
♦ Large powerboat (>5.5m)	31		25		6		8		6		2		1		0		0		42		0		0		121	
♦ Personal watercraft	0		0		0		0		0		1		0		0		0		0		0		0		1	
♦ Powerboat, size unspecified	0		4		0		2		1		0		1		1		0		4		1		0		14	
Unpowered boat	3	7	1	3	1	14	1	7	3	23	3	23	3	33	1	17	2	67	3	6	1	50	0	0	22	11
♦ Canoe	0		0		0		0		1		0		2		1		0		0		0		0		4	
♦ Rowboat	2		0		1		0		0		0		1		0		0		0		0		0		4	
♦ Raft/inflatable	0		0		0		0		0		1		0		0		0		0		0		0		1	
♦ Other/unknown	1		1		0		1		2		2		0		0		2		3		1		0		13	
Attempting rescue	0	0	0	0	1	5	1	2	3	1	10	2	1	1	2	3	1	1	6	2	3	5	0	0	28	2
Other/unknown	4	4	6	5	1	5	2	4	5	2	4	1	0	0	2	3	0	0	1	0	0	0	0	0	25	1
NON-DROWNING FATALITIES§	8	7	3	3	0	0	4	7	27	8	39	7	1	1	5	6	7	8	50	12	4	6	1	5	149	8
TOTAL	122	6	118	6	20	1	61	3	335	17	541	28	92	5	83	4	88	5	407	21	65	3	20	1	1,952	100

** Values in unshaded areas refer to shaded totals above; values in lighter shaded areas refer to darker shaded totals above; drowning and non drowning percents refer to bottom row totals; bottom row percents refer to 10-year total at right*
† Data for Nunavut and Northwest Territories have been combined, since Nunavut was not a separate territory until 1999 ‡ Includes open outboard motorboats & other open powered boats such as inflatables; excludes personal watercraft
§ Primary cause of death was injury other than drowning, although drowning may have complicated another injury; in case of hypothermia, only hypothermia deaths reportedly uncomplicated by drowning are included here

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

Annex 2b

REGIONAL SUMMARY OF NUMBERS AND PERCENTS* FOR NON-DROWNING† INJURY FATALITIES DURING BOATING, CANADA 1991-2000 (n=149)

	NL		NS		PE		NB		QC		ON		MB		SK		AB		BC		NU/NT†		YT		CANADA	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
TOTAL	8	5	3	2	0	0	4	3	27	18	39	26	1	1	5	3	7	5	50	34	4	3	1	5	149	100
Hypothermia	**6**	**75**	**1**	**33**	**0**		**1**	**25**	**8**	**30**	**9**	**23**	**0**	**0**	**2**	**40**	**3**	**43**	**16**	**32**	**4**	**100**	**1**	**100**	**51**	**34**
Powerboat	5	83	1	100	0		1	100	4	50	5	56	0		1	50	2	67	11	69	4	100	0	0	34	67
♦ Small powerboat§ (≤5.5m)	5		1		0		0		4		3		0		1		2		9		0		0		25	
♦ Large powerboat (>5.5m)	0		0		0		1		0		2		0		0		0		2		4		0		9	
Unpowered boat	1	17	0	0	0		0	0	4	50	4	44	0		1	50	1	33	5	31	0	0	1	100	17	33
♦ Canoe	0		0		0		0		4		1		0		1		1		3		0		1		11	
♦ Kayak	0		0		0		0		0		2		0		0		0		0		0		0		2	
♦ Raft/inflatable	0		0		0		0		0		1		0		0		0		0		0		0		1	
♦ Sailboat/sailboard	0		0		0		0		0		0		0		0		0		1		0		0		1	
♦ Other/unknown	1		0		0		0		0		0		0		0		0		1		0		0		2	
Collision	**1**	**13**	**1**	**33**	**0**		**2**	**50**	**14**	**52**	**26**	**67**	**1**	**100**	**3**	**60**	**3**	**43**	**25**	**50**	**0**	**0**	**0**	**0**	**76**	**51**
Powerboat	1	100	1	100	0		2	100	14	100	25	96	1	100	3	100	3	100	21	84	0		0		71	93
♦ Small powerboat§ (≤5.5m)	0		1		0		0		4		6		0		2		1		9		0		0		23	
♦ Large powerboat (>5.5m)	0		0		0		1		3		7		0		0		0		5		0		0		16	
♦ Personal watercraft	1		0		0		1		3		5		1		1		2		7		0		0		21	
♦ Powerboat, size unspecified	0		0		0		0		4		7		0		0		0		0		0		0		11	
Unpowered boat	0	0	0	0	0		0	0	0	0	1	4	0	0	0	0	0	0	4	16	0		0		5	7
♦ Canoe	0		0		0		0		0		1		0		0		0		0		0		0		1	
♦ Sailboat/sailboard	0		0		0		0		0		0		0		0		0		2		0		0		2	
♦ Other/unknown	0		0		0		0		0		0		0		0		0		2		0		0		2	
Propeller injury	**0**	**0**	**0**	**0**	**0**		**0**	**0**	**2**	**7**	**2**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**4**	**0**	**0**	**0**	**0**	**6**	**4**
Powerboat	0		0		0		0		2	100	2	100	0		0		0		2	100	0		0		6	100
♦ Small powerboat§ (≤5.5m)	0		0		0		0		0		1		0		0		0		0		0		0		1	
♦ Large powerboat (>5.5m)	0		0		0		0		1		1		0		0		0		0		0		0		2	
♦ Personal watercraft	0		0		0		0		1		0		0		0		0		1		0		0		2	
♦ Powerboat, size unspecified	0		0		0		0		0		0		0		0		0		1		0		0		1	
Fell/thrown overboard	**0**	**0**	**1**	**33**	**0**		**1**	**25**	**2**	**7**	**2**	**5**	**0**	**0**	**0**	**0**	**1**	**14**	**4**	**8**	**0**	**0**	**0**	**0**	**11**	**7**
Powerboat	0		1	100	0		1	100	1	50	2	100	0		0		0	0	2	50	0		0		7	64
♦ Small powerboat§ (≤5.5m)	0		0		0		1		1		0		0		0		0		0		0		0		2	
♦ Large powerboat (>5.5m)	0		1		0		0		0		1		0		0		0		1		0		0		3	
♦ Powerboat, size unspecified	0		0		0		0		0		1		0		0		0		1		0		0		2	
Unpowered boat	0		0	0	0		0	0	1	50	0	0	0		0		1	100	2	50	0		0		4	36
♦ Raft/inflatable	0		0		0		0		0		0		0		0		1		1		0		0		2	
♦ Other/unknown	0		0		0		0		1		0		0		0		0		1		0		0		2	
Other/unknown	**1**	**13**	**0**	**0**	**0**		**0**	**0**	**1**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**6**	**0**	**0**	**0**	**0**	**5**	**3**
Powerboat	1	100	0		0		0		1	100	0		0		0		0		2	67	0		0		4	80
♦ Large powerboat (>5.5m)	1		0		0		0		1		0		0		0		0		1		0		0		3	
♦ Powerboat, size unspecified	0		0		0		0		0		0		0		0		0		1		0		0		1	
Unpowered boat	0	0	0		0		0		0	0	0		0		0		0		1	33	0		0		1	20
♦ Raft/inflatable	0		0		0		0		0		0		0		0		0		1		0		0		1	

** Values in unshaded areas refer to shaded totals above; values in lighter shaded areas refer to darker shaded totals above; top row percents refer to 10-year total at right † Primary cause of death was injury other than drowning, although drowning may have complicated another injury; in case of hypothermia, only hypothermia deaths reportedly uncomplicated by drowning are included here ‡ Data for Nunavut and Northwest Territories have been combined, since Nunavut was not a separate territory until 1999 § Includes open outboard motorboats & other open powered boats such as inflatables; excludes personal watercraft*

Source: The Canadian Red Cross Society & the Canadian Surveillance System for Water-Related Fatalities, 2009

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SEARCH AND RESCUE / RECHERCHE ET SAUVETAGE

For more information, please contact:

Canadian Red Cross

170 Metcalfe Street, Suite 300
Ottawa, Ontario, Canada K2P 2P2
(613) 740-1900 Fax: (613) 740-1911

www.redcross.ca

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