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TRENDS IN RECREATIONAL BOATING FATALITIES

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COVER

Advanced swiftwater rescue training held in the snow on the Nantahala River, NC, in April 2021. This advanced training teaches recreational paddlers how to prevent and respond to emergencies....

TRENDS IN US RECREATIONAL BOATING FATALITIES: CAUSES, CONTRIBUTING FACTORS, AND EVIDENCE-BASED STEPS FOR PREVENTION

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ABSTRACT

Recreational boating is enjoyed by millions of people each year but each year thousands are involved in boating accidents causing hundreds of fatalities and millions of dollars in property damage. The annual number of boating accidents and fatalities is lower in 2019 than in 1991, but during the decade 2010 to 2019, that decline has essentially stopped. To further reduce recreational boating accidents, the types of accidents and their contributing factors must be understood.

The most common boating accidents are collisions but the most common fatal boating accidents are unexpected entry into the water (capsizing and falling overboard) associated with alcohol consumption, hazardous waters, inattention, and inexperience. Life jacket wear and boating education are not considered by the USCG as independent contributing factors but the majority of subjects who die while boating are not wearing a lifejacket and have not obtained boating education. Open motorboats account for nearly half of all boating fatalities and open motorboats, kayaks, canoes, and PWCs account for nearly three-quarters of all boating fatalities. Core boating instruction appropriate for all craft can be developed with this data. These educational interventions may be most effective if they include core knowledge, vessel-specific information, and opportunities to gain experience while applying the knowledge

INTRODUCTION

Recreational boating is enjoyed by tens of millions of people in the United States. Most boaters have enjoyable and uneventful experiences on the water. However, each year, thousands are involved in boating accidents, leading to millions of dollars of property damage and hundreds of boater fatalities. To prevent these accidents, it is necessary to understand what types of accidents occur and why they happen.

Below, publicly available data, along with additional data obtained by querying the Boating Accident Report Database, is examined to determine trends in boating fatalities and participation. Then, common contributing factors and accident types for boating accidents and fatalities between 2010 and 2019 are evaluated, creating a baseline for future work. Finally, evidence-based recommendations intended to prevent future accidents and fatalities are offered. Evidence-based education, with course content explicitly developed in response to boating fatality data, might further reduce the annual number of boating fatalities, as well as reduce boating-related accidents, injuries, and property damage. Future communication will compare the 2010 - 2019 results with data from 2020 forward and specifically consider the impact of the Covid-19 pandemic.

METHODS AND DATA

Boating participation data was taken from the 2011, 2012, and 2018 National Recreational Boating Safety Surveys, available at https://uscgboating.org/statistics/national-recreational-boating-safety-survey.php. Further information was taken from the Outdoor Foundation's 2021 outdoor participation trends report, found at https://americancanoe.org/wp-content/uploads/2021/07/2021-Outdoor-Participation-Trends-Report.pdf.

Recreational boating statistics published by the US Coast Guard's Boating Safety Division (https://uscgboating.org/statistics/accident_statistics.php) and additional data from the Boating Accident Reporting Database were examined to evaluate accident types and contributing factors leading to recreational boating fatalities. Data was transcribed to an Excel spreadsheet and Excel tools were used for analysis. Table 1 below shows tables from the Recreational Boating Statistics used for evaluation in this report.

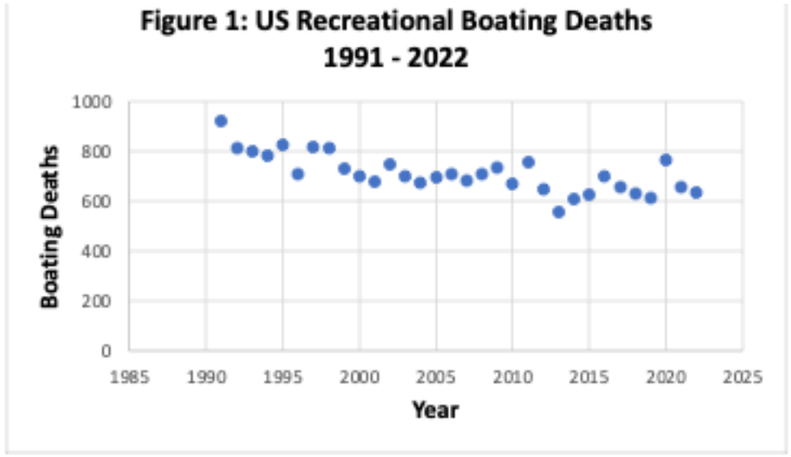
TABLE 1: Information sources from Recreational Boating Statistics (https://uscgboating.org/statistics/accident_statistics.php)

Source	Information Extracted
Table 5	Contributing factors to accidents, injuries, and deaths for all craft combined
Table 7	Contributing factors to accidents, injuries, and deaths by craft type
Table 16	Accident type and casualty numbers for all craft combined
Table 19	Accident types by craft type
Table 23	Educational status of boaters involved with accidents, injuries, and fatalities
Table 29	Historical numbers of boating accidents, injuries, and fatalities
Table 31	Number of registered vessels
Table 35	Cause and number of deaths by craft type and PFD wear

RESULTS AND DISCUSSION

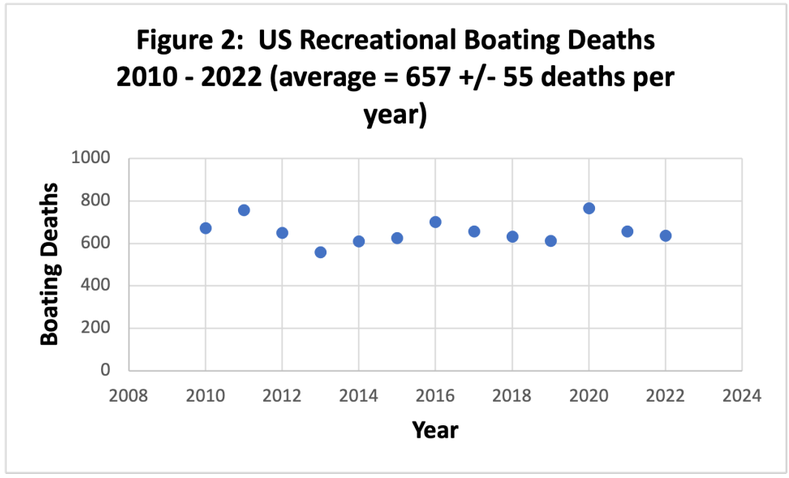
Overall Boating Deaths

924 recreational boating death were reported in 1991. The number of annual boating deaths has generally declined ever since (Figure 1), reaching a low point of 560 deaths in 2013.



This steady decline in fatalities is likely due to a wide range of interventions, including mandatory life jacket wear in some venues, mandatory education for some boaters, and increased availability of boating education programs. Manufacturing improvements, along with improved communication, navigation, rescue, and weather alert systems, also likely contributed.

Unfortunately, as shown in Figure 2, the decline in fatalities seen since 1991 appears to have plateaued or even, if measured since the low point in 2013, reversed. This could indicate increases in boating participation (e.g., more people on the water leading to more deaths) or changes in boating habits (e.g., more time on the water). It also might indicate that the effectiveness of current interventions has reached its maximal effectiveness and that new, additional interventions are needed.



Boating Deaths by Type of Vessel

To evaluate the need for specific new interventions, it is important to understand fatality trends for specific vessels. Figures 3, 4, and 5 show trends in boating deaths, from 2010 to 2019, for motorized, sail-powered, and human-propelled craft. Motorized vessels contributed an average of 65.9 +/- 2.0% of all recreational boating fatalities, sailboats contributed an average of 3.3 +/- 0.7%, and human-propelled craft contributed an average of 28.3 +/- 1.7%. There was no clear trend year-to-year for motorized vessels. The contribution of paddlecraft (canoes, kayaks, and SUPs) to boating fatalities dropped from 21.0% in 2010 to 16.1% in 2012. They then increased to 23.8% in 2016 before dropping to 22.4% in 2019. Overall, paddlecraft showed an average annual increase of about 3 fatalities or about 0.4% of all boating deaths. Sailing vessels showed a slight decrease, from 3.4% to 2.9%, in their contribution to overall boating fatalities during the decade.

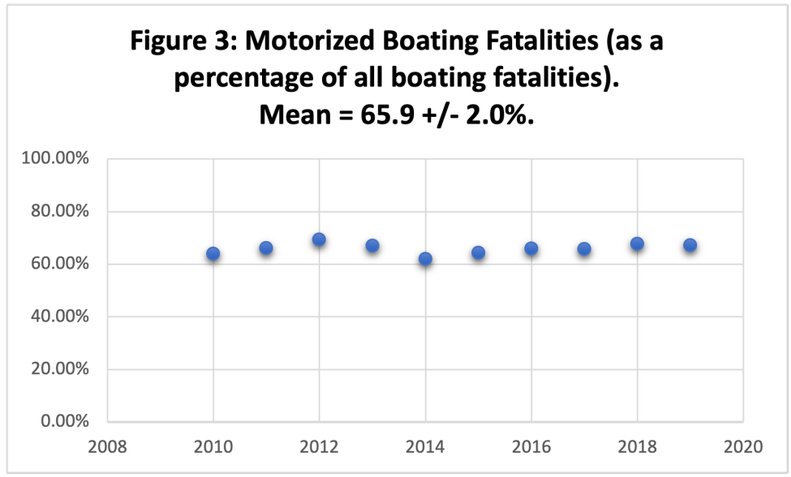


Table 2 shows the contribution of each type of motorized craft to overall boating fatalities between 2010 and 2019. Open motorboats are responsible for nearly half of all boating deaths and more than 70% of all deaths associated with motorized craft

Table 2: Motorized vessel contribution to boating fatalities 2010 - 2019

Vessel Type	Percentage contribution to total recreational boating deaths
Total	**65.9%**
Airboat	0.4%
Cabin Motorboat	5.8%
Houseboat	0.6%
Open Motorboat	47.1%
Personal Watercraft	6.5%
Pontoon Boat	5.5%

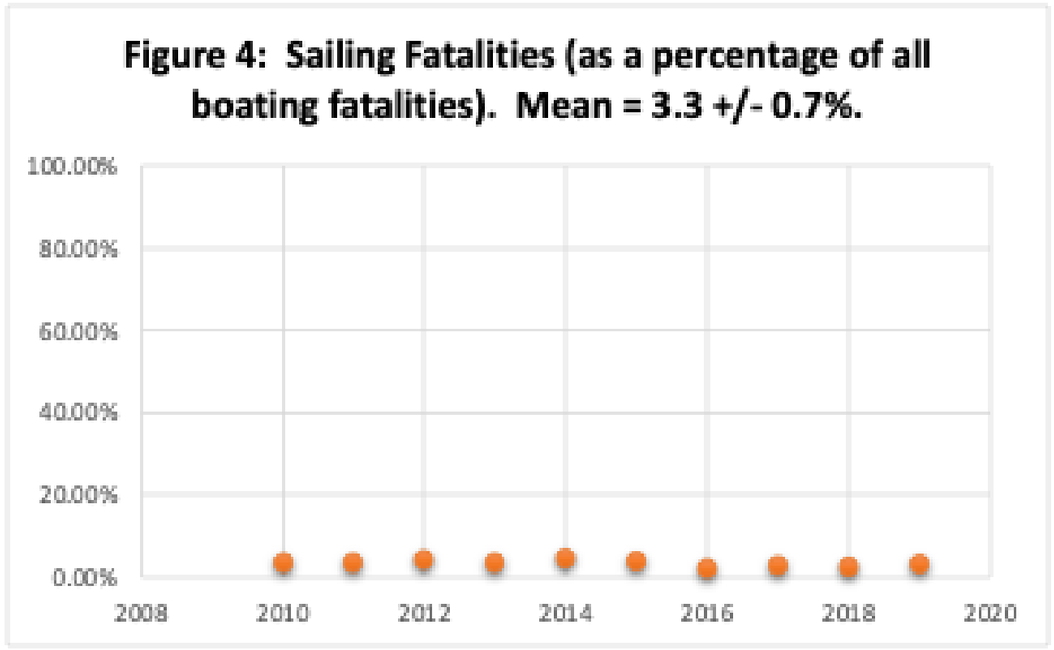


Table 3 shows the contribution of various types of sailboats to overall recreational boating deaths between 2010 and 2019. The total contribution from sailing vessels is consistently small. This likely reflects both the small size of the sailing community relative to other types of craft and the level of training required to operate a sailboat.

Table 3: Sailboat contributions to boating fatalities 2010 - 2019

Vessel Type	Percentage contribution to total recreational boating deaths
Total	**3.3%**
Auxiliary Sailboat	2.0%
Sailboat (only)	1.0%
Sailboat (unknown propulsion)	0.2%

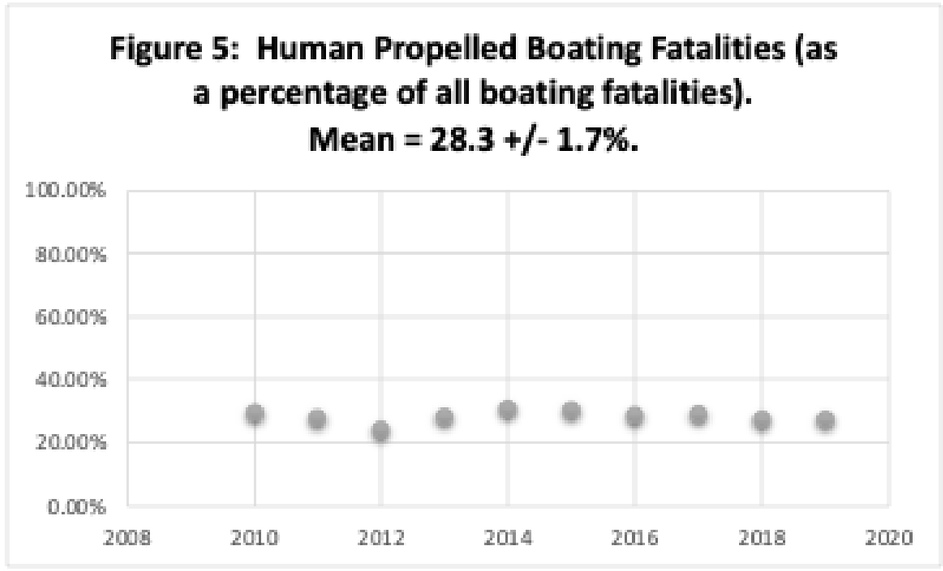
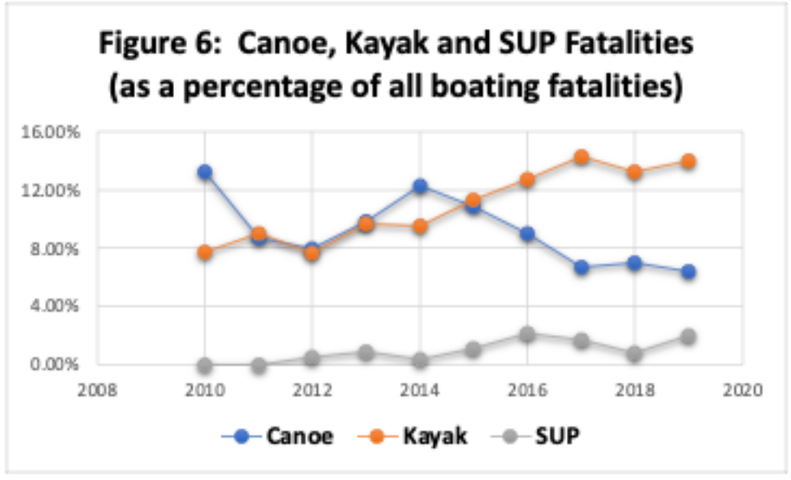


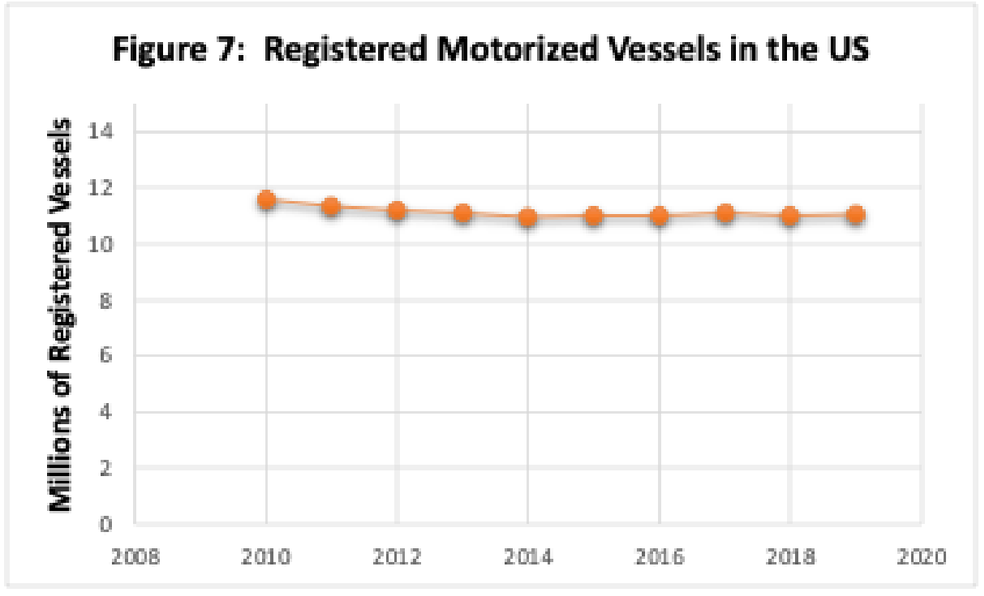
Table 4 shows the contribution of various types of human-propelled craft to overall recreational boating deaths between 2010 and 2019. Human-propelled craft contributed 28.3% of all recreational boating fatalities during the decade whereas paddlecraft (canoes, kayaks, and SUPs) contributed 21.0%. When canoes, kayaks, and SUPs are summed, there appears to be a slight annual increase (about 0.4% per year) in their contribution to total recreational boating fatalities between 2010 and 2019.

Table 4: Human-propelled vessel contributions to boating fatalities 2010 - 2019

Vessel Type	Percentage contribution to total recreational boating deaths
Total	**28.3%**
Total Paddlecraft (canoe, kayak, SUP)	**21.0%**
Canoe	9.2%
Inflatable	3.2%
Kayak	10.9%
Rowboat	4.1%
Stand Up Paddleboard	0.9%

When examined on an individual craft basis, all vessels show year-to-year variability but only three – canoes, kayaks, and SUPs – show clear trends across the decade (Figure 6). The contribution of canoeing fatalities decreased steadily from 13% in 2010 to 6% in 2019. In contrast, the contribution of kayaking fatalities increased from 8% to 14% and the contribution of SUP fatalities increased from 0% to 2% over the same time frame. The decrease in canoeing fatalities nearly balances out the increases in kayaking and SUP fatalities.





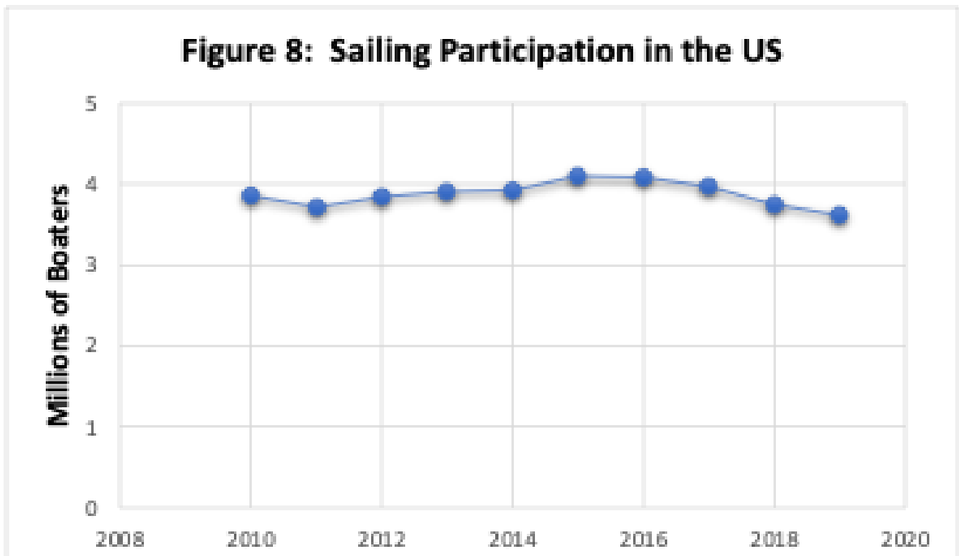
Participation

The National Recreational Boating Safety Survey (NRBSS) was conducted in 2011, 2012 and 2018. These surveys show recreational boating participation in the US grew from 73,560,000 participants (23.8% of the US population) in 2011 to 84,544,000 participants (26.5% of the US population) in 2018.

Reports showing year-to-year changes in the use of motorized vessels overall, or in specific types of motorized vessels, are difficult to find. However, NRBSS reports from 2011, 2012, and 2018 do provide valuable snapshots. The 2011 NRBSS report suggests as many as 71.9% of boaters, or about 52,890,000 people, used motorized vessels in 2011. In 2012, 70.4% of boaters, or about 52,474,000 people, are believed to have used motorized vessels. The 2018 NRBSS exposure report does not indicate the percentage of boaters who use motorized craft. However, multiplying the number of outings by the average number of people aboard and then dividing by the average number of outings per craft type yields an estimate of about 54,826,000 people using motorized vessels, or about 65% of the boating population.

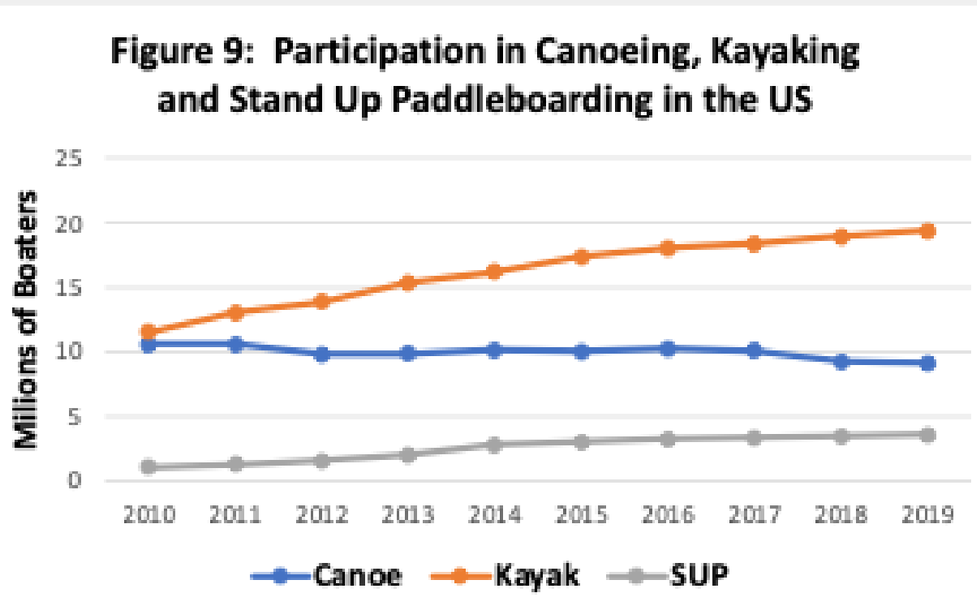
To obtain a year-to-year estimate of motorized vessel participation, the number of registered motorized vessels can be used as a proxy. This number is closely tracked for tax purposes, and numbers from each year are published in the Recreational Boating Statistics. Figure 7 shows there has been a slight decrease in annual motorboat registration, from 11.6 million in 2010 to 11.1 million in 2019. NRBSS data suggest that motorized craft are used, on average, by 3 people at a time, suggesting that as few as 35 million people boat each year about motorized vessels. In contrast, data from NRBSS reports described above suggests powerboat participation is closer to 55 million people per year. Several factors might be responsible for the two different estimates. For example, although the average powerboat outing involves three people, those might not always be the same people. In particular, the use of rental boats might lead to an increased number of people using a registered vessel, and yield higher overall participation numbers for motorized craft. Changes in the distribution of vessels (e.g., increases in pontoon boat operation, carrying several people, relative to PWC operation, carrying a single person) also might increase the average number of people aboard motorized vessels.

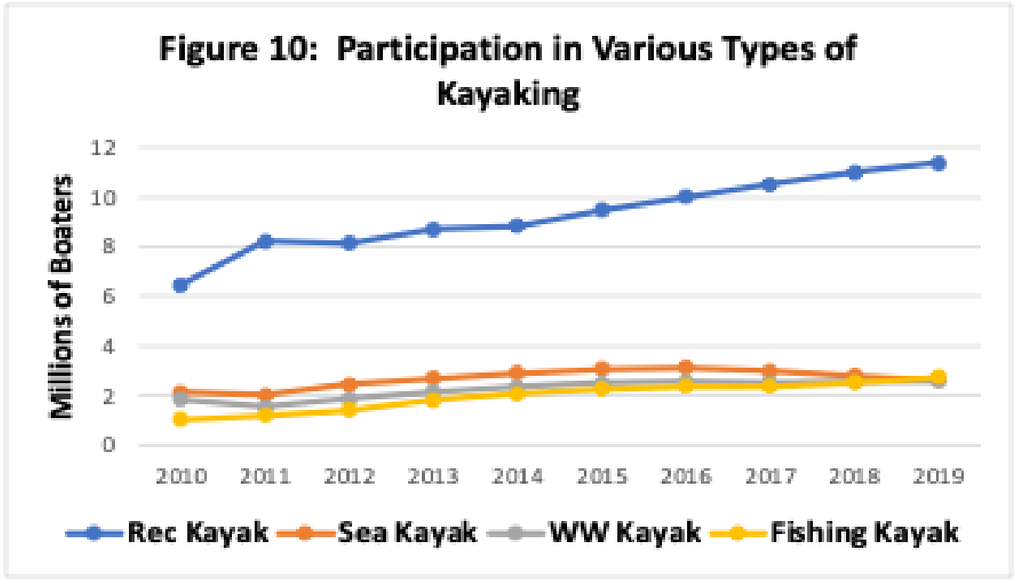
Data from the Outdoor Foundation track sailing, canoeing, kayaking, and SUP participation on an annual basis. Sailing participation rose from 3.9 million boaters in 2010 to 4.1 million in 2015 and 2016, before dropping to 3.6 million in 2019 (Figure 8). The 2018 NRBSS data suggest 3.7 million people participated in sailing in 2018. Outdoor Foundation data suggest about 3.8 million people sailed in 2018, closely agreeing with NRBSS data.



Participation in canoeing, kayaking, sailing and stand up paddleboarding has been directly tracked by the Outdoor Foundation, whereas data describing rowing and inflatable participation are difficult to find. OF's data (shown in Figure 9) suggest kayaking participation (including recreational, sea, whitewater, and fishing kayaks) grew from 11.5 million participants in 2010 to 19.4 million in 2019, an average increase of about 790,000 participants per year. SUP participation also grew, rising from 1.1 million in 2010 to 3.6 million in 2019, an average increase of 250,000 participants per year. Canoeing participation, on the other hand, decreased from 10.6 million in 2010 to 9.1 million in 2019, an average decrease of about 150,000 participants per year. Recreational kayaking, generally done with inexpensive boats that have little internal flotation, is consistently the most popular type of kayaking (Figure 10) and grew by about 490,000 paddlers each year. OF data are consistent with 2018 NRBSS data that suggest 33.1 million people – 39% of the recreational boating community – used paddlecraft in 2018.

Figure 9: Participation in Canoeing, Kayaking and Stand Up Paddleboarding in the US





Between 2011 and 2018, NRBSS data show boating participation grew by about 1.57 million people per year. Over that same time frame, paddling participation grew by about 900,000 people per year. It appears that nearly 60% of the increase in boating participation between 2011 and 2018 was due to growth in kayak and SUP paddling.

Participation vs. Fatalities

Figure 11 presents motorized vessel fatalities as a function of registered motorized vessels. There is little variation in the number of registered vessels or deaths aboard motorized vessels. Year-to-year scatter could represent changes in time spent on the water, in life jacket wear, or activities done on the water.

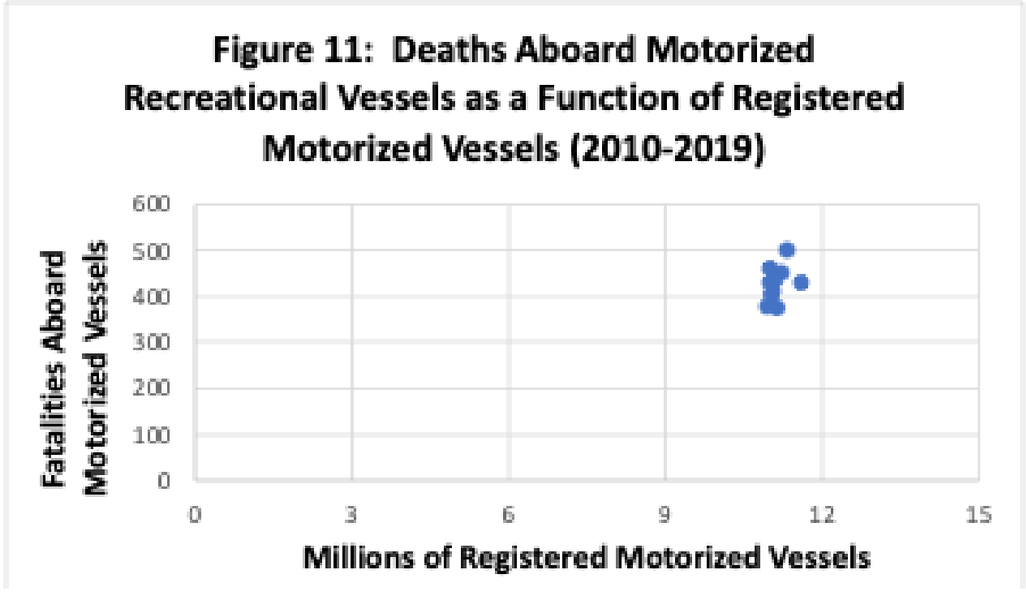
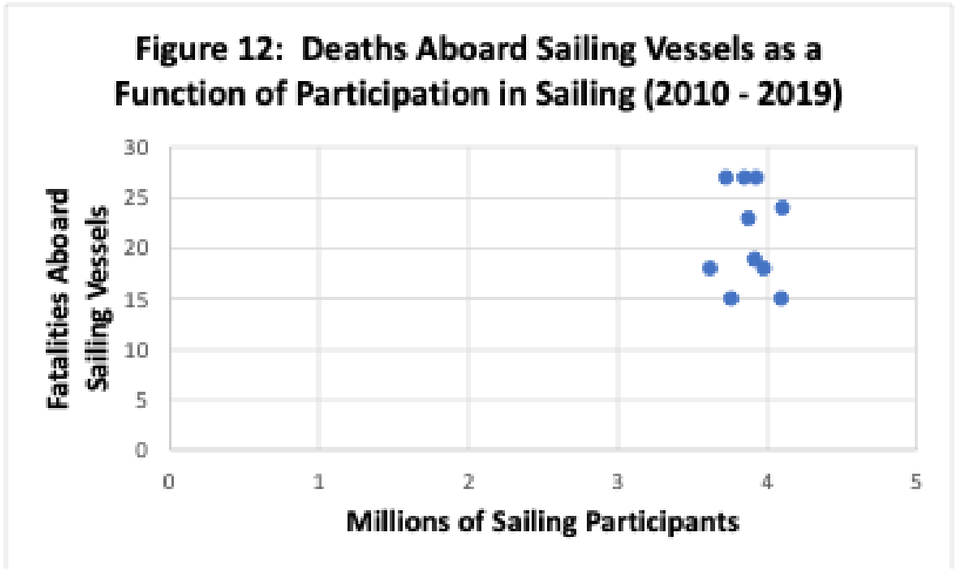
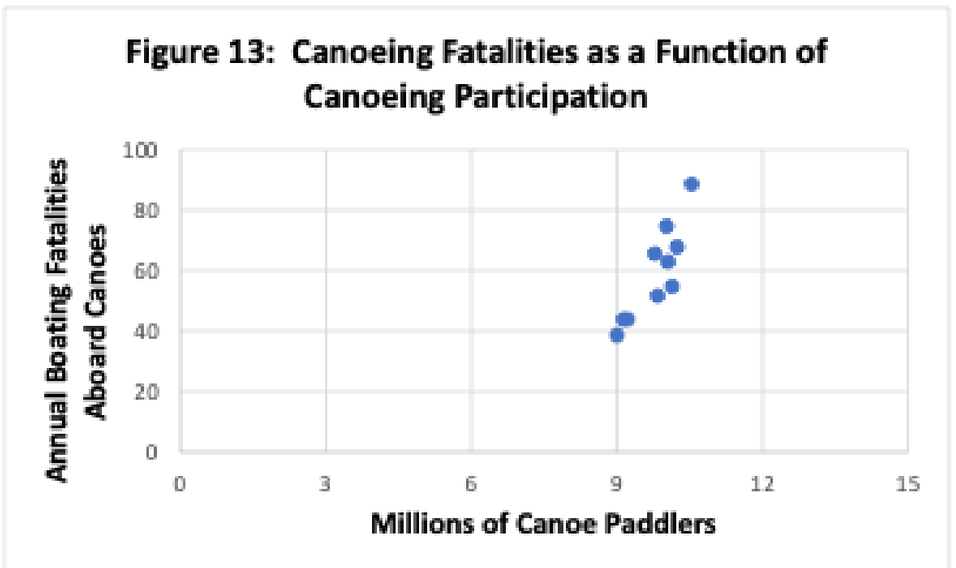
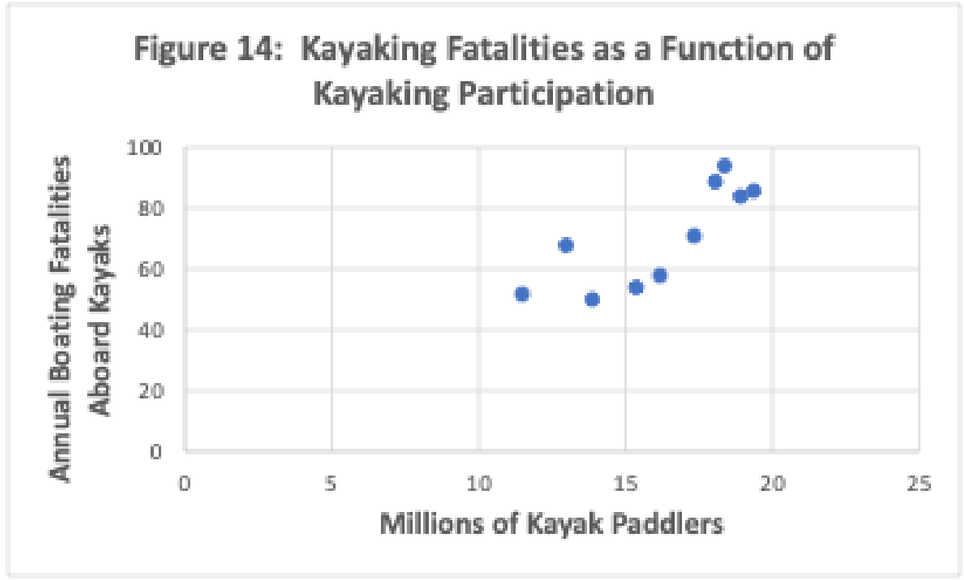


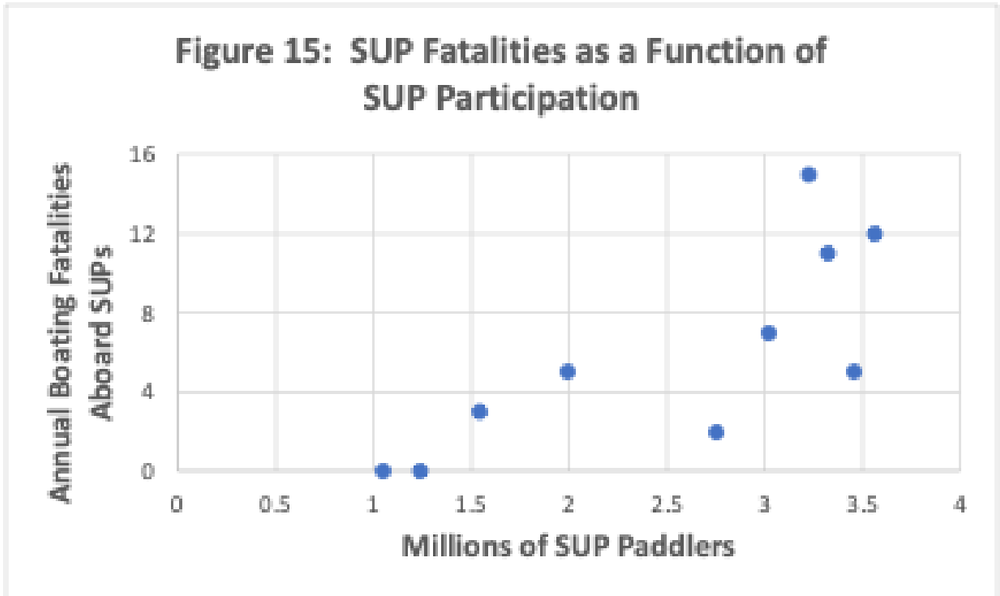
Figure 12 presents fatalities aboard sailing vessels as a function of sailing participation. As with motorized vessels, scatter about a central point is noted, but no there is no clear trend in annual fatalities due to changes in participation.



Data showing rowing and inflatable craft participation is not available. However, direct comparisons between participation and fatalities for canoes, kayaks, and SUPs are shown in figures 13, 14, and 15 below. These vessels all show that as participation increased, annual fatalities also increased. The increase in kayak and SUP participation, and the associated increase in boating fatalities, is likely one reason why annual boating fatalities are no longer steadily decreasing.







Fatal Accident Types

Between 2010 and 2019, drowning was the cause of death in 70.4% of recreational boating fatalities (4566 out of 6482). Traumatic injuries were responsible for an additional 15.4% of boating deaths (1018 out of 6482). Cardiac arrest, carbon monoxide poisoning, hypothermia, and other unclassified causes were responsible for the remaining fatalities. The cause of death and percentage of deceased subjects wearing a life jacket does not show clear interannual trends.

Life Jacket Wear

Out of 4566 drownings between 2010 and 2019, life jacket wear was unknown in 192 cases. Where it was known, 81.0% of subjects (3698 out of 4566) who drowned were not wearing a life jacket. In an additional 4% of cases (192 out of 4566), life jacket wear by drowning subjects was unknown. Over the same time frame, 1018 deaths (15.7% of all boating deaths) occurred due to traumatic injuries while boating. Out of these, life jacket wear was unknown in 84 cases. Where it was known, 59% (555 out of 934) of subjects who died due to traumatic injury were not wearing a life jacket.

Impact of Education

Boating education is widely believed to reduce the likelihood of boating accidents, injuries, and fatalities. In response, many states have implemented mandatory boating education for operators of motorized vessels. Despite this, in 49% of cases between 2010 and 2019, the educational status of the vessel operator involved with a fatality is unknown. Over the same decade, in the 51% of cases where education status was known, 77% of boating deaths occurred to boaters who had no boating education.

Causes and Contributing Factors to Overall Boating Accidents and Deaths

Tables 5 and 6 below show commonly reported accident types (including those that cause fatalities, injuries, and property damage) and fatal accident types. The most reported type of boating accident is a collision with another recreational vessel, accounting for 24% of all boating accidents but only 6.7% of fatal boating accidents. In contrast, the most frequently reported types of fatal accidents are falling overboard (27.5%) and capsizing (22.9%), but these account respectively for only 6.9% and 6.7% of all boating accidents. Unexpected entry into the water, due to capsizing, falling overboard, sinking, or being ejected from a vessel, accounts for nearly two-thirds of all boating fatalities but less than a third of all boating accidents.

Table 5: Top 10 boating accident types, 2010-2019, for all types of boats aggregated. The cumulative percentage for a given rank is the sum of all percentages from that rank and all lower ranks (e.g., the cumulative percentage for collision with a fixed object is 11% plus 23.9%). "Other" and "Unknown" categories are not included.

Accident Type and Rank	Number of Accidents	Percent of Total Accidents	Cumulative Percentage of Accidents
All types	43058		
1. Collision with recreational vessel	10269	23.9%	23.9%
2. Collision with fixed object	4738	11.0%	34.9%
3. Flooding / swamping	4547	10.6%	45.5%
4. Grounding	3738	8.7%	54.1%
5. Skier mishap	3221	7.5%	61.6%
6. Falling overboard	2965	6.9%	68.5%
7. Capsize	2874	6.7%	75.2%
8. Ejected	1814	4.2%	79.4%
9. Fall in Vessel	1805	3.7%	83.1%
10. Fire / Explosion (fuel)	1508	3.5%	86.5%

Table 6: Top ten accident types leading to recreational boating deaths, across all types of craft. The cumulative percentage for a given rank is the sum of the percentages from that rank and all lower ranks (e.g., the cumulative percentage for capsizing is 22.9% plus 26.5%). "Other" and "Unknown" categories are not included.

Accident type	Number of Deaths	Percentage of Total Deaths	Cumulative Percentage of Deaths	Percentage of Deaths that are Drownings
All types	6482			70.4%
1. Falling overboard	1715	26.5%	26.5%	77.2%
2. Capsizing	1482	22.9%	49.3%	85.1%
3. Flooding / swamping	701	10.8%	60.1%	82.2%
4. Departed vessel	617	9.5%	69.7%	86.7%
5. Collision with fixed object	543	8.4%	78.0%	51.8%
6. Collision with recreational vessel	437	6.7%	84.8%	14.7%
7. Ejected	289	4.5%	89.2%	70.6%
8. Grounding	145	2.2%	91.5%	40.7%
9. Skier Mishap	126	1.9%	93.4%	42.1%
10. Collision with Submerged Object	56	0.9%	94.9%	80.4%

Although most boating fatalities are due to drowning, there is considerable variation depending on accident type. Accident types that lead to a person in the water (e.g., falling overboard, vessel departure) are much more likely to lead to drowning than those likely to cause traumatic injury (e.g., collisions with recreational vessels).

Common contributing factors for boating fatalities involving all types of boats are shown in Table 7. None of the contributing factors show clear interannual variation. In every year examined, alcohol consumption has been the leading contributing factor for total fatal boating accidents. Hazardous waters, bad weather, operator inattention, and operator inexperience also are common contributing factors to fatal accidents.

Table 7: Top ten contributing factors for recreational boating deaths, across all types of craft. The cumulative percentage for a given rank is the sum of the percentages from that rank and all lower ranks (e.g., the cumulative percentage for capsizing is 22.9% plus 26.5%). "Other" and "Unknown" categories are not included; they were assigned as contributing factors in 21.9% of boating deaths.

Primary Contributing factor	Total Number of Deaths	Percentage of Total Deaths	Cumulative Percentage of Deaths
All	6482		
1. Alcohol	1037	16.0%	16.0%
2. Hazardous Waters	686	10.6%	26.6%
3. Operator Inattention	483	7.5%	34.1%
4. Operator Inexperience	446	6.9%	41.0%
5. Weather	415	6.4%	47.4%
6. Excess Speed	234	3.6%	51.0%
7. Overloading	224	3.5%	54.5%
8. Improper Lookout	219	3.4%	57.9%
9. Improper Loading	218	3.4%	61.3%
10. Sudden Medical Issue	182	2.8%	63.1%

When all types of boats are considered, drowning is the most common cause of death while boating, and unexpected entry into the water (capsize, falling overboard, flooding/swamping, and ejection) is the most common type of fatal accident. Voluntary vessel departure – deliberately jumping off a boat into the water – leads to another 9.5% of all boating fatalities. Collisions of all kinds contribute to 16% of all boating fatalities.

Alcohol consumption is the most common contributing factor for boating fatalities, followed by exposure to hazardous waters, operator inattention, and operator inexperience. Failure to wear a life jacket and failure to obtain boating education are not considered distinct contributing factors but are strongly associated with an elevated risk of fatal accidents. Nearly all contributing factors leading to boating deaths are directly under the vessel operator's direct control (e.g., alcohol consumption, operator inattention) or could reasonably be prevented by a vessel operator (e.g., exposure to hazardous waters or bad weather). Of the ten most often reported contributing factors for fatal boating accidents, only sudden medical issues, accounting for only 2.8% of deaths, might be considered out of the vessel operator's direct control.

Craft Specific Trends.

General educational programs are likely to reduce boating fatalities but interventions targeted at the risks involved with specific craft might lead to even great reductions. Nearly three-quarters of all boating fatalities between 2010 and 2019 involved only four types of craft - open motorboats, kayaks, canoes, and personal watercraft (Table 8). Open motorboats alone accounted for nearly half of all fatal accidents. Focusing efforts on these four types of vessels is likely to yield interventions that would impact other types of craft, and decrease overall boating deaths.

Table 8: Craft most involved with fatal boating accidents between 2010 and 2019.

Craft	Total Number of Deaths	Percentage of Total Deaths	Cumulative Percentage of Deaths	Percentage of Deaths Due to Drowning
All	6482			70.4%
1. Open Motorboats	3051	47.1%	47.1%	67.8%
2. Kayak	706	10.9%	58.0%	83.4%
3. Canoe	595	9.2%	67.2%	90.4%
4. Personal Watercraft	423	6.5%	73.7%	35.5%
5. Cabin Motorboat	377	5.8%	79.5%	54.4%
6. Pontoon Boat	359	5.5%	85.0%	78.3%
7. Rowboat	265	4.1%	89.1%	88.3%
8. Inflatable	207	3.2%	92.4%	87.9%
9. Auxiliary Sailboat	131	2.0%	94.4%	62.6%
10. Sail (only)	67	1.0%	95.4%	59.7%

Open motorboats

Between 2010 and 2019, open motorboats accounted for 47.1% of all boating fatalities (Table 8). There was no clear trend from year to year. Of those deaths, 67.8% occurred due to drowning and 86.7% of drowning subjects were not wearing a lifejacket. Collisions with other recreational vessels contribute 29% of open motorboat accidents, but only 7.3% of fatal accidents (Table 9). In contrast, falling overboard contributes only 5.1% of open motorboat accidents but is associated with 27.7% of fatal accidents.

Table 9: Five most common types of fatal open motorboat accidents, 2010-2019. "Other" and "Unknown" are not included but account for less than 1.0% of accidents.

Accident Type	Number of Fatalities	Percentage of Fatalities	cumulative percentage
Total	3051		
Falls overboard	844	27.7%	27.7%
Flooding/swamping	470	15.4%	43.1%
Capsizing	367	12.0%	55.1%
Collision with fixed object	292	9.6%	64.7%
Person voluntarily departed vessel	273	9.0%	73.6%

Leading contributing factors for fatal open motorboat accidents (Table 10) include alcohol consumption (16.3%) and operator inattention (9.6%). Contributing factors were unknown in 14.1% of cases. In contrast, operator inattention (15.0%) and improper lookout (12.7%) were the most common contributing factors for all open motorboat accidents.

Table 10: Five most common reported contributing factors for fatal open motorboat accidents, 2010-2019. "Other" and "Unknown" are not included but account for 21.1% of all contributing factors.

Accident Contributing Factor	Number of Accidents	Percentage of Accidents	Cumulative Percentage
Total	3051		
Alcohol	498	16.3%	16.3%
Operator Inattention	293	9.6%	25.9%
Hazardous Waters	204	6.7%	32.6%
Weather	192	6.3%	38.9%
Excessive Speed	156	5.1%	44.0%

Kayaks

Between 2010 and 2019, kayaks accounted for an average of 10.9% of all boating fatalities (Table 11). However, kayaking-associated deaths showed a steady increase, from 7.7% of all boating deaths in 2010 to 14.0% in 2019. Of those deaths, 83% occurred due to drowning and 63% of drowning subjects were not wearing a lifejacket. Capsizing was the accident type (53.5%) most often reported and the most often reported type of fatal accident (58.8%). Capsizing and falling overboard accounted for 83% of all kayaking deaths. Collisions with fixed objects accounted for more than 5% of kayaking deaths. These collisions likely occurred at low speed and led to entrapment underwater, leading to drowning rather than traumatic injury.

Table 11: Five most common types of fatal kayaking accidents, 2010-2019. "Other" and "Unknown" are not included but account for less than 1.0% of all accidents.

Accident Type	Number of Fatalities	Percentage of Fatalities	cumulative percentage
Total	706		
Capsizing	415	58.8%	58.8%
Falls overboard	167	23.7%	82.5%
Collision with fixed object	39	5.5%	88.0%
Flooding/swamping	28	4.0%	92.0%
Person departed vessel	16	2.3%	94.3%

Leading contributing factors for fatal kayaking accidents (Table 12) include hazardous waters (24.4%), operator inexperience (18.0%), and weather (9.2%). Contributing factors were unknown in 20% of cases. Alcohol was an important contributing factor in 9.9% of kayaking deaths, compared to 16.3% of open motorboat deaths. Contributing factors for all kayaking accidents were similar to those for fatal kayaking accidents.

Table 12: Five most common contributing factors for fatal kayaking accidents, 2010-2019. "Other" and "Unknown" are not included but account for 20.8% of all contributing factors.

Accident Contributing Factor	Number of Accidents	Percentage of Accidents	Cumulative Percentage
Total	706		
Hazardous Waters	172	24.4%	24.4%
Operator Inexperience	127	18.0%	44.4%
Alcohol	70	9.9%	54.3%
Weather	65	9.2%	63.5%
Dam/lock	27	3.8%	67.3%

Canoes

Between 2010 and 2019, canoes accounted for an average of 9.2% of all boating fatalities (Table 13). However, canoeing-associated deaths showed a steady decline, from 13.2% of all boating deaths in 2010 to 6.4% in 2019. Of those deaths, 90% occurred due to drowning and 85% of drowning subjects were not wearing a lifejacket. Capsizing was the accident type (59.3%) most often reported and the most often reported type of fatal accident (66.9%). Capsizing and falling overboard accounted for 82% of all canoeing deaths. Collisions with fixed objects accounted for 5% of canoeing deaths. These collisions likely occurred at low speed and led to entrapment underwater, leading to drowning rather than traumatic injury.

Table 13: Five most common types of fatal canoeing accidents, 2010-2019. "Other" and "Unknown" are not included but account for less than 1.0% of all accidents.

Accident Type	Number of Fatalities	Percentage of Fatalities	cumulative percentage
Total	595		
Capsizing	398	66.9%	66.9%
Falls overboard	89	15.0%	81.9%
Flooding/swamping	46	7.7%	89.6%
Collision with fixed object	30	5.0%	94.6%
Person departed vessel	15	2.5%	97.1%

Leading contributing factors for fatal canoeing accidents (Table 14) include alcohol (17.5%), hazardous waters (14.6%), and operator inexperience (13.8%). Contributing factors were unknown in 16.1% of cases. Improper loading, presumably leading to capsize or swamping, accounted for 11.4% of fatalities. Hazardous waters and operator inexperience were the leading contributing factors for canoeing accidents whereas alcohol consumption and hazardous waters were the leading contributing factors for fatal canoeing accidents.

Table 14: Five most common contributing factors for fatal canoeing accidents, 2010-2019. "Other" and "Unknown" are not included but account for 19.2% of all contributing factors.

Accident Contributing Factor	Number of Accidents	Percentage of Accidents	Cumulative Percentage
Total	595		
Alcohol	104	17.5%	17.5%
Hazardous Waters	87	14.6%	32.1%
Operator Inexperience	82	13.8%	45.9%
Improper Loading	68	11.4%	67.3%
Weather	36	6.1%	73.4%

Personal Watercraft (PWC)

Between 2010 and 2019, PWCs accounted for an average of 6.5% of all boating fatalities (Table 15) and showed no clear year-to-year trend. Of those deaths, 52% occurred due to traumatic injury and only 11% of those subjects were not wearing a life jacket. In contrast, 35% of PWC-associated deaths were due to drowning and 65% of those who drowned were not wearing a lifejacket. PWCs are the only craft where drowning was not the most common cause of death in fatal boating accidents and the only craft where most of the subjects who died were wearing a lifejacket.

Collision with a recreational vessel was both the accident type (30.2%) most often reported and the most often reported type of fatal accident (35.9%). Collisions with recreational vessels and fixed objects accounted for nearly half of PWC fatalities. Falling overboard, flooding/swamping, and capsizing accounted for only 25% of PWC fatalities.

Table 15: Five most common types of fatal PWC accidents, 2010-2019. "Other" and "Unknown" are not included but account for less than 1.0% of all accidents.

Accident Type	Number of Fatalities	Percentage of Fatalities	cumulative percentage
Total	423		
Collision with recreational vessel	152	35.9%	35.9%
Falls overboard	92	21.8%	57.7%
Collision with fixed object	51	12.1%	69.8%
Person Ejected from Vessel	51	12.1%	81.9%
Skier Mishap	15	3.6%	85.5%

Leading contributing factors for fatal PWC accidents (Table 16) include alcohol (16.6%), operator inexperience (15.4%), and excessive speed (11.6%). Contributing factors were unknown in 6.6% of fatal accidents. Operator inexperience and improper lookout were the leading contributing factors for PWC accidents, whereas alcohol consumption and operator inexperience were the leading contributing factors for fatal PWC accidents.

Table 16: Five most common contributing factors for fatal PWC accidents, 2010-2019. "Other" and "Unknown" are not included but account for 9.5% of all contributing factors.

Accident Contributing Factor	Number of Accidents	Percentage of Accidents	Cumulative Percentage
Total	423		
Alcohol	70	16.6%	16.6%
Operator Inexperience	65	15.4%	32.0%
Excessive Speed	49	11.6%	43.6%
Improper Lookout	43	10.2%	53.8%
Navigation Rules Violation	42	9.9%	63.7%

Other Vessels

Open motorboats, kayaks, canoes, and PWCs account for nearly three-quarters of all boating fatalities. Accident types and contributing factors for these vessels represent common types for the remaining quarter of vessel types (Table 17). For example, sailboats, while requiring skill sets that are quite different than other types of vessels, show the same fatal accident types and contributing factors to fatal accidents as seen in Tables 6 and 7. Nearly all the unique factors listed below would be addressed by efforts to avoid falling overboard, capsizing, flooding/swamping, and collision. Only machinery failure, accounting for 0.3% of all fatal boating accidents and 5.6% of fatalities aboard cabin motorboats, appears to be truly unique. Even so, several points from individual craft deserve mention.

Table 17: Fatal accident types and contributing factors to fatal accidents unique to specific vessel types from 2010 to 2019, when compared to all craft, open motorboats, kayaks, canoes, and PWCs. The total number of associated fatal accidents is shown in parentheses.

Vessel type	Unique Accident Types	Unique Contributing Factors
Cabin Motorboat	None	Machinery failure (21)
Pontoon Boat	Skier Mishap (21)	Person on Gunwale, Bow, or Transom (15)
Rowboat	None	Overloading (22)
Inflatable	Collision with Submerged Object (18), Person Ejected from Vessel (13)	None
Sail (all types)	None	None

Although alcohol is an important contributing factor to fatalities for all vessel types, it is particularly important aboard cabin motorboats and pontoon boats. On these vessels, alcohol is a contributing factor in 24% and 29% of boating deaths, respectively.

Voluntary departures from a vessel account for 9.5% of all boating fatalities. However, for pontoon boats, it accounts for 47% of fatalities. Swimming skills, life jacket wear, the ability to re-board a vessel, and situational awareness during recreational swims are all important protective measures when swimming from a boat. These factors are particularly important aboard pontoon boats.

Capsizing is an important type of fatal accident, associated with nearly 23% of all boating deaths. However, capsizing is much more likely in smaller, narrow-beamed boats such as a canoe where two-thirds of deaths are due to capsizing and 15% are due to falling overboard. In contrast, only 3.4% of fatalities aboard pontoon boats are due to capsizing, and 31% are associated with falling overboard.

IMPLICATIONS FOR BOATING EDUCATION

Boating fatalities have decreased since 1991, although over the past decade that decline appears to have slowed or stalled. A review of boating accidents suggests existing approaches that deserve stronger emphasis and further suggests new approaches for consideration. Consistent lifejacket wear appears to be the simplest step that could reduce boating deaths. 70% of boating deaths are due to drowning; as many as 85% of drowning subjects are not wearing a lifejacket. Although current boating safety programs emphasize life jacket wear, more work encouraging and promoting life jacket wear fatality data shows more work is needed.

Alcohol consumption is the leading contributing factor to boating deaths. Boating safety programs encourage abstinence from alcohol while boating and Boating Under the Influence (BUI) laws provide significant penalties for those who do drink and boat. However, as with lifejacket wear, it appears clear that further efforts are needed.

Although collisions with other vessels are the most common type of boating accident, capsizing, and falling overboard are the most common types of fatal accidents. Preventing these accident types could decrease annual boating fatalities by more than 50%. Vessel operators must know how to prevent and respond to both accident types. Although life jacket wear is an important component, boaters also must understand how to prevent unintentionally entering the water and how to rescue people in the water.

Voluntary departures from a vessel account for nearly 10% of all recreational boating deaths. On some types of vessels (e.g., pontoon boats), voluntary departures are the most common type of fatal accident, accounting for nearly half of all deaths. In addition to life jacket wear, assessment of safe swimming conditions, swimming skills, ability to reboard a vessel from the water, and the ability to help another reboard a vessel all deserve emphasis in boating education programs.

Boater education status is unknown in nearly half of all boating deaths. However, where known, 77% of deaths occurred when the vessel operator had no boating education. Education appears to be an important part of preventing boating fatalities. Boating education must have a strong emphasis on lifejacket wear and alcohol avoidance but must also teach how to prevent capsizing or falling overboard, and how to respond when these events happen.

Three-quarters of all boating fatalities are associated with only 4 types of craft - open motorboats, kayaks, canoes, and PWCs. Nearly half of all boating fatalities are associated with open motorboats. Reducing fatality rates for these vessel types will have a significant impact on overall boating fatalities. Accident types and contributing factors for these four types of craft are common among the remaining quarter of boating fatalities. Therefore, steps taken to reduce fatalities for these four types of craft will also reduce fatalities in other types of craft. Although current boating safety programs emphasize life jacket wear, fatality data shows more work encouraging and promoting life jacket wear is needed.

Table 18 presents the five most common types of fatal boating accidents and contributing factors for all accidents for all vessel types combined and compares them with those for specific vessel types. The selected vessel types are associated with more than 95% of all recreational boating deaths.

Table 18: Common fatal accident types and contributing factors for fatal recreational boating accidents, 2010-2019. "Other" and "Unknown" are not included.

Table 18: Common fatal accident types and contributing factors for fatal recreational boating accidents, 2010-2019. "Other" and "Unknown" are not included.

Vessel type	Five most often reported types of fatal accident	Five most often reported contributing factors to fatal accidents "Unknown" and "other" are commonly reported but not included below	Unique factors, not seen when all vessel types are aggregated
All	Falling Overboard (27%), Capsizing (23%) and Flooding/Swamping (11%), Person Departed Vessel (10%), Collision with Fixed Object (8%)	Alcohol (16%), Hazardous Waters (11%), Operator Inattention (7%), Operator Inexperience (7%), Weather (6%)	n/a
Open Motorboat (47.1% of fatal boating accidents 2010-2019, no clear year-to-year trend)	Falling Overboard (28%), Flooding/Swamping (15%), Capsizing (12%), Collision with Fixed Object (10%), Person Departed Vessel (9%)	Alcohol (16%), Operator Inattention (10%), Hazardous Waters (10%), Weather (6%), Excessive Speed (5%)	Excessive Speed
Kayak (10.9% of fatal boating accidents 2010-2019, increase from 7.7% in 2010 to 14.0% in 2019)	Capsizing (59%), Falling Overboard (24%), Collision with Fixed Object (6%), Flooding/Swamping (4%), Person Departed Vessel (2%)	Hazardous Waters (24%), Operator Inexperience (18%), Alcohol (10%), Weather (9%), Dam/lock (4%)	Dam/lock
Canoe (9.2% of fatal boating accidents 2010-2019, decrease from 13.2% in 2010 to 6.6% in 2019)	Capsizing (67%), Falling Overboard (15%), Flooding/Swamping (8%), Collision with Fixed Object (5%), Person Departed Vessel (3%)	Alcohol (17%), Hazardous Waters (15%), Operator Inexperience (14%), Improper Loading (11%), Weather (6%)	Improper Loading
Personal Watercraft (6.5% of fatal boating accidents 2010-2019, no clear year-to-year trend)	Collision with Recreational Vessel (36%), Falling Overboard (22%), Collision with Fixed Object (12%), Person Ejected from Vessel (12%), Skier Mishap (4%)	Alcohol (17%), Operator Inexperience (15%), Excessive Speed (12%), Improper Lookout (10%), Navigation Rules Violation (10%)	Collision with Recreational Vessel, Person Ejected from Vessel, Skier Mishap, Excessive Speed, Improper Lookout, Navigation Rules Violation

(Continued) **Table 18: Common fatal accident types and contributing factors for fatal recreational boating accidents, 2010-2019. "Other" and "Unknown" are not included.**

Cabin Motorboat (5.8% of all fatal boating accidents 2010-2019, no clear year-to-year trend)	Falling Overboard (21%), Person Departed Vessel (15%), Flooding/Swamping (13%), Collision with Fixed Object (12%), Capsizing (8%)	Alcohol (24%), Operator Inattention (8%), Hazardous Waters (6%), Machinery Failure (6%), Excessive Speed (5%)	Machinery Failure, Excessive Speed
Pontoon Boat (5.5% of all fatal boating accidents 2010-2019, no clear year-to-year trend)	Person Departed Vessel (47%), Falls Overboard (31%), Skier Mishap (6%), Collision with Recreational Vessel (5%), Capsizing (3%)	Alcohol (29%), Operator Inattention (10%), Weather (4%), People on Gunwale, Bow or Transom (4%), Hazardous Waters (3%)	Skier Mishap; People on Gunwale, Bow or Transon
Rowboat (4.1% of all fatal boating accidents 2010-2019, decrease from 5.2% in 2010 to 2.9% in 2019)	Capsizing (36%), Falling Overboard (35%), Flooding/Swamping (13%), Collision with Fixed Object (6%), Person Departed Vessel (3%)	Improper Loading (13%), Hazardous Waters (11%), Alcohol (11%), Overloading (8%), Operator Inattention (8%)	Improper Loading, Overloading
Sailboats (all types) (3.3% of all fatal boating accidents 2010-2019, slight decrease in participation over the decade)	Falling Overboard (41%), Capsizing (21%), Flooding / Swamping (13%), Person Departed Vessel (10%), Collision with Fixed Object (2%)	Weather (22%), Hazardous Waters (14%), Alcohol (12%), Operator Inattention (4%), Operator Inexperience (3%)	None
Inflatable (3.2% of all fatal boating accidents 2010-2019, no clear year-to-year trend)	Capsizing (29%), Falling Overboard (25%), Collision with Fixed Object (18%), Collision with Submerged Object (9%), Person Ejected from Vessel (6%)	Hazardous Waters (48%), Operator Inexperience (10%), Alcohol (9%), Operator Inattention (4%), Improper Loading (3%)	Collision with Submerged Object, Person Ejected from Vessel, Improper Loading

When the core instructional content identified above is compared to existing knowledge standards, areas for future emphasis become apparent. First, the importance of preventing unexpected entry into the water is clear. Life jacket wear is important, but avoiding situations where a life jacket is needed is even more important. Second, self-rescue skills deserve strong emphasis, as does the ability to rescue others. A person in the water must know how to re-enter a boat independently and people aboard boats must know how to assist a person in the water. Third, methods for proper lookout must be developed and taught. Inattention and improper lookout are significant contributing factors for fatal boating accidents. Boaters must understand how to provide a proper lookout and must understand the importance of broad situational awareness. Finally, the value of hands-on, in-water practice and learning cannot be overemphasized. It is one thing to teach that it is important to be able to reenter a boat from the water – and an entirely different thing to do after falling overboard. Knowledge learned in a class is important but the ability to apply that knowledge under real-life conditions is the true test of learning.

The information summarized in Table 18 suggests core information that should be included in all boating safety programs, as well as additional information to be included in courses targeting specific craft or types of craft. An outline of potential core and supplemental educational content appears in Table 19.

Table 19: Evidence-based educational content likely to reduce boating fatalities.

Vessel Type	Key Educational Content to Reduce Recreational Boating Fatalities
All vessels (Core Instruction)	1. Trip planning to avoid hazardous conditions. 2. Boat handling to avoid falling overboard, capsizing, and flooding/swamping 3. Mitigation and management steps for falling overboard, capsizing, and flooding/swamping to include lifejacket wear and rescue of persons in the water. 4. Take care when swimming from a vessel 5. Abstain from alcohol while boating 6. Recognize and avoid hazardous waters 7. Pay attention, keep a sharp lookout, and maintain strong situational awareness to avoid collision 8. Pay attention to the weather and modify trips in response to bad weather 9. Gain practical experience through hands-on instruction, skills practice, and mentoring
All Motorized Vessels *** Because of the unique nature of common PWC accidents, courses specifically focused on PWC operation may be needed.	1. Core instruction 2. Maintain safe operating speeds to reduce the risk of collision
All Human Propelled Vessels *** Inexperience is an important contributing factor to human-propelled boating deaths.	1. Core instruction 2. Recognize the hazards created by dams and locks and takes steps to avoid them. 3. Proper vessel loading to reduce the risk of capsizing, flooding, and swamping
All Sail Powered Vessels	1. Core instruction
Open Motorboats	1. Core instruction 2. Maintain safe operating speeds to reduce the risk of collision
Kayak	1. Core instruction 2. Recognize the hazards created by dams and locks and takes steps to avoid them.
Canoe	1. Core instruction 2. Proper vessel loading to reduce the risk of capsize
Personal Watercraft *** PWCs are the only vessel where most fatal boating accidents are due to trauma (rather than drowning) and where most deceased subjects are wearing a lifejacket	1. Core instruction 2. Maintain safe operating speeds to reduce the risk of collision 3. Follow Navigation Rules 4. Be aware of water skiers and other vessels
Cabin Motorboats	1. Core instruction 2. Maintain safe operating speeds to reduce the risk of collision 3. Proper machinery maintenance
Pontoon Boats ***Deserves emphasis on safer swimming from the vessel and alcohol abstinence	1. Core instruction 2. Be aware of water skiers and other vessels 3. Do not ride on the bow, stern, or transom
Rowboat	1. Core instruction 2. Proper vessel loading to reduce the risk of capsizing, flooding, and swamping
Inflatable	1. Core instruction 2. Boat handling to reduce the risk of ejection 3. Proper vessel loading to reduce the risk of capsizing, flooding, and swamping

TAKE HOME MESSAGES

In the United States, recreational boating is enjoyed by millions of people each year. The vast majority have a safe and enjoyable experience, but some do not. To make boating even safer than it currently is, boating safety specialists, boating education providers, and boaters, in general, should consider the points below.

1. Boating fatalities have declined since 1991. Unfortunately, that decline has stalled and over the past decade, there has been little significant decrease in the number of annual recreational boating fatalities. However, fatalities associated with some craft have seen significant changes, with increases in kayak and SUP fatalities and decreases in canoe and rowboat fatalities.
2. Between 2011 and 2018, boating participation increased by nearly 1.6 million boaters per year. Nearly 60% of that growth was due to growth in kayaking and stand up paddleboarding. The growth in paddlesports participation has been matched by a growth in paddlesports-associated fatalities.
3. Boating fatality data reveal a core set of boating safety points that should be addressed in all safe boating courses.
4. Boating fatality data further reveal craft-to-craft differences that should be emphasized in craft-specific instruction. This includes both specific content (e.g., high-speed collisions are important for PWCs but not canoes) and application of content (e.g., capsizing a kayak is not the same as capsizing a sailboat; falling off an SUP is not the same as falling off the flying bridge of a cabin motorboat).
5. Motorized vessels contribute about two-thirds of all recreational boating deaths; open motorboats alone contribute nearly half of all recreational boating deaths. Efforts to reduce boating fatalities must focus on these vessels.
6. Human-propelled vessels contribute less than a third of all recreational boating deaths, although they make up 40% or more of the total boating community. Paddling is a rapidly growing segment of the boating community, with annual participation growth of about 900,000 people each year. Kayak and stand-up paddleboard participation in particular show significant year-to-year growth. Unfortunately, the growth in participation has led to an associated growth in kayak- and SUP-associated fatalities. Efforts to reduce boating fatalities should include increased focus on kayaks and SUPs.
7. Collisions with recreational vessels are the most common type of accident reported, but contribute only a small portion of fatal boating accidents. In contrast, falling overboard, flooding/swamping, and capsizing are the most common types of fatal accidents but contribute only a small fraction of total boating accidents.
8. Unexpected entry into the water due to falling overboard, capsizing, flooding/swamping, and ejection from a vessel account for roughly two-thirds of all fatal boating accidents. To prevent boating fatalities, the prevention and management of unexpected entry into the water must be addressed in boating safety classes. All boaters should know how to avoid and respond to these accidents. Boating instruction should include a discussion of trip planning and boat handling to avoid these problems, as well as self-rescue and rescue of persons in the water. Avoiding situations that lead to a person in the water and knowing how to respond to these situations should receive greater emphasis in boating education courses.
9. Life jacket wear and abstinence from alcohol while boating are critical parts of preventing and mitigating unexpected person in the water situations. Existing efforts emphasizing these points should be continued and strengthened.
10. Operator inattention is a leading contributing factor to fatal boating accidents. Safe boating programs should emphasize the value of situational awareness and proper lookout, along with the value of early and obvious efforts to avoid problems. Specific strategies for effective lookout should be developed and taught.
11. Hazardous waters are a leading contributing factor to fatal boating accidents. Safe boating programs should emphasize recognizing and avoiding hazardous waters.
12. Voluntary departures from a vessel are responsible for nearly 10% of all recreational boating deaths. The importance of swimming skills, life jacket wear, the ability to re-board a vessel, and situational awareness during recreational swims are all important protective measures that deserve strong instructional emphasis.
13. Open motorboats, kayaks, canoes, and personal watercraft are responsible for about 75% of all boating fatalities. Boating educators should focus on these vessel types to have the greatest impact on boating fatalities. Open motorboats contribute nearly half of all boating fatalities and deserve the greatest emphasis.
14. Inexperience is a common contributing factor in boating accidents. Boating safety education should stress the value of gaining experience through mentorship, hands-on on-water instruction, and practice.
15. Most boating fatalities are due to drowning. However, aboard personal watercraft traumatic injury, rather than drowning, is the leading cause of death. PWC educational programs should provide additional focus on collision avoidance and speed control. PWC operators may benefit from boating safety courses designed specifically to address the unique elements of PWC accidents.

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OUR MISSION IS TO PREVENT THE LOSS OF LIFE, PERSONAL INJURY, PROPERTY DAMAGE, AND ADVERSE ENVIRONMENTAL IMPACT ASSOCIATED WITH RECREATIONAL BOATING, THROUGH OUTREACH TO THE RECREATIONAL BOATING COMMUNITY.

THIS IS WHAT WE STRIVE FOR. RECREATIONAL BOATING SAFETY IS OUR JOB ONE. THIS IS A CORNERSTONE OF THE U.S. COAST GUARD AUXILIARY.

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