

## ***Interactive comment on “Rip current rescues and drowning in the United States” by B. Chris Brewster et al.***

**B. Chris Brewster et al.**

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Anonymous Reviewer #1 writes: Overall this update to use of USLA statistics is extremely valuable to the rip current research community. Most statistics being used to date are either a decade old or failed to specifically elaborate on methods employed to arrive at reported stats

Authors' Response: We thank the reviewer for seeing the value in this study and for the reviewer's constructive comments throughout the review. As is noted below, the reviewer's suggestions have led to what we consider to be significant improvements to the paper. We are most grateful.

Reviewer Comment #1: The abstract would be served by including more robust details

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from the body of the submission regarding how the data was treated.

Authors' Response: We agree with this comment and have added in additional detail to the abstract so that it now reads:

'Rip currents are the greatest hazard to swimmers on surf beaches, but due to a lack of consistent incident reporting in many countries, it is often difficult to quantify the number of rip current related rescues and drowning deaths occurring along surf beaches. This study uses rescue data reported to the United States Lifesaving Association (USLA) by surf beach rescuers from 1997 through 2016. This data was checked, corrected, and culled so that only data from surf beach rescue agencies that reported the primary cause of rescue were included. Results show that rip currents are the primary cause of 81.9% of rescues on surf beaches, with regional variation from 75.3% (East Coast) to 84.7% (West Coast). These values are significantly higher than those previously reported in the scientific literature (e.g. 36.5%; 53.7%). Using this value as a proxy when examining overall surf beach related drowning fatalities, it is suggested that more than 100 fatal drownings per year occur due to rip currents in the United States. However, it is clear that the United States data would benefit by an increase in the number of lifeguard agencies which report surf related rescues by primary cause.'

Reviewer Comment #2: The mention in methodology of why the Great Lakes remained in the dataset is undermined by the first portion of results in discussion where it's revealed the Great Lakes were ultimately removed anyway due to lack of primary cause reports. This should be included in the methodology section. Something like "while the Great Lakes are subject to physical forces resulting in rip currents; the Great Lakes reports contained no primary cause of drownings. As such, while they were initially defined as one of our 5 research regions, the Great Lakes data was unable to be included".

Authors' Response: Thank you for identifying this discrepancy. We have changed the text, in several areas, with statements similar to this:

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'While the Great Lakes represent one of the five coastal regions in the U.S. and are subject to physical forcing mechanisms that can generate rip currents, they were not included in further analysis since, with one minor exception, rescue data from the Great Lakes does not include primary cause of rescue.'

Reviewer Comment #3: Section 4.1, underestimating is one word, no hyphen

Authors' Response: This has been corrected.

Reviewer Comment #4: Section 4.2 Steve Pfaff at the Wilmington, NC office of the NWS may actually be driving the reports you mention on line 370. He started just such a database from his forecasting region compiling medical examiner notes, news stories and speaking with lifeguards to more definitively track the causes of reported drowning deaths. He's been doing this for a while. At the very least, he may know what it is being reported by NWS.

Authors' Response: We have contacted the NWS directly regarding this and were advised that John Kuhn is the person leading maintenance of this database. Through personal communication (email) he told us that the primary source is from media outputs with some input from emergency management and water rescue officials. We have therefore adjusted the text to read:

'As described in the Introduction, some discrepancy also exists regarding estimates of annual average rip current related drowning fatalities in the U.S., with reported values ranging from 35 (Gensini and Ashley, 2009) to more than 100 (USLA, 2004) and as high as 150 (Lushine, 1991). It is important to note that all of these values are estimates as there is no comprehensive U.S. national database for surf beach drowning fatalities. The closest attempt at this is by the U.S. National Weather Service (NWS) which posts reports of U.S. surf zone fatalities at: <https://www.weather.gov/safety/ripcurrent-fatalities17> and includes an annual average number of reported rip current related drowning fatalities between 2013-2017 of 62 per year.

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According to the NWS (personal communication with John Kuhn, August 6, 2018) the primary source of this data are media reports with some input from emergency management and water rescue officials. Of note, the website states "Accurately tracking these types of fatalities is difficult because so many go unreported and undocumented." As an example of this difficulty, in 2016 the NWS reported a total of 108 surf zone fatalities, but in that same year surf rescue agencies reported 145 drowning fatalities within their jurisdictions to the USLA. This is a global problem.'

Reviewer Comment #5: My concern with the paper revolves around potentially unfounded assertions regarding extrapolated "real" number of fatalities presented in a quantitative manner. I don't have issue with the data as presented, but the way it's being expanded is not supported. Mentions either need to be removed or covered in a more detail. For instance, line 374-376 states "The data includes an annual average number of rip current related drowning fatalities between 2013-2017 of 62 fatalities per year. This would again suggest that the actual number is closer to the USLA estimate [of 100 instead of 35]. This paper concluded a measurable 62 annual fatalities; that's 38 from the USLA estimate of 100 and only 27 fatalities away from the Gensini and Ashley 2010 total of 35. You've made the case for fatalities from the USLA dataset to likely be underestimates, but it would have to be an underestimate by nearly 20% to make the assertion that "...suggest that the actual number is closer to the USLA..." true. Further, you state in section 4.2 line 358 through 361 that the most recent fatality stats available are less than 100 (though from 128 agencies of the 150 mentioned in the introduction). On line 405-408 of the Conclusion the authors do this one last time "...an annual figure of over 100 is not unreasonable...". You're extrapolating 62 to be close to 100, and then conclude it's likely even higher than that. What the authors could do for this discussion is compare the average number of fatalities in 2016 per reporting agency (128) and use the total number of USLA certified agencies to put some actual numbers to these estimates. This should lead you to a higher number that could be used in support of the assertion in conclusion in line 407 that "...annual figure of over 100 is not unreasonable...". Currently, you have no real evidence for this. However, 99

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drownings from 128 agencies is .77 fatalities per reporting agency. That multiplied by 150 agencies is an estimate of 116 fatalities; if the rescue data is a proxy for likely fatalities (81.9%). 81.9% of 116 is 95; and then your case for 95 being an underestimate could make sense. THIS IS STILL A STRETCH, but at least it's based on presented data instead of what seems emotional extrapolation. Specifically, the entire point of this paper is to call-out potential errors in formerly reported numbers, so grand statements largely unsupported by presented evidence seems counter to the overall theme.

Authors' Response: The reviewer's comments are excellent and caused us to reevaluate this section and to take a somewhat different approach. Regarding the 128 agencies versus 150, some of these are non-surf agencies, so not applicable, but we also found that we had undercounted the number of reporting surf agencies (and their data). Rather than focus on one year, we chose to conduct a five-year review of reports of actual drowning deaths from surf rescue agencies reporting to the USLA. We have modified this section to state as follows:

'As noted earlier, the USLA has theorized the percent of rescues from drowning in rip currents as a proxy for the percentage of drowning deaths at surf beaches in the absence of rescue. To examine this approach in more detail, we chose to review the most recent five-year period (2012 – 2016) of drowning fatality reports from surf rescue agencies reporting to the USLA, since during this period the number of reporting agencies is the highest historically, ranging from 111 in 2012 to 136 in 2016 (Figure 1). Of note, these agencies report drowning fatalities in both guarded areas (those under active lifeguard surveillance at the time of the drowning death) and unguarded areas (those within the jurisdiction of the agency, but not under lifeguard surveillance at the time of the death) and during this period an average of 109.6 drowning deaths per year were reported.

If we apply the long-term national average of 81.9% of rip current related rescues (Table 1) to the actual reports of drowning deaths (109.6 per year) from surf rescue agencies, it can be hypothesized that 89.8 deaths per year were likely due to rip currents in the

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jurisdictions of the reporting agencies. This value is both higher than the estimate of 62 per year from the NWS and close to the previous estimate of 'more than 100' by the USLA (2004).

The authors estimate that less than 5% of the U.S. coastline lies within the jurisdiction of surf rescue agencies which report to the USLA. While these agencies tend to oversee highly attended beach areas (e.g. Southern California, Florida, and Hawaii), many drowning deaths outside these areas are reported each year. Thus, relying only on drowning fatality reports from these agencies will understate the number of surf drowning deaths by an unknown, but potentially significant number.'

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