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Short communication

Rip Current Mortality in the Coastal Zone of the United States and its Territories: 2000-2024

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Abstract

Rip currents are the primary cause of surf zone mortality in the United States. This study examines mortality reports for 2000-2024 as compiled by the National Weather Service. Analysis includes demographic, spatial, and temporal distributions. Results show that males are six times more likely to be victims, while those under 40 years of age accounted for 52% of reported mortality. Most drownings occurred in the warm summer months of May to September. Results of the analysis may be used to identify specific locations, timeframes, and populations adversely affected by this hazard. Such information may be used to tailor warnings and safety information to those populations most at risk.

Keywords: Rip currents, drowning, United States, coastal hazards.

Abbreviations: Km – kilometer

Introduction

Rip currents are just one type of coastal zone hazard. Others include high surf, storm surge, and high tide flooding. This study uses mortality reports from the National Oceanic and Atmospheric Administration/National Centers for Environmental Information (NOAA/NCEI) Storm Events Database during the years 2000-2024. For each death attributed to a rip current, the date and location are extracted along with the age and gender of the victim [1]. There are 30 states and territories with shorelines along the Atlantic Ocean, Pacific Ocean, Gulf of Mexico (America) or the Great Lakes. In addition, the database lists reports from American Samoa, Guam, the Northen Mariana Islands, Puerto Rico, and the United States Virgin Islands.

The National Weather Service (NWS) defines rip currents as "strong, narrow, seaward flows of water that extend from close to the shoreline to outside of the surf zone. Breaking waves push water near the shore to converge as narrow river-like channels moving away from the shore at high speed. Rip currents are found on almost any beach with breaking waves" [2]. The current is a concentrated flow at all depths and extends through the surf zone [3]. If the surf zone bathymetry has sandbars, a rip current may form in the slightly deeper channel between adjacent bars [4] This is one of three types of rip currents identified by Castel et al. [5]. The others include structurally controlled and hydrodynamically controlled. One of the earliest attempts at explaining the physical dynamics of the phenomena that he dubbed rip currents is attributed to Shepard [6] based on observations and anecdotal evidence gathered along beaches in Southern California. As recognition of the danger of this phenomena, increased studies have taken place in many coastal areas around the world resulting in several expansive review articles of the physical processes involved [4, 5, 7, 8]. Meteorological factors such as strong onshore winds may also play a role in the generation of rip currents [9, 10, 11]. Most of these papers also provide information on rip current mortality for a limited time period or a particular state. Lushine [9, 12] reported on mortality in Florida, while Gensini and Ashley [10] analyzed fatalities in the conterminous United States from 1994-2007. They concluded that approximately 35 deaths per year can be attributed to rip currents. Brewster et al. [13] used data reported to the United States Lifesaving Association (USLA) from 1997 through 2016 on surf beach rescues and drownings to extrapolate a value of 100 annual rip current drownings in the United States.

Discussion

The Storm Events Database lists 1259 deaths attributed to rip currents in the study area from January 2000 to December 2024, an annual average of 50 deaths. This is on average 15 more deaths than the value reported by Gensini and Ashley [10] and one half the extrapolated value of Brewster et al. [13]. Only Alaska, Hawaii, Maine, Mississippi, and Pennsylvania reported no rip current mortality in the database. Hawaii reports all surf zone deaths as due to high surf. Since this could include some of the other causes listed in the Introduction, this state was excluded from the study. Males (1049) were six times more likely than females (173) to fall victim to rip currents (37 reports failed to list the victim's gender). The warm season months of May to September recorded 60% of the mortality. Including the months of April and October raised the percent total mortality from rip currents to 71%. This is to be expected as beach attendance peaks in the warmer months.

Table 1 lists rip current mortality by age cohort. Those under 40 years old accounted for 52% of the reported mortality, while adults 60 or older accounted for 12%. Age was not reported in 11% of cases.

Listing raw counts of rip current deaths by state may be misleading due to the varying lengths of beaches in each state. To account for this the number of deaths in the state was normalized by the state's length of beaches. The Environmental Protection Agency (EPA) maintains this information as part of the monitoring requirements of the Beaches Environmental Assessment and Coastal Health Act [14]. This database also includes numbers of beaches monitored for water quality in each state and territory.

Table 2 lists the numbers of reported rip current deaths for each state and territory during the study period, their beach length, and the resulting rip current death rate per 100 km of beach length. While Florida reported the highest number of deaths among the 30 states and territories reporting, it is only tied for tenth due to its long beach length in both the Atlantic and Gulf Coasts. Four territories rank in the top ten, a reflection of their open ocean island status and spatially constrained beaches with year-round beach attendance. Alabama (rank 3rd) is the only all Gulf Coast state to make the top 10, while Maryland (7th) and South Carolina (T8th) rank highest among the Atlantic Coast states. Surprisingly, two Great Lakes states, Illinois (T4th) and Indiana (T8th) appear in the top 10. The large Chicago Metropolitan Area encompasses most of the southern portion of Lake Michigan in these states and is home to a large population of potential beachgoers along with the Indiana Dunes State and National Parks. The three West Coast states of California (20th), Oregon (26th), and Washington (T29th) all reported relatively few rip current deaths.

Table 1: Age distribution of rip current fatalities.

Age [years]	Number of Deaths (2000-2024)	Percent
1-19	298	24
20-39	354	28
40-59	318	25
60 or older	149	12
Unknown	140	11
Total	1259	100

Table 2: Rip current death rate per 100 km of beach length.

State or Territory	Beach Length [km]	Total Rip Current Deaths (2000-2024)	Total Deaths per 100 km of Beach Length	Annual Deaths per 100 km of Beach length	Rank
Puerto Rico	25.9	125	482.1	19.3	1
Guam	25.6	44	171.6	6.9	2
Alabama	45.5	59	129.6	5.2	3
American Samoa	11.7	9	76.6	3.1	T4
Illinois	26.9	21	77.9	3.1	T4

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Virgin Islands	12.9	6	46.7	1.9	6
Maryland	31.4	12	38.2	1.5	7
Indiana	78.8	28	35.5	1.4	T8
South Carolina	146.4	50	34.2	1.4	T8
Florida	1462	447	30.6	1.2	T10
New York	197.7	57	28.8	1.2	T10
North Carolina	559.2	99	17.7	0.7	T12
Louisiana	35.2	6	17.1	0.7	T12
Northern Mariana Isls.	52.8	9	17	0.7	T12
New Jersey	316.8	54	17	0.7	T12
New Hampshire	14.1	2	14.2	0.6	16
Texas	534.1	68	12.7	0.5	T17
Virginia	58.8	7	11.9	0.5	T17
Delaware	35.4	4	11.3	0.5	T17
California	595.3	62	10.4	0.4	20
Georgia	135.9	10	7.4	0.3	T21
Rhode Island	45.2	3	6.6	0.3	T21
Wisconsin	195.6	12	6.1	0.2	T23
Michigan	755.2	41	5.4	0.2	T23
Connecticut	24.8	1	4	0.2	T23
Oregon	360.5	11	3.1	0.1	T26
Minnesota	98.3	2	2	0.1	T26
Ohio	71.1	2	2.8	0.1	T26
Massachusetts	245.9	1	0.4	<0.1	T29
Washington	1721	7	0.4	<0.1	T29

Conclusion

Death rates from rip currents indicate that additional mitigation measures should be adopted in the Territories as four of the five are in the top 10 in mortality rate. Rates for the Lake Michigan states of Illinois and Indiana reflect their position at the southern end of the lake where physical factors related to wind velocity and water temperature may be contributing factors in this highly populated area. The remaining four top 10 states of Alabama, Maryland, South Carolina, and Florida are all famous for their beach tourism. Targeted education efforts may lower the death rates in these tourism-intensive states. In addition, awareness efforts directed at males under 40 years of age may help to lower rip current mortality across the country.

While no mortality database is 100% accurate as they all rely on agency reports, the results of this study show that rip current mortality is indeed a coastal zone hazard of concern. This study has identified specific states and territories where targeted education efforts should be undertaken.

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Conflict of Interest

The author claims no financial nor conflict of interest in this work.

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