International Journal of Aquatic Research and Education

Volume 5 | Number 4 Article 11

11-1-2011

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Recommended Citation

Brander, Robert W.; Bradstreet, Anthony; Sherker, Shauna; and MacMahan, Jamie (2011) "Responses of Swimmers Caught in Rip Currents: Perspectives on Mitigating the Global Rip Current Hazard," *International Journal of Aquatic Research and Education*: Vol. 5 : No. 4 , Article 11.
DOI: 10.25035/ijare.05.04.11
Available at: https://scholarworks.bgsu.edu/ijare/vol5/iss4/11

International Journal of Aquatic Research and Education, 2011, 5, 476-482

Responses of Swimmers Caught in Rip Currents: Perspectives on Mitigating the Global Rip Current Hazard

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Rip currents are a primary mechanism on many of the world's beaches associated with rescues and drownings and have long been the focus of beachgoer education and awareness strategies. Traditional approaches to mitigating the rip current hazard typically provide information on escape procedures for beachgoers caught in a rip current. Several of these approaches are now being challenged by new scientific findings leading to uncertainty and debate among scientists and beach safety practitioners. This paper suggests that future research efforts on mitigating the rip current hazard should focus on quantifying the physical and behavioral responses of beachgoers who have been caught in rip currents. Descriptions of new approaches adopted recently in Australia by a joint collaboration between the University of New South Wales and Surf Life Saving Australia are presented.

Keywords: rip currents, drowning, beach safety, injury prevention, swimmer behavior, community outreach, surf education

Rip currents are strong, narrow, seaward flowing currents that can quickly carry unsuspecting bathers away from the beach into deeper water. They occur on any beach characterized by waves breaking across a wide area (Brander & MacMahan, 2011; Dalrymple, MacMahan, Reniers, & Nelko, 2011; MacMahan et al., 2006, 2011) and are the leading cause of drowning and surf rescue on many of the world's beaches (e.g., Hartmann, 2006; Klein et al., 2003; Scott et al., 2009; Short, 2007). In Australia, 89% of the more than 25,000 annual surf rescues conducted by lifeguards, lifesavers, and surfers are caused by rip currents (Short & Hogan, 1994) with an estimated 40–50 rip-related drownings per year (Sherker et al., 2008; SLSA, 2010). In the United States, it is estimated from United States Lifeguard Association (USLA) statistics that rip currents account for 80% of all surf rescues and over 100 fatalities per year (Lascody, 1998; Lushine, 1991). Between 1960 and 2000, the total cost of drowning deaths at American beaches was estimated at U.S. $4.2 billion (Branche & Stewart, 2001). Rip currents are a global natural hazard

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with significant personal, societal, and economic costs. Herein, new perspectives on traditional approaches to mitigating the rip current hazard and methods for improving rip current education and awareness are discussed.

Traditional Rip Current Education Strategies

Most countries with popular recreational beaches characterized by rip currents engage in various forms of public rip current education and awareness strategies that extend beyond the presence of beach lifeguards and warning signage. These strategies typically involve the development and distribution of brochures, stickers, fridge magnets, and posters, often with a slogan, to tourist information centers, holiday accommodations, and other public tourist amenities near beaches with rip currents (e.g., Brander & MacMahan, 2011; Carey & Rogers, 2005). Some programs also include activities and educational presentations made to primary and high school children both in-class and on the beach.

One consistent theme of rip current education relates to the response of people who find themselves caught in a rip current. Messages adopted and promoted in various combinations by beach safety practitioners around the world include

- always swim at a location patrolled by lifeguards;
- stay calm and don’t panic;
- never swim against the rip current;
- for assistance, float and attract the attention of a lifeguard (passive response); and
- to escape the rip, swim parallel to the beach or across the current (active response).

There is universal agreement over the first three points, as they encourage a person to swim at a patrolled location, remain calm in a stressful situation, and avoid exhausting themselves. A recent debate has arisen among beach safety practitioners and rip current scientists, however, regarding the passive and active advice: Should a person caught in a rip current passively stay afloat or actively attempt to swim out of the rip? Which is the best advice?

The traditional paradigm of rip current flow established by early scientific work (Inman & Brush, 1973; Shepard et al., 1941; Shepard & Inman, 1951) suggests that rip currents flow perpendicular to the beach and extend well offshore of the region of breaking waves (the surf zone). This model supports the active “swim parallel” swimmer response in two ways: (a) rip currents are narrow so a person doesn’t have to swim very far in either sideways direction to escape the rip; (b) self-escape at an early stage of the rip current flow is more desirable than being taken long distances offshore. It has also had a major impact on messages and imagery associated with national rip current education campaigns in the United States and Australia (Brander & MacMahan, 2011). In addition, on unpatrolled beaches, an active response may be the only escape and/or survival option. Between 2009 and 2010 in Australia, 93% of coastal drownings occurred on unpatrolled beaches (SLSA, 2010).

Recent scientific research has challenged the traditional understanding of rip current flow with potentially serious implications for beach safety practitioners and beachgoers. Using constructed drifters attached with Global Positioning Systems (GPS) in morphologically-fixed rip currents along open coast beaches in California,

https://scholarworks.bgsu.edu/ijare/vol5/iss4/11
DOI: 10.25035/ijare.05.04.11

the United Kingdom, and France, MacMahan et al. (2010) showed that rip current flow recirculated within the surf zone approximately 80–90% of the time. These findings suggest that the best option may be to "stay afloat" as the rip current flow will carry the swimmer onto shallow adjacent sandbars within minutes with little effort required by the swimmer or concern about swimming direction. These results were met with a degree of skepticism among beach safety practitioners and scientists alike, as they significantly challenged the accepted traditional view of rip current flow behavior (Brander & MacMahan, 2011).

One key variable that has largely been ignored in existing rip current interventions are the actual behavioral responses of beachgoers themselves. While some information exists regarding beachgoers' knowledge and perception of rip currents (Ballantyne et al., 2005; McCool et al., 2008; Sherker et al., 2010), more attention should be focused on what "rip current survivors" have to tell us about their experience. In the event that people do get caught in a rip current, it is important to understand both their physiological and behavioral responses. This information is essential for developing appropriate messages that will help reduce the onset of panic, thus enabling the swimmer to become a rip current survivor and not a rip current victim. Unfortunately, at the moment, this type of information is largely anecdotal and has yet to be addressed with any rigor.

Physiological and Behavioral Responses to Rip Currents

The physiological response of a person to a stressor, such as being caught in a rip current, is an important consideration in rip-related drowning prevention. When an individual perceives a stressor, reflexes initiate the physiological adrenaline reaction (Lehrer & Woolfolk, 1993), which includes the following effects on the body:

- Increase in the rate and capacity of heartbeat resulting in higher blood pressure;
- Blood is redirected from the skin and visceral organs to the skeletal muscle, coronary arteries, liver and base of the brain;
- Rise in blood sugar;
- Increased metabolic rate;
- Dilation of the bronchi;
- Hair stands on end and "goose flesh" appears on the skin; and
- Clotting time of blood is reduced.

This process also redirects blood flow that reduces the abilities of higher cortical functions in the brain, logical thinking, and strategy evaluation processes (LeDoux, 1996). In many situations, this evolutionary function saves valuable seconds of processing and allows individuals to remove themselves from the threat. Once individuals are safe from the stressor, higher function can then take over. The existing evolutionary perspectives on the acute stress response fit into the following categories: freeze (Gray, 1988), flight or fight (Cannon, 1929), and fright or faint (Bracha, 2004). While these general responses are well acknowledged as reactions to stressors, the specific physiological responses exhibited by people caught in a rip current have not been accurately observed or assessed.

Our understanding of the key rip current stressor(s) is based on situational analysis, lifeguard reports, eyewitness accounts, and anecdotal evidence. These include bathers (a) losing tactile footing with the ocean floor (sometimes mistakenly reported as a "collapsing sand bar"), (b) being aware of water movement and actively being swept into a rip current, (c) being suddenly aware that they are moving away from the shoreline or have moved some distance offshore, and (d) experiencing the sensation that they are being pulled under the water surface. An investigation into these stressors has important implications for lifeguards and will influence existing and future development of appropriate rip current survival messages.

Lifeguarding and lifesaving literature has long focused on surveillance and identification of the signs of a person who is in trouble as vital skills for the lifeguard (Fenner et al., 1999; Pia, 1997). These signs remain common for people who are in a rip current, a deep pool, a dam, river, or any body of water over their standing depth. On land, the panic process is related to body movement against a tactile surface being the ground or an object. In the water, this physical resistance against gross motor action is nonexistent. Hypothetically, we can assign these commonly observed reactions to distress in the water to the fight, flight, and freeze terminology:

- Lashing out in bursts of energy attempting to remain above water in primal movements such as "climbing the ladder" (fight);
- Struggling toward an object that will help them stay afloat, including family or friends who may be in the rip current with them (flight);
- Becoming overwhelmed with the situation and struggling on the spot, usually probing with their feet while sinking under water in their indecisiveness (freeze).

Anecdotally, the initial stressor is thought to be deeper water and movement away from the shoreline. The desire to return to the safety of the beach is the primary behavioral response. It is not unreasonable to further assume in many cases that any learned or logical behavior is bypassed owing to the shutdown of logical brain function. The instinctive reaction is to swim directly toward the shoreline. In many cases, this is directly against the strong flow of a rip current, which can lead to exhaustion. When this initial response to the stressor is ineffectual and the logical centers of the brain are shutting down, panic can set in which further limits effectual response.

One active response that a swimmer may take to escape a rip current is to swim parallel to the beach. It remains unclear whether a distressed swimmer can override the deep water stressor and adopt this approach as they are being moved farther from the beach. The alternative passive response is to float with the rip current and conserve energy. This option promotes signaling for help and scientific research has shown that there is a high probability of floating objects in rip currents being circulated onto adjacent shallow sand bars within minutes (MacMahan et al., 2010). Assuming that beachgoers are fully aware of the "stay afloat" response option, however, we similarly do not know if beachgoers have the capacity to override the deep water stressor, resist the physiological urge to "fight," and trust that the rip current will eventually return them to the relative safety of shallower water.

It is highly likely that no single swimmer response (passive or active) will suit all individuals in different rip current scenarios. Given the high probability that rip current circulation will carry swimmers onto adjacent shallow sandbanks,

DOI: 10.25035/ijare.05.04.11

MacMahan et al. (2011) suggest that swimmers caught in rip currents should adopt a passive "stay afloat" response when caught in a rip current inside the surf zone but adopt the active "swim parallel" approach if carried seaward of the surf zone (assuming that self-escape is the only option). While this advice sounds logical in principle, we simply do not know the efficacy of promoting such a dual message to the general public or the ability of distressed swimmers to recall or act on these messages.

New Approaches

A conservative estimate of the number of people caught in rip currents based on rescues conducted by lifeguards, lifesavers, surfers, other swimmers, or self-escapes over the last ten years would easily exceed 500,000 in both Australia and the United States alone. In this regard, the vital role of the lifeguard cannot be overlooked. They are important sources of information and could provide dramatically improved and robust statistical evidence of rip drowning, rescues, and self-escapes if incident reporting systems were reviewed and improved in consultation with beach safety practitioners and rip current scientists.

Lifeguards also have a significant educational capacity while on the beach as they represent the initial point of contact with most rip current survivors and are therefore in a prime position to gain information from them shortly after they have been rescued; however, Williamson (2006) found that lifeguards were a poor source of information gathering on beaches. To access rip current survivors directly, the University of New South Wales, Australia and Surf Life Saving Australia (SLSA) engaged in a project in 2011 that involved conducting (a) an online survey for rip current survivors and (b) in depth interviews of rip current survivors. The aim of this project was to ascertain survivors' demographics, surf knowledge, awareness of beach safety messages, and behavioral responses to being caught in a rip to assist in developing and modifying ongoing rip current education and awareness interventions.

To increase awareness of rip currents and of this project, the first Rip Current Awareness Day was designated in Australia on February 6, 2011. This was the anniversary of an infamous mass rip current-related drowning and rescue at Sydney's famous Bondi Beach in 1938. Promotion of the event and the online survey was achieved through a Public Service Announcement created by the Australian Broadcasting Corporation (ABC) Radio and was broadcast around Australia in the week leading up to the event. As part of the Day, SLSA also conducted a simultaneous release of harmless purple dye into 32 rip currents along every surf beach in Sydney, Australia. The dye created a dramatic visual educational demonstration of rip current flow speed and trajectory. Preliminary data from recent research in Australia shows that the visual dye release method is particularly effective as an educational method for improving awareness and understanding of the rip current hazard.

The United States already has a designated Rip Current Awareness Week at the start of each summer. We encourage program and beach safety practitioners in other countries to use such visual displays and the previously described research approaches to gain valuable information and data from people who have been caught in rip currents. A global database of physical, demographic, psychological, and behavioral factors relating to rip current rescues would be an extremely practical outcome.

Summary

Public education and awareness strategies of the global rip current hazard have traditionally focused on the response of swimmers who find themselves caught in rip currents. Much of this information is based on traditional scientific paradigms of rip current flow that are now being challenged. Little information has been obtained from the hundreds of thousands of people who have been caught in rip currents around the world. It is our belief that future research efforts in regions and countries with a rip current drowning problem should focus on quantifying the demographics, surf knowledge, and physical and behavioral responses of swimmers caught in rip currents. This information will greatly improve the design and effectiveness of large-scale public rip current education campaigns and will ultimately contribute to a significant decrease in the incidence of beach drowning. We also believe that the key to making such an endeavor successful involves open two-way communication and collaboration between rip current scientists and beach safety practitioners.

Acknowledgment

Jamie MacMahan was supported by NSF (OCE# 0728324 & 0926750).

References

Ballantyne, R., Carr, N., & Hughes, K. (2005). Between the flags: An assessment of domestic and international university students' knowledge of beach safety in Australia. *Tourism Management, 26*(4), 617–622.

Bracha, H. (2004). Does "fight or flight" need updating? *Psychosomatics, 45,* 448–449.

Branche, C.M., & Stewart, S. (Eds.). (2001). *Lifeguard effectiveness: A report of the working group*. Atlanta, GA: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control.

Brander, R.W., & MacMahan, J.H. (2011). Future challenges for rip current research and community outreach. In S. Leatherman & J. Fletemeyer (Eds.), *Rip currents -Beach safety, physical oceanography, and wave modeling* (pp. 1–29). Boca Raton, FL: CRC Press.

Cannon, W. (1929). *Bodily changes in pain, hunger, fear, and rage: An account of recent researches into the function of emotional excitement* (2nd ed.). New York: Appleton-Century-Crofts.

Carey, W., & Rogers, S. (2005). Rip currents – coordinating coastal research, outreach and forecast methodologies to improve public safety. *Proceedings of Coastal Disasters 2005*, ASCE, 285-296.

Dalrymple, R.A., MacMahan, J.H., Reniers, A.J.H.M., & Nelko, V. (2011). Rip currents. *Annual Review of Fluid Mechanics, 43,* 551–581.

Fenner, P., Leahy, S., Buhk, A., & Dawes, P. (1999). Prevention of drowning: visual scanning and attention span in lifeguards. *Journal of Occupational Health and Safety – Australia and New Zealand, 15*(1): 61-66

Gray, T. (1988). *The psychology of fear and stress* (2nd ed.). New York: Cambridge University Press.

DOI: 10.25035/ijare.05.04.11

Hartmann, D. (2006). Drowning and beach-safety management (BSM) along the Mediterranean beaches of Israel – a long-term perspective. *Journal of Coastal Research, 22*(6), 1505–1514.

Inman, D.L., & Brush, B.M. (1973). Coastal challenge. *Science, 181,* 20–32.

Klein, A.H da F., Santana, G.G., Diehl, F.L., & Menezes, J.T. (2003). Analysis of hazards associated with sea bathing: Results of five years work in oceanic beaches of Santa Catarina State, Southern Brazil. *Journal of Coastal Research, SI, 35,* 107–116.

Lascody, R.L. (1998). East Central Florida rip current program. *National Weather Digest, 22*(2), 25–30.

LeDoux, J. (1996). *The emotional brain: The mysterious underpinnings of emotional life*. London: Simon and Schuster.

Lehrer, P., & Woolfolk, R. (1993). *Principles and practice of stress management* (Vol. 2). New York: Guildford Press.

Lushine, J.B. (1991). A study of rip current drownings and weather related factors. *National Weather Digest, 16,* 13–19.

MacMahan, J.H., Thornton, E.B., & Reniers, A.J.H.M. (2006). Rip current review. *Coastal Engineering, 53,* 191–208.

MacMahan, J.H., Reniers, A., Brown, J., Brander, R., Thornton, E., Stanton, T. & Carey, W. (2011). An introduction to rip currents based on field observations. *Journal of Coastal Research, 27*(4): iii-vi.

MacMahan, J.H., Brown, J., Brown, J., Thornton, E., Reniers, A., Stanton, T., et al. (2010). Mean lagrangian flow behavior on an open coast rip-channeled beach: A new perspective. *Marine Geology, 268,* 1–15.

McCool, J.P., Moran, K., Ameratunga, S., & Robinson, E. (2008). New Zealand beachgoers' swimming behaviours, swimming abilities, and perception of drowning risk. *International Journal of Aquatic Research and Education, 1,* 7–15.

Pia, F. (1997). Reflections on Element #1 of effective surveillance: Water crisis recognition training. In B.C. Brewster (Ed.), *Proceedings of the International Medical –Rescue Conference,* Sept 15-17, International Life Saving Federation.

Scott, T.M., Russell, P.E., Masselink, G., & Wooler, A. (2009). Rip current variability and hazard along a macro-tidal coast. *Journal of Coastal Research SI, 50,* 1–6.

Shepard, F.P., Emery, K.O., & Lafond, E.C. (1941). Rip currents: A process of geological importance. *The Journal of Geology, 49,* 338–369.

Shepard, F.P., & Inman, D.L. (1951). Nearshore circulation related to bottom topography and wave refraction. *Transactions - American Geophysical Union, 31*(4), 196–213.

Sherker, S., Williamson, A., Hatfield, J., Brander, R., & Hayen, A. (2010). Beachgoers' beliefs and behaviours in relation to beach flags and rip currents. *Accident Analysis and Prevention, 42,* 1785–1804.

Sherker, S., Brander, R.W., Finch, C., & Hatfield, J. (2008). Why Australia needs an effective national campaign to reduce coastal drowning. *Journal of Science and Medicine in Sport, 11,* 81–83.

Short, A.D. (2007). Australian rip systems: Friend or foe? *Journal of Coastal Research, SI, 50,* 7–11.

Short, A.D., & Hogan, C.L. (1994). Rip currents and beach hazards: Their impact on public safety and implications for coastal management. *Journal of Coastal Research, SI, 12,* 197–209.

Surf Life Saving Australia (SLSA). (2010). *National Coastal Safety Report*. Sydney, Australia: Surf Life Saving Australia.

Williamson, A. (2006). Feasibility study of a water safety data collection for beaches. *Journal of Science and Medicine in Sport, 9,* 243–248.