

**RIP CURRENTS IN THE UK:
INCIDENT ANALYSIS,
PUBLIC AWARENESS, AND EDUCATION**

by

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Abstract

Name: Eleanor Woodward

Title: Rip Currents in the UK: incident analysis, public awareness, and education.

Rip currents present a severe hazard to water users worldwide, resulting in over 100 drownings and thousands of lifeguard rescues annually. This thesis examines the demographics of who is effected by rip currents in the UK, what activity they are undertaking, when and where incidents occur, how much the public know, what people have experienced, and how best to educate them.

Analysis of 7909 rip current lifeguard rescues (16777 people) across the UK between 2006-2013 highlighted the most at risk group, and subsequent target audience for education, to be male teenagers aged between 13-17 years old (n=2906, 17%). Geographically, the highest incidents occurred on the beaches in the Southwest of England (n=6911, 87%). Incidents mostly occurred outside of lifeguard flagged areas (n=4302, 54%) and mainly involved those using bodyboards (n=5290, 52%).

Through the analysis of 407 public beach-based rip current and beach safety questionnaires, it was established that beach users have a poor understanding of rip currents (n=263, 65%) but a good perception of the beach safety flags (n=389, 96%). People with greater knowledge were typically educated by a lifeguard, enter the sea more frequently or have been caught in rip currents themselves.

The experiences of 553 people caught in rip currents were analysed using an online questionnaire. The gender split was 69% male (n= 382) to 31% female (n= 171), indicating that males are caught in rip currents more than females. Swimming directly to shore against the rip followed an initial panic (n=108, 34%) for most people caught in a rip. Swimming parallel to the beach was the most remembered, advised, utilised, and promoted safety message. Respondents advocated the use of lifeguards to disseminate rip current safety messages.

A new and unique rip current education programme was developed from the synthesis of these results. A lifeguard delivered a pilot programme to 185 teenagers in three schools and two community groups in the Southwest of England. This interactive pilot consisted of exercises using videos, photographs, news reports, and a swimming machine. Levels of rip current knowledge were evaluated before and after, and at regular intervals, to assess

knowledge retention. The short-term effects after 3 months were positive, showing statistically significant ($p < 0.0005$) improvements in mean knowledge levels.

This thesis provides a new contribution to the expanding field of social and behavioural rip current research. The development of a unique rip current education programme presents an alternative method for increasing public awareness, and supports the worldwide prevention of rip current incidents and fatalities.

Author's Declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Committee.

Work submitted for this research degree at Plymouth University has not formed part of any other degree either at Plymouth University or at another establishment.

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Chapter 1

Introduction

1.1 Preamble

Rip currents represent the greatest risk to water users on beaches in the United Kingdom (UK), and are responsible for the largest proportion of all beach lifeguard incidents (Figure 1.1) (RNLI, 2010). This has led to a number of studies being carried out in the UK to investigate the dynamics of rip currents (Austin *et al.*, 2009, 2010, 2013) and their implications for beach safety (Scott *et al.*, 2007, 2008, 2009a, 2009b, 2011a, 2011b, 2014). These studies complement similar work undertaken worldwide to increase understanding of rip current systems and their physical characteristics in different environments (Short, 1985; Brander, 1999; MacMahan *et al.*, 2010).

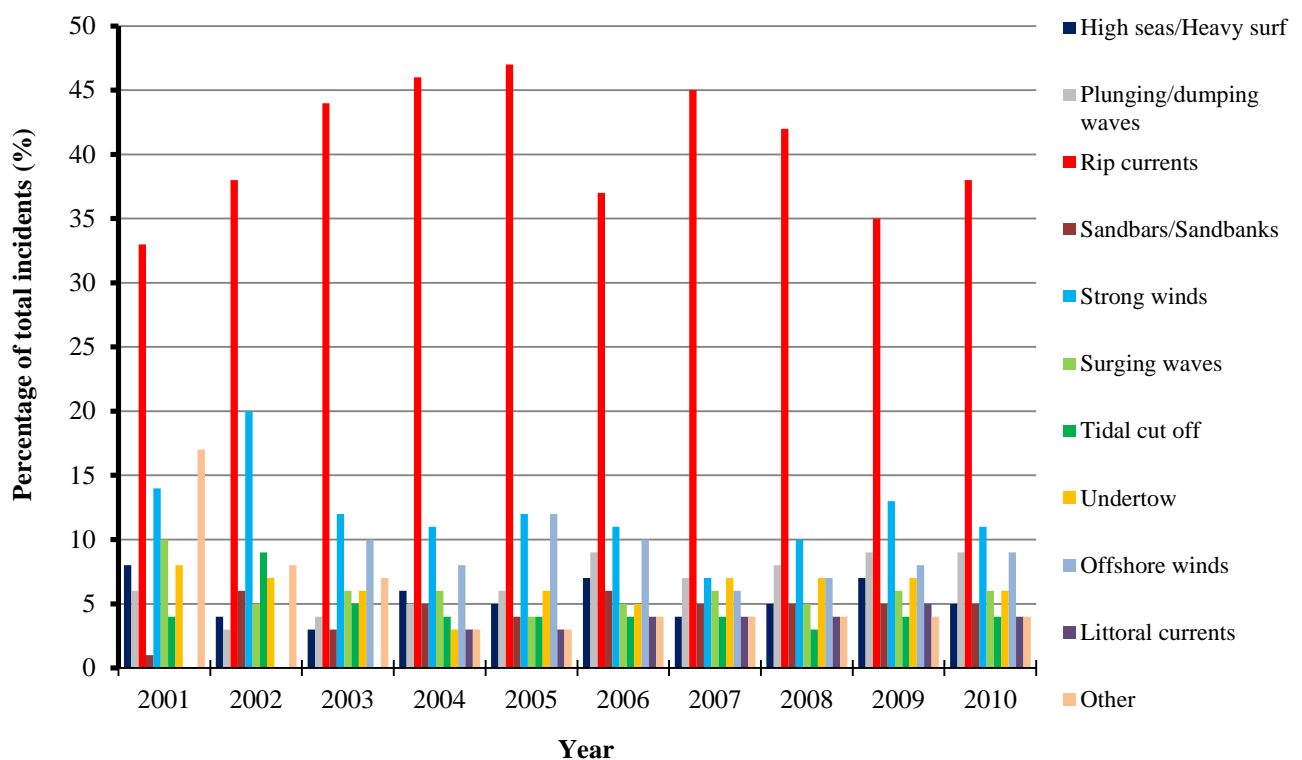


Figure 1.1: Environmental impacts of lifeguard rescues 2001-2010. (Adapted from RNLI operational statistics, 2010).

Despite the extensive research into rip current dynamics, studies on the human behavioural aspects, such as how humans interact with rip currents, have mainly been carried out in Australia (Sherker *et al.*, 2010; Drozdowski *et al.*, 2012), and the USA (Caldwell *et al.*, 2013; Branstromm *et al.*, 2014), with no previous research undertaken in the UK. Recent studies in Australia have shown that a greater understanding of beach users' behaviour and perception of risks is essential in reducing rip current related incidents (Ballantyne *et al.*, 2005; Sherker *et al.*, 2008, 2010).

The UK coastal environment has been highlighted as hazardous to water users (Scott *et al.*, 2007, 2009a). In particular, the large tidal ranges, geomorphologies, and high energy swells, promote the formation of rip current systems on many beaches around the UK. The RNLI is the chief provider of lifeguards in the UK, and a large proportion of beaches where the organisation operates exhibit these hazardous environments. The UK coastal environment is popular with day-trippers and holidaying tourists; 37 million people visited a beach, and 17 million holidayed at the seaside in 2013 (Visit England, Great Britain Tourism Statistics, 2013). These large visitor populations, coupled with an increasing year round water user community, continue to preserve high rip current incident numbers: for example, in 2010, 2262 people were rescued in 1077 rip current incidents (37%) by RNLI lifeguards (RNLI, 2010).

This PhD investigates the critically important human behavioural context to existing physical rip current research. The thesis is concerned with social, behavioural, cultural, and educational aspects surrounding rip currents, increasing the understanding of beach users' interactions with rips in order to provide the framework for a rip current awareness/education programme within the UK.

The need for this social rip current research is required by the RNLI, and the collaboration will assist the organisations' beach safety and prevention teams. Through the integration of rip current incident analysis and public surveys, a rip current education pilot will be developed through the synthesis of these results. The evaluated scheme will provide a novel method to disseminate important information and advice to help reduce rip current incidents and fatalities in the UK.

1.2 Aims and structure of the thesis

The broad aim of this study is to improve the understanding of rip currents in a social context in the UK, and provide a framework for a public rip current/beach safety education programme. The following specific project aims are defined:

1. Analyse the demographics of people caught in and rescued from rip currents on UK beaches through examination of RNLI lifeguard incidents. Determine where these incidents occur, and what activities people were undertaking at the time of rescue.
2. Evaluate the current level of awareness and understanding UK beach users have of rip currents and beach safety, through the design and implementation of face-to-face questionnaires.
3. Investigate the knowledge and awareness of people who have physically experienced rip currents, and gain an insight into their reaction, through the analysis of online questionnaire results.
4. Develop a pilot rip current education scheme through the synthesis of aims 1-3, and evaluate its design, delivery, and effectiveness.

The structure of this thesis is depicted in Figure 1.2, and Figure 1.3 highlights the aims and subsequent integration of the data chapters, providing a conceptualisation of the flow of the thesis.

Chapter 1 introduces the aims and objectives, and addresses the main research questions to be examined throughout the thesis. A detailed literature review of relevant previous research relating to rip currents and beach safety provides a baseline understanding from which to focus the research.

Chapter 2 provides the methodological approach taken to inform the choice of data collection, analysis, and methods used within the thesis. The philosophical and theoretical positions which underpin the thesis are explored, followed by the research design and methods used.

Chapter 3 investigates the RNLI lifeguard incident database and provides the foundation for the progression of the thesis. The demographics of rip current ‘victims’, the water based activities they are undertaking at the point of rescue, the beaches where, and when most

incidents occur, are all examined to provide a comprehensive understanding of the rip current hazard in the UK.

Chapter 4 assesses the level of beach safety and rip current knowledge of UK beach users. Beaches identified as being high rip current risk were visited and a face-to-face questionnaire conducted with beach users. This provides an understanding of public rip awareness.

Chapter 5 explores the experiences of people caught in rip currents. An online questionnaire recorded the physical and emotional reactions of people who found themselves in a rip, and provided public opinion on the best methods, education, or training they thought might equip people to be able to survive a rip current.

Chapter 6 builds on Chapters 3-5 informing the development, audience, methods, and delivery of a rip current education pilot. Chapter 6 provides details on the rip current knowledge of teenagers in secondary schools and scout groups before and after the delivery of a rip current education programme.

Chapter 7 integrates the main findings with literature and theories examined throughout the thesis providing a synthesis of the whole study. An evaluation of these findings in relation to the project aims and wider implications is discussed.

Chapter 8 outlines the main conclusions of the thesis.

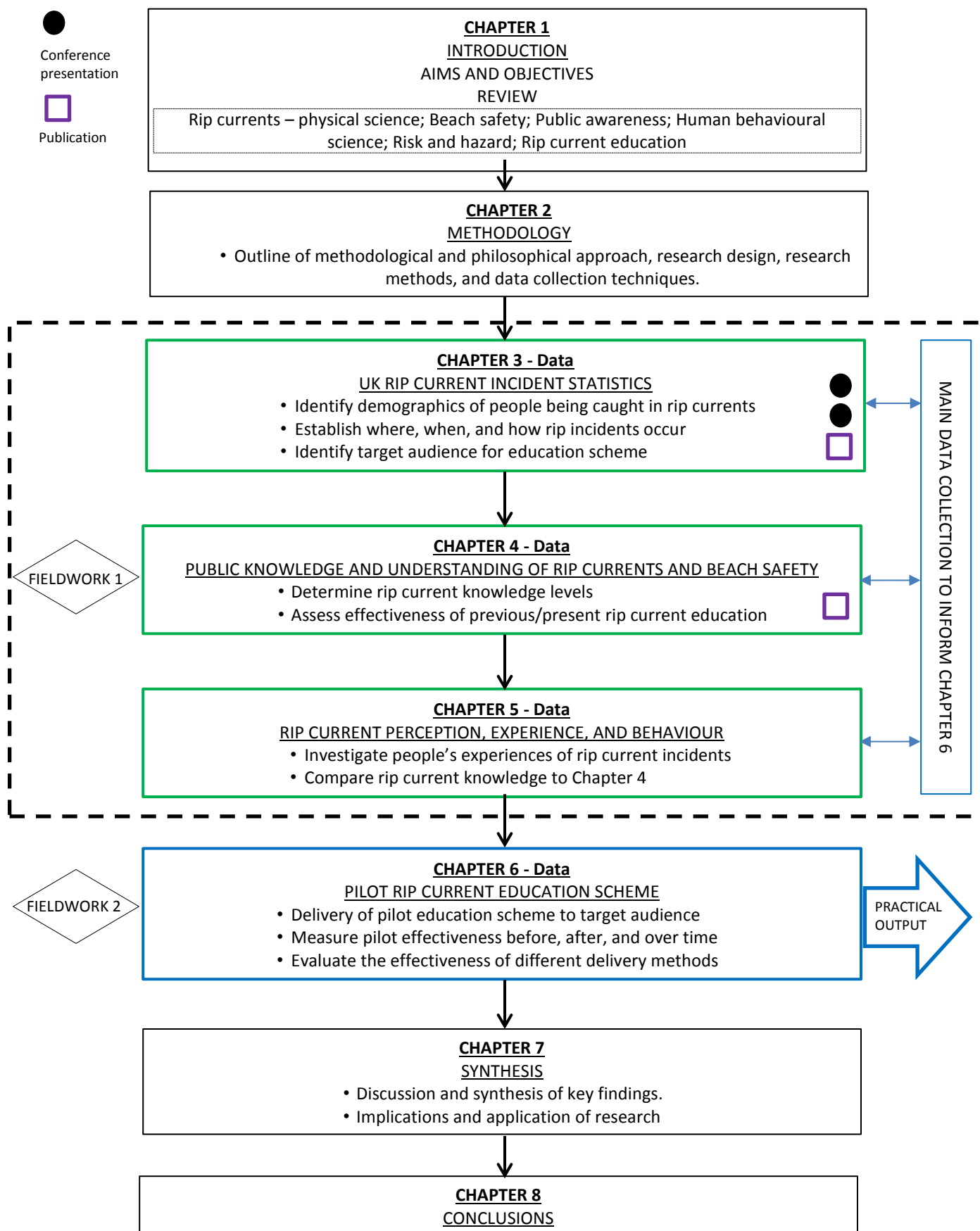


Figure 1.2 – Flow chart detailing the structure of the thesis. The content, aims, and summary of each chapter, and outlining the main outputs of work from certain areas of the thesis, including published papers and conference presentations (page viii and Appendix 9 and 10).

PRE CHAPTER QUESTIONS

ANALYSIS OF RNLI RIP CURRENT INCIDENT DATA FOR THE UK

- WHO IS CAUGHT IN RIP CURRENTS?
- WHERE?
- HOW? WHAT ACTIVITIES?
- WHEN? TIME OF DAY/YEAR?

UK BEACH USER KNOWLEDGE AND UNDERSTANDING OF RIP CURRENTS AND BEACH SAFETY

- HOW MUCH DO PEOPLE KNOW?
- IS THE CURRENT LEVEL OF KNOWLEDGE SUFFICIENT?
- HOW DO PEOPLE ACT ON EXISTING KNOWLEDGE?
- WHERE HAS RIP EDUCATION COME FROM?

PERSONAL EXPERIENCE OF BEING CAUGHT IN A RIP CURRENT – THEIR REACTIONS, BEHAVIOUR & ATTITUDE

- DOES EXPERIENCE INCREASE KNOWLEDGE?
- WHAT IS THEIR SUGGESTED EDUCATION?
- WHAT CAN WE LEARN FROM 'VICTIMS'?

DEVELOP, TEST, AND EVALUATE

- WHAT ARE THE BEST METHODS?
- WHAT ARE THE BASELINE LEVELS OF KNOWLEDGE?

POST CHAPTER QUESTIONS

①
RIP CURRENT
INCIDENT
STATISTICS

- PEOPLE ARE GETTING CAUGHT
- WHY?
- IS THEIR KNOWLEDGE POOR?
 - WHAT IS THEIR LEVEL OF KNOWLEDGE?
 - HOW MUCH DO UK BEACH USERS KNOW ABOUT RIP CURRENTS?

②
BEACH USER RIP
CURRENT
KNOWLEDGE
QUESTIONNAIRE

- WHAT BASELINE LEVELS OF KNOWLEDGE DO WE HAVE TO WORK FROM?
- DO PEOPLE WITH RIP CURRENT EXPERIENCE KNOW MORE?

③
RIP CURRENT
'VICTIM'
PERCEPTION
QUESTIONNAIRE

- ARE RECOMMENDATIONS DIFFERENT BETWEEN THESE GROUPS OF PEOPLE?
- IS THERE SOMETHING WE CAN LEARN FROM THEM?

④
RIP CURRENT
EDUCATION
PILOT

- HOW CAN WE EDUCATE?
- WHAT ARE THE KEY MESSAGES?

- HOW SUCCESSFUL WAS IT?
- WHAT ARE THE IMPLICATIONS?

Figure 1.3– Flow diagram highlighting the research questions of the thesis and data chapter rationale. Starting with the first piece of data collection (Chapter 3), each one informing the next, culminating in the rip current education pilot (Chapter 6).

Chapter 1

Literature Review

1.3 Introduction

This review provides an understanding of the core themes of the PhD, and helps to shape the focus of the study discovering gaps in research and emphasising the research aims. The PhD is multidisciplinary in nature and requires discussion of several major areas of research (Figure 1.4). Examination of physical rip current science is firstly considered, followed by hazard and risk in the beach environment. Mention is made to beach safety and lifeguarding, as well as rip current incidents and fatalities worldwide. Important consideration is then given to the social research undertaken by rip current scientists, sociologists, and psychologists as this PhD is firmly linked with these areas of research. Links to beach safety education and behavioural science are made.

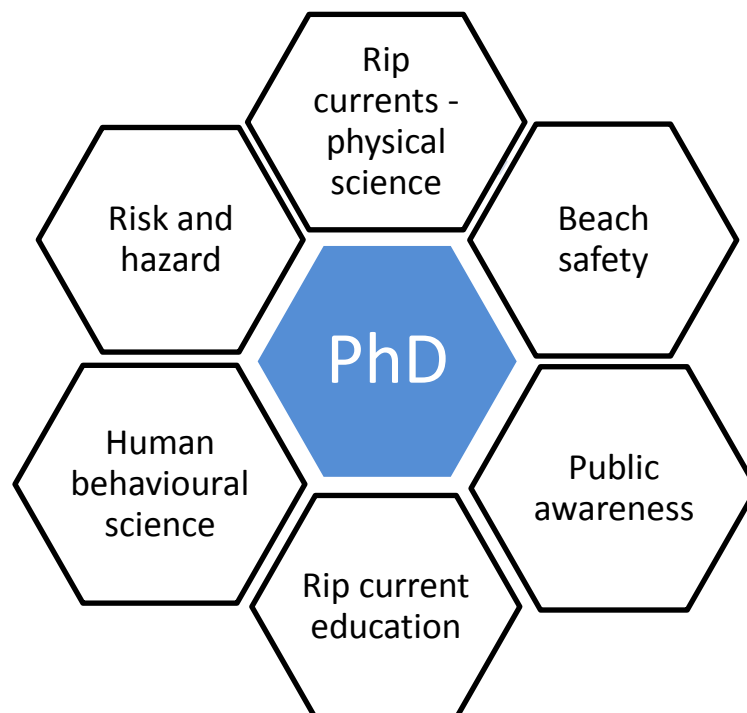


Figure 1.4 - The major themes within the PhD literature review providing the baseline understanding for the multidisciplinary study.

1.4 Rip currents

Rip currents can be found on wave dominated coastlines and beaches around the world and are a fundamental component of nearshore systems (Shepard, 1936; Dalrymple, 1978; Bowen, 1969; Brander, 1999; Brander and Short, 2000; MacMahan *et al.*, 2005; Austin *et al.*, 2009, 2010; Scott *et al.*, 2011a). The basic foundations of physical rip current science are essential aspects of any study focussing on rips. Rips have been studied scientifically since measurements were made of the nearshore currents in La Jolla, California, and it was here they were first termed ‘rip currents’ (Shepard, 1936; Shepard *et al.*, 1941).

Rip currents are described as “strong, narrow currents that flow seaward from the surf zone” (Bowen, 1969, p.5467), and are produced by the “continuous interchange of water between the surf zone and areas offshore” (Brander and MacMahan, 2011, p.4). They can reach relatively high velocities (Sonu, 1972; Aagard *et al.*, 1997; MacMahan *et al.*, 2008) and present a significant hazard to beach users’ worldwide (Lushine, 1991; Brander, 1999; Klein *et al.*, 2003; Hartmann, 2006; Sherker *et al.*, 2006; Scott *et al.*, 2007; Brander and MacMahan, 2011; Arun Kumar and Prasad, 2014). Rips are a complex nearshore system essentially determined by wave energy and the physical morphology of the beach, particularly within the surf zone (Inman and Brush, 1973). Early researchers were aware that breaking waves on beaches was a transport mechanism of offshore flow (Shepard *et al.*, 1941; Bowen, 1969; Dalrymple, 1978).

The earliest schematic of an open beach rip current was developed by Shepard *et al.* (1941) indicating feeder currents, rip neck, and rip head (Figure 1.5). As the waves break on sandbars the water flows into a feeder or longshore current which then finds the deeper areas between the bars to flow offshore as a rip current (Wright and Short, 1984). The neck is the confinement of this flow between breaking waves and may receive further flows from the surf zone along the flanks of the rip (Inman and Brush, 1973). Depending on the force and direction of the waves and the wind, the rip may recirculate back into the surf zone, or exit beyond into the rip head, where the flow of the rip then dissipates and is taken over by other longshore currents (MacMahan *et al.*, 2006, 2010).

Rip current formation and flows vary largely depending on the swell height, wave period, and direction to shore (MacMahan *et al.*, 2005; Scott *et al.*, 2009a), beach morphology (Wright and Short, 1984; Brander, 1999), wind direction and speed (Lushine, 1991; Houser *et al.*, 2011; Winter *et al.*, 2012), tidal levels (Short and Hogan, 1994; Engle *et al.*, 2002; Austin *et al.*, 2010; Houser *et al.*, 2011), and topographic features both natural and manmade (Short,

2007; Pattiaratchi *et al.*, 2009). These studies highlight the variable conditions associated with rip currents systems emphasising the complexities involved. Although there have been attempts to predict rip currents, where the environmental conditions that create higher rip current risk can be determined (Lushine, 1991; Lascody, 1998; Austin *et al.*, 2013), there will always be an unpredictability and an inability to pinpoint exactly where and when rips will occur.

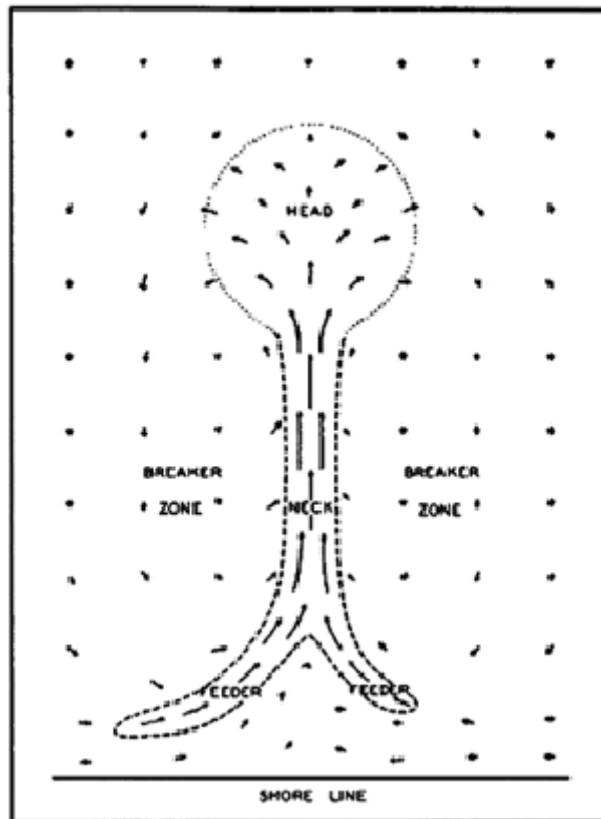


Figure 1.5 - Original rip current diagram from Shepard *et al.*, (1941, p.345) showing the feeder channels, rip neck and head in the traditional understanding of a rip current system.

Rips are often classified into different types (Short, 1985) where accretionary rips have been described above, and are associated with beach rips. The three remaining are topographic rips, transient/erosional rips, and mega-rips. Mega-rips are large scale erosion rips associated with high wave periods (>3m), and velocities can exceed 2-3m/s (Short, 1985). Topographic rip currents are found where physical features, such as headlands and promontories exist, or man-made structures such as piers, jetties, groynes, or pipelines (Short, 2007; Castelle and Coco, 2013). These topographic rips are driven by the deflection of the longshore current against the obstruction (Castelle and Coco, 2013), and often have a

continuous mean offshore flow that may ‘pulse’ strongly (Johnson, 2004). Short (2007) argues that headland rips can travel faster and further than open beach rips, posing a greater risk to water users, yet conversely Pattiaratchi *et al.* (2009) discovered that rips also recirculate within the lee of the structure. Castelle and Coco (2013) were in agreement with Short (2007), stating that headland rips reached high velocities and travelled a further distance offshore than open beach rips, indicating that rocky coasts pose a severe danger to water users.

Transient rips, also known as ‘flash’ rips, vary in occurrence and location, and are controlled by surf zone hydrodynamics as opposed to beach morphology (Johnson, 2004; Johnson and Pattiaratchi, 2006; Castelle *et al.*, 2013; Murray *et al.*, 2013). Transient rips are unpredictable as to where they occur as they are driven by pressure gradient fluctuations – increased wave sets breaking on a beach increase water levels developing pressure gradients which then force water into the depressed areas of the water surface (Johnson, 2004). This mechanism of offshore flow can be the most hazardous type of rip current to water users due to its unpredictability and speed of flow into deep water (Murray *et al.*, 2013).

Rip currents can also be found in large bodies of inland water such as the Great Lakes in North America, where wind driven waves alter water levels in the lakes, interacting with the sandy shore and structures creating hazardous rips (Meadows *et al.*, 2011). This region contributes a large proportion of rip incidents and fatalities to the US statistics (Lushine, 1991; Gensini and Ashely, 2010).

The traditional understanding of rip current systems was questioned after in-situ rip measurements on open beaches were undertaken (MacMahan *et al.*, 2010). The use of GPS ‘drifters’ in rip current measurements have shown rips to produce cellular flow patterns within the surf zone, with approximately 20% being expelled out beyond the surf zone in intermittent spurts (Figure 1.6) (MacMahan *et al.*, 2009; Austin *et al.*, 2010). The rip circulation patterns were discovered to be unequal in size, strength and direction and often masked by breaking waves, meaning the identification of rips to the eye was difficult (MacMahan *et al.*, 2010). This new insight into rip current dynamics has had far reaching implications for beach safety, and sparked a debate among scientists and beach safety practitioners, which will be discussed in section 1.7.

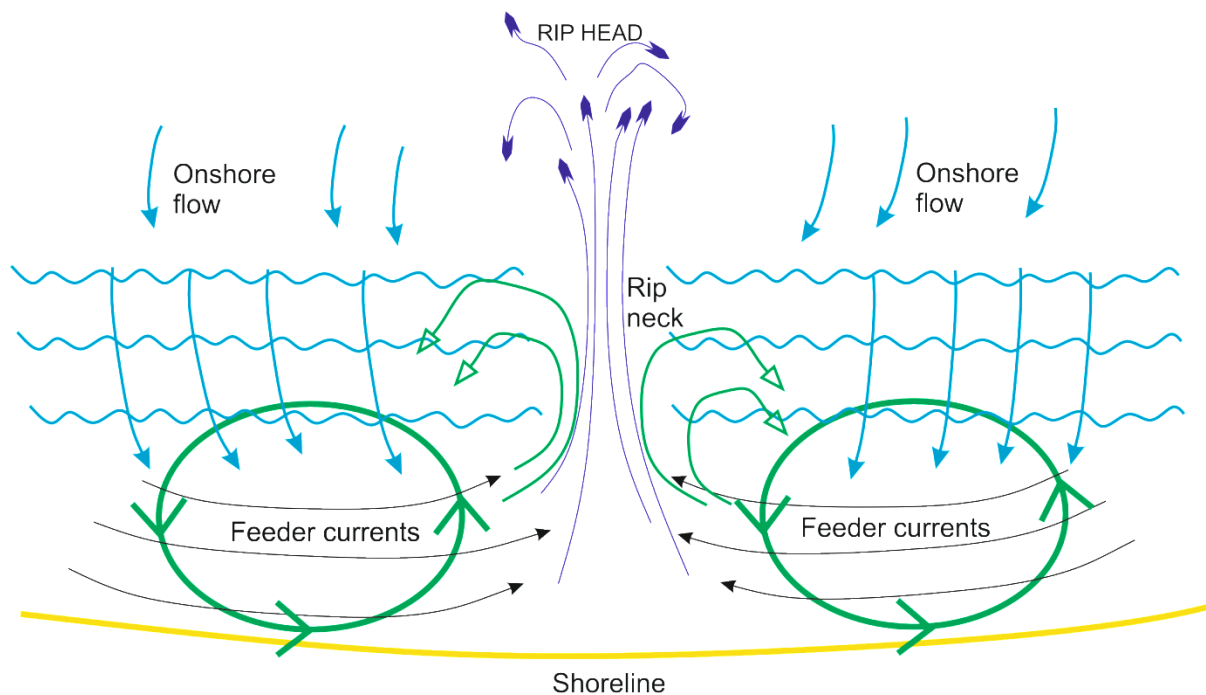


Figure 1.6 - Rip current circulation diagram indicating the circulation cells within the surf zone following research by MacMahan *et al.* (2010) suggesting that rip dynamics are now known to be much more complex than originally discovered by Shepard (1936) (Adapted from Brander and MacMahan (2011, p.6))

1.5 UK perspective

The UK possesses a dynamic coastal setting where swell, wind, tides, and beach morphologies create a variety of hazards to coast and water users, of which rip currents are prevalent. As outlined by Figure 1.1, rip currents are responsible for the greatest number of lifeguard rescues in the UK. This fits with lifeguard incident statistics from around the world, further emphasising the rip current issue.

The physical dynamics of rip currents in the macro-tidal environment of the UK have been thoroughly investigated by Scott *et al.* (2007, 2008, 2009a, 2011a, 2011b, 2014), Austin *et al.* (2009, 2010, 2013, 2014), Thorpe *et al.* (2012, 2013), and Masselink *et al.* (2014). A large number of beaches, especially on the Southwest peninsula, typically exhibit a low-tide bar-rip (LTBR) classification according to Masselink and Short's (1993) beach classification model. These beaches produce well defined rip channels, and the majority (90%) of rip current

incidents occur on beaches with this Low Tide Bar/Rip (LTBR) and Low Tide Terrace and Rip (LTTR) morphology (Figure 1.7) (Scott *et al.*, 2008).

Due to the macro-tidal environment of the UK, the tide plays a large part in affecting rip current development, flow, and speed, where Austin *et al.* (2010) found that as the tide falls, it exposes sand bars and increases rip current flow between the bars. The lower the tidal levels (spring-tides), the more exposed the bars become and the greater the rip flow speeds.

UK studies have been a significant addition to global knowledge on rip currents by contributing to the worldwide studies using GPS drifters to measure rip current circulation, and providing a macro-tidal perspective. Austin *et al.* (2013) found that rip current systems often form small rotational eddies mostly restricted within the surf zone, and on occasion exit beyond the surf zone. These measurements were also observed in France in a similar environment (Castelle *et al.*, 2007), and due to this increased tidal range, more exits occurred than in other studies with lower tidal ranges (Scott *et al.*, 2014).

This increased understanding of the hydrodynamic and morphodynamic systems that generate and influence rip currents has been studied alongside lifeguard incident data. Scott *et al.* (2011a) observed a combination of environmental factors that led to rip related ‘mass rescue’ events. Where well developed intermediate beaches receive small to medium long-period swell waves, and are subject to large tidal ranges, the rip current risk is exacerbated. These beach morphologies in the UK are typically formed during the summer months where smaller swell waves and wave period and onshore winds accrete sediment. These conditions occur simultaneously with high beach population in the summer months increasing the rip risk for bathers and water users. The risk increases further when the large range spring tides occur, as the rapid tidal flow accelerates the rip current flow, and paradoxically occur in the middle of the day, again to coincide with peak water use (Figure 1.8).

It is important to understand these physical dynamics in order to measure levels of risk and provide appropriate safety measures and lifeguard cover to mitigate rip current incidents (Scott *et al.*, 2014). This comprehension of how rip currents occur in the UK environment is also advantageous for the advancement of rip education and awareness to the public. This thesis complements the prior work implemented in the UK, combining the physically dynamic and diverse environment with the social and cultural factors which make rip current safety so multifaceted.

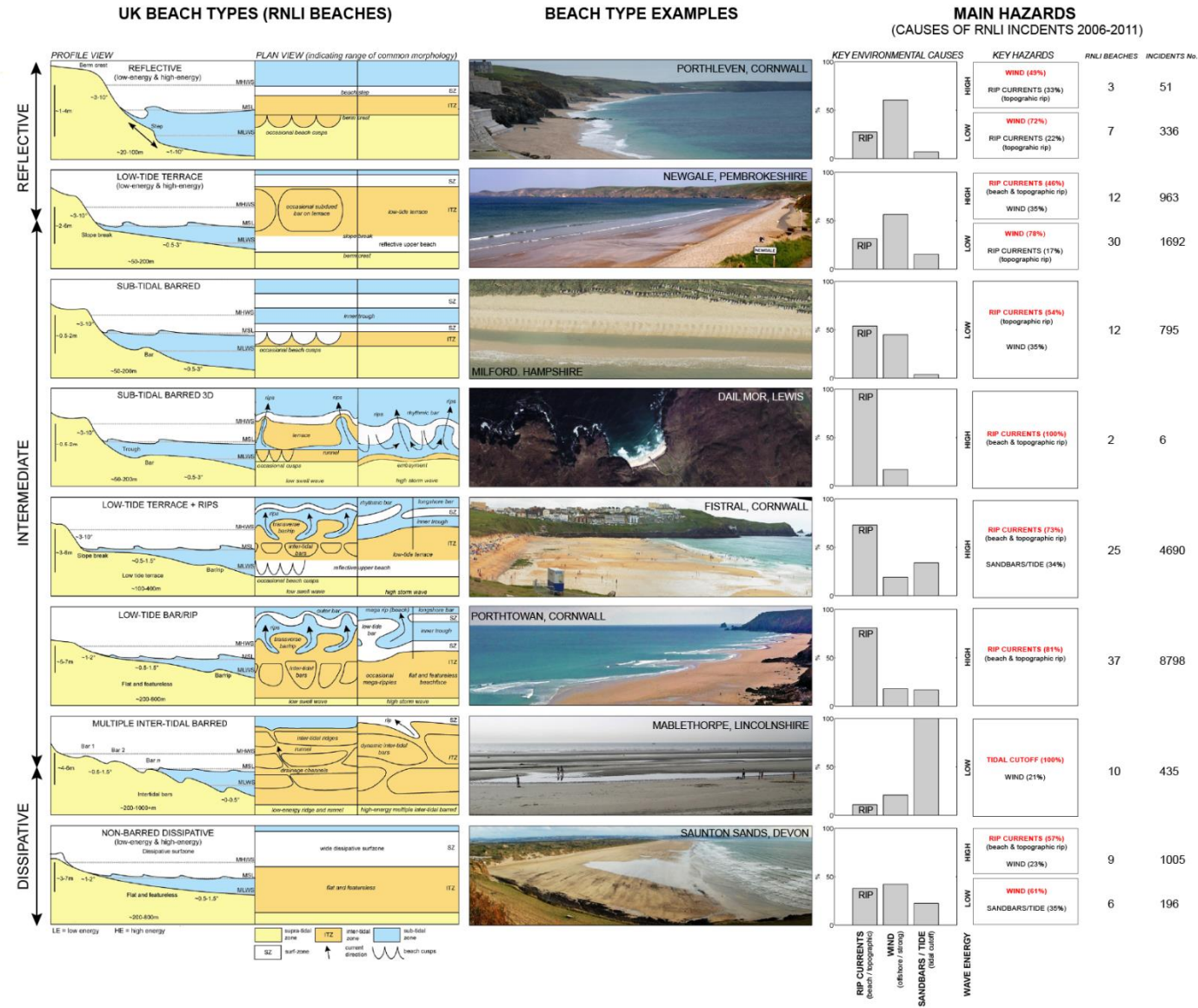


Figure 1.7– Commonly found beach types in the UK and their main hazards. Illustrations of typical lifeguarded beach types with photographic examples. On the right side the main causes of incidents are shown for RNLI beaches of that type (bold red indicates largest cause of incident). (Scott, 2009b, with permission)

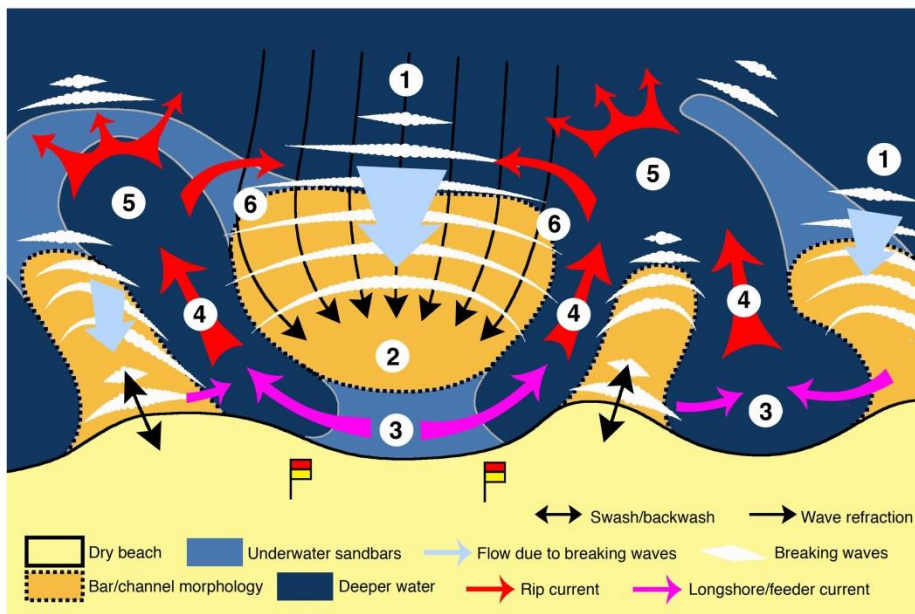


Figure 1.8 - Well-developed sandbars and deeper rip channels are seen in the top picture, and the bottom schematic of the photograph illustrates the key parts of this complex surf zone current system. (DRIBS, 2011).

1.6 Rip current hazard

As previously mentioned in section 1.5, rip currents can present a severe risk to water users, especially those unaware of the hazard. Rip currents can occur on any wave dominated coastline around the world, going largely unnoticed until human interaction alters the natural nearshore process into a potential hazard (Brander *et al.*, 2013). They are responsible for hundreds of fatalities and thousands of rescues worldwide (Lushine, 1991; Short and Hogan, 1994; Engle, 1998; Lascody, 1998; Klein *et al.*, 2003; Scott *et al.*, 2008; Gensini and Ashley, 2010; Brighton *et al.*, 2013; Arun Kumar and Prasad, 2014).

When compared to fatality numbers from hazards in Australia, Brander *et al.* (2013) indicate that annual rip current fatalities are greater than those from cyclones, bushfires, floods, and sharks combined. Additionally, in Florida, rip currents account for more deaths on average than from tropical storms, tornadoes, severe thunderstorm and lightning combined (Lascody, 1998). Rip current incidents are high-frequency low-impact in terms of public profile, because they do not always have such a dramatic impact in terms of destruction or violence, often only involving one person, and in this respect are often seen as the ‘silent killers’ of the natural world (Lascody, 1998).

The dangers of rip currents were noticed as early as the 1930’s by Shepard (1936, p.369) after consulting lifeguards in San Diego, stating “their velocity is such that a swimmer may not be able to make progress against the current”, and adding that most beach rescues along the southern coast of California are made in rip currents. This was later reinforced by Inman and Brush (1973, p.21) who declared that “rip currents are the ‘freeways’ across the surf zone for experienced surfers, and the greatest cause of drownings for inexperienced swimmers”. Rip currents have, therefore, been a hazard to water users for decades and continue to be so.

1.6.1 Fatalities and incident numbers

Published reporting of rip current incidents and fatalities worldwide is limited, yet growing. Lushine *et al.* (1999) originally estimated 150 people drowned in rip currents annually in the United States. This figure was significantly reduced after Gensini and Ashley (2010) analysed historical hazard data and concluded that an average of 35 people drown in rip currents annually. Brighton *et al.* (2013) analysed rescue service data in Australia between 2004-2011, concluding that on average 21 people drown in rips each year. In India over the

past decade it was estimated on average 39 people drowned in rip currents around the coastline (Arun Kumar and Prasad, 2014).

All these studies attribute rip currents to the majority of lifeguard rescues and coastal fatalities worldwide, and agree that detailed analysis of these databases is needed to fully understand the impact of rip currents on public safety. Lifeguard responses to rip current incidents are high. Rips are responsible for 81% of lifeguard rescues in the USA (Brewster and Gould, 2014), 89% in Australia (Short and Hogan, 1994), 68% in the UK (Scott *et al.*, 2008), and in Santa Catarina State in Brazil, for 82% of all accidents (Klein *et al.*, 2003). A lifeguard's role is one of prevention, for example, in 2013 RNLI lifeguards in the UK carried out 2,388,296 preventative actions (face-to-face, public announcements, moving signs/flags) throughout the season. Studies, however, have not illustrated how many rip incidents could have occurred without the presence of a lifeguard.

1.6.2 Rip current, rip tide, and undertow

A debate concerning rip current nomenclature has existed since Davis (1925), who connected the term 'undertow' with inexperienced swimmers caught the backwash of waves on a steep reflective beach, unable to negotiate the shorebreak. Confusion between different types of nearshore currents and flows then ensued (Quirke, 1925; Davis, 1931; Evans, 1938) until Shepard and LaFond (1939) settled the debate between rip currents and undertow, stating that rip currents are a near surface current running out to sea beyond the surf zone, and that undertow is the forward-backward motion of waves producing movement on the seabed.

The term 'rip-tide' was scorned by Shepard *et al.* (1936) who after pioneering and promoting 'rip current' as a name which most suited the "ripping current through the surf", deemed 'rip-tide' an inappropriate phrase to use when referring to rip currents because they have nothing to do with the tide. This debate still rages presently, particularly between scientists, beach safety practitioners, and the public, with the phrase 'rip-tide' used commonly within the media (Leatherman and Fletemeyer, 2010).

There is a misconception that rip currents drag people under the water, and it was noted by Shepard *et al.* (1941, p.349) that the velocity of the flow in a rip current is just below the water but that "there is little if any tendency to be pulled under the surface". The reason for the fear of a rip current pulling people underwater might be due to the mechanism of drowning, whereupon after struggling for a period of time, a swimmer will become exhausted and drown (Fenner, 1999).

The relationship between the drowning process and rip currents is important. Not only can rip currents reach rapid velocities (MacMahan *et al.*, 2008) leaving swimmers generally unable to counteract them, but unwary swimmers or surfers can find the experience overwhelming and sudden, which often instils panic (Drozdowski *et al.*, 2012). This initiates a rapid desire to reach the shore (Brander *et al.*, 2011), subsequently futile against the flow of the rip, leading to exhaustion and on occasion, drowning.

1.7 Escape strategies

As rip current research has progressed, the reality is that rip currents rarely correspond to the archetypal descriptions used for beach safety signage and campaigns (Brander and MacMahan, 2011; McCarroll *et al.*, 2014). The standard advice of swimming parallel to shore to escape a rip can in some situations be ineffective in systems that exhibit a cyclical motion, posing a problem to those attempting escape using this traditional advice.

This has led to a debate of effective swimmer escape methods that are currently promoted by beach safety practitioners (Brander and MacMahan, 2011). The exploration of rip current dynamics with in-situ drifter measurements (MacMahan *et al.*, 2010; Austin *et al.*, 2010; Miloshis and Stephenson, 2011) and human responses (McCarroll *et al.*, 2014) has allowed further worldwide comparisons of rip current flow. MacMahan *et al.* (2010) pioneered the ‘float’ escape strategy as an alternative to ‘swim parallel’, arguing that the recirculation pattern of rip currents will mostly transport swimmers back onto the sandbar allowing escape. This was challenged by Miloshis and Stephenson (2011) who suggested promoting a ‘do nothing’ strategy as there was no evidence that either tactic would produce a more effective escape.

These studies all used GPS drifters, and whilst successful and representative of human behaviour in the surf zone, did not physically measure a human body. McCarroll *et al.* (2014) has since used human participants to investigate how effective different escape strategies actually are. Where subjects were asked to utilise both the ‘swim parallel’ and ‘float’ strategies, the study concluded that neither method was dependable in a variety of rip current situations, with one working better than the other in certain conditions and vice versa. The study also took into account swimmer ability and experience, and the presence of lifeguard patrols, suggesting that the interaction of humans and physical rip current processes are complex and vary in individual situations.

Miloshis and Stephenson (2011) admit that rip currents behave differently in certain situations and on different beaches, and it is therefore difficult to pinpoint the most effective safety advice. McCarroll *et al.* (2013) further add that the inexperienced swimmer will find it more difficult to know which way to swim, especially those who are unfamiliar with ocean conditions.

Despite the debate, researchers are in agreement that swimming against the rip current is futile, and whichever escape strategy is promoted the advice of not swimming against it is paramount. Miloshis and Stephenson (2011, p.824) note that “swimmers who attempt to swim back to shore, against the current, suffer exhaustion and may drown if not rescued.” Despite promoting a ‘float’ strategy, Davis (1931) advised “if a bather is caught in a rip-tide [*sic*] he is advised to swim with it, not against it, for he will then be carried in a curving line back into shallow water”.

Aside from the best method to escape a rip current and which advice safety organisations should adopt, researchers all agree that the promotion of safe swimming on patrolled beaches should continue to be the leading piece of safety advice (Brander and MacMahan, 2011).

1.8 Beach safety and Lifeguarding

The Royal Life Saving Society (RLSS) was established in 1891 to assist those in the water in difficulty (Pearsall, 1991) after accidents on British beaches became more frequent in the heyday of public sea-bathing (Bloomfield, 1965). This movement spread throughout the British Empire after gaining Royal consent in 1904 and was strongly adopted in Australia as the coast became more populated and the surfing culture burgeoned (Booth, 2001). As regulations on sea swimming were lifted or ignored, the more experienced water users pioneered lifesaving techniques in the surf and soon formed the Bondi Surf Bathers’ Life Saving Club in 1906 (Bloomfield, 1965). This was the start of the surf lifesaving movement and voluntary lifesaving patrols in Australia which is still very much at the heart of Australian beach culture.

In Australia, the beach is seen as a traditional national identity and very much a way of life for a large proportion of the population (Webb, 2003). James (2000) describes the beach as Australia’s icon, a place where pleasure seeking is rife and is firmly fixed within the cultural sphere of the country. Although the British developed the notion of a beach resort town with a desire to civilise the beach with various architectural attractions such as promenades, piers,

and bathing pools, the Australians developed a unique culture of their own (Spearritt, 2003). Hartley and Green (2006) concur that the beach is the ‘cultural motif’ of Australia and is a way of merging the natural world that is argued to be part of Australians’ existence into modern society and culture.

1.8.1 Lifeguarding in the UK – history to present

Lifesaving had long been established in the swimming pools, lidos, rivers and lakes of Great Britain with the RLSS proving to be proficient in flat water lifesaving (Pearsall, 1991), but it wasn’t until the 1950’s that *surf* lifesaving became established in the country after a visiting Australian lifeguard fulfilled a promise to promote surf lifesaving throughout the world (Wake-Walker, 2007). Australian Allan Kennedy arrived at Bude in North Cornwall with concerns for beach safety and he immediately requested a reel, line and belt from the Surf Life Saving Australia to instruct locals in surf life saving techniques well established in Australia to ensure the future safety of beach users in Bude, culminating in the establishment of Bude Surf Life Saving Club (SLSC) in 1953 (Wake-Walker, 2007). The small fishing community of St. Agnes was next to form a surf lifesaving club in 1955 after a tragic accident, and this, coupled with the founding of Brighton SLSC, lead to the formation of the Surf Life Saving Association of Great Britain (SLSGB, 2010).

The SLSGB is the main provider of beach lifeguard qualifications through surf lifesaving clubs around the coastline. Once the qualification is gained, lifeguards can then work in a professional or voluntary capacity for the RNLI, who is the sole provider of a beach lifeguard service in the UK. The RNLI has operated since 2001 on 29 beaches, and now patrols on 214 beaches. It plans to expand into other areas of the UK currently without cover, to provide a nationwide service.

The UK bathing season is short in comparison to Australia, which can be attributed to the seasonal weather fluctuations and colder water temperatures. However, due to unseasonal weather patterns, increasing popularity of watersports such as surfing, advancing wetsuit technology, and an uncertain economic period which favours domestic holidaying, lifeguard services operate from April-October. Despite the extension of lifeguard cover, people in the UK use the water all year round when lifeguard cover is not present, increasing the risk of being caught in a rip current.

1.9 Risk – construction, management, perception, and communication

People form an understanding of environments in which they find themselves, and where they perceive threats or hazards. They will then operate accordingly to be safe, enjoy themselves, or achieve a goal. There are many risks within the beach environment, of which rip currents is one, and it is important to understand the history and human construction of risk and how it links with the work in this thesis.

Risk is defined in many different ways, but essentially is a combination of the probability of an event and its consequences (Institute of Risk Management, 2002). Toft and Reynolds (1997) state that risk is a concept inextricably linked with hazard, and Lupton (1999) declares that risks are socially and culturally constructed. Uncertainty is an addition to the complexity of risk as it is entwined with random chance and is something that occurs in the future (Cardona, 2007). Indeed, Borodzicz (2005) describes risk to be the degree of uncertainty within the consequences of an action.

The emergence of risk has long been established with the pioneering maritime ventures in the 17th century, where risk was once seen as a neutral entity where chance and probability balanced out loss and damage (Lupton, 1999; Borodzicz, 2005). Now, risk is deemed to mean a threat, hazard, danger or harm. Transformations in society, changes in economics and politics, and a growing distrust of institutions and authorities have provided ambivalence to everyday life, changing risk to mean threat (Lupton, 1999).

Risk management is the “systematic process of understanding, evaluating, and addressing risks to maximise the chances of objectives being achieved and ensuring organisations, individuals, and communities are sustainable” (Institute of Risk Management, 2015). For risk management to work effectively within a group, organisation, or community, people need to be in agreement or working at the same level (Toft and Reynolds, 1997). Slovic (2000) argues that the public must be involved in decision making processes relating to risk management, and that their early involvement must be encouraged. This is a topic that has long been discussed by risk experts, stating that there is a divide between the understanding of risk between the scientist and ‘layperson’ (Slovic, 2000), and that risks are often unknown to the public without information from scientists (Arnoldi, 2009). Slovic (2000) argues, however, that the bridging of this gap can often be a difficult and problematic process. This disconnect has been emphasised by Brander and MacMahan (2011) in relation to beach

safety and rip currents, where they argue that for an effective reduction in rip incidents, the public, safety practitioners and scientists must unite.

Complex social, cultural, natural or technical systems have inbuilt risks. Perrow (1999) suggests that an increased understanding of the complex systems increases understanding of the risks and the burden of potential disaster. The beach environment is a complex natural system, and it is important, therefore, to increase our understanding of the rip current risk to reduce the impacts. The physical rip current system is now well understood in most environments, but the social interaction is not – an issue which this thesis aims to address.

Reason (2008) developed the ‘Swiss Cheese Model’ (Figure 1.9) which looks at the breakdown of a system by latent conditions and active failures; it was dubbed ‘Swiss cheese’ due to the pictorial depiction of the holes in the cheese representing holes within a system through which errors creep. It is thought that only when an accident trajectory can pass freely through the holes within a system when the holes are lined up, that accidents can occur causing harm.

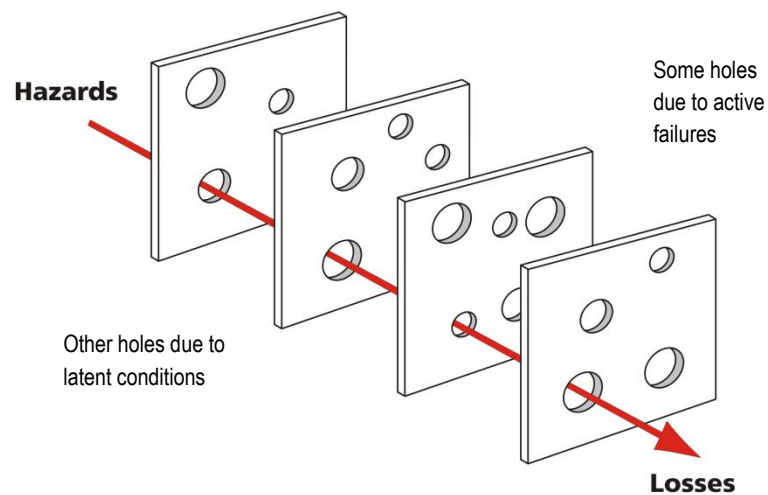


Figure 1.9 The ‘Swiss cheese’ model of risk (Reason, 2008, p.102).

Although originally developed for organisational systems, it is noted that this model can be conceptually used within any environment where risks reside (Reason, 2008). This model can be used for the beach environment, where for example on a UK beach in the summer where small to medium sized waves break on an intermediate beach, and simultaneously combine with a spring low tide, the rip current risk is heightened. When large numbers of water users enter this system, the accident trajectory can pass straight through the system

creating an incident. This is where lifeguards mitigate against this risk, but people need to be made aware of these risks and what to do when it occurs. The complexities of risk intermingled with the complexities of rip currents produce a complicated concept to grasp.

1.9.1 Risk perception

Risk perception is a major contributor to the construction of risk. Smith and Petley (2009, p.62) state “an individual’s perception of risk is the result of a complex interaction of factors and is culturally determined.” They argue that underlying cultural values sculpt individual’s beliefs and interpretations of risk. Borodzicz (2005, p.15) understands risk perception to be a theme in psychology which focusses on cognitive research with “humans acquiring knowledge through perception, reasoning or intuition” and then basing any decisions about what constitutes a risk on this.

‘Social amplification’ is thought to occur when social influences and subtleties shape risk perceptions and embellish the threat (Smith, 2006), particularly when coupled with a lack of understanding, inexperience, media coverage, and trust concepts particularly of experts in relation to the risk (Cronin *et al.*, 2004).

The difference in risk perception is therefore subjective, and can be a factor of both personal and socio-cultural issues (Michalsen, 2003) as well as the political and psychological issues mentioned above (Slovic, 2000; Borodzicz, 2005). Risks are constructed and perceived in different ways depending on age. There is a higher level of risk taking which occurs between childhood and adolescence, which explains why teenagers are prone to pushing boundaries of risk perception (Irwin and Millstein, 1991).

It is important to discuss risk perception within this thesis, because how beach users perceive rip current risk is a major topic of inquiry. Risks are perceived differently for many reasons, and this thesis is particularly interested in how different ages, genders, water users and rip current knowledge have a bearing on how people perceive the risk of rip currents. The UK beach culture under study has not been explored before, and so a grasp on what influences risk perceptions must be obtained.

1.9.2 Aquatic risk

In the aquatic world, especially in beach and coastal activity, males are overrepresented, and risk literature has long established this male dominance in risk taking (Peden and McGee,

2003). Experts in risk and gender have documented that men generally assess risks as lower compared to women (Slovic, 2000), due to levels of maturity, social pressures and a desire to prove masculinity (Slovic, 2000; Lupton, 1999).

It is reported that males spend more time in the water and venture further out to sea thus exposing themselves to risk (Gulliver and Begg, 2005; McCool *et al.*, 2008; Morgan *et al.*, 2009; Moran, 2011). This is partly due to females perceiving a greater risk, feeling more vulnerable, and having more concern about entering the water (McCool *et al.*, 2009). These differences in risk perception and levels of confidence are not defined by ability, but an underlying psychology and genetic makeup (Goya *et al.*, 2011; Moran, 2011a, 2011b).

The essential link between gender and risk, especially in the aquatic world, is that males tend to overestimate their ability and underestimate the risks, and dominate drowning and incident statistics, particularly in relation to rip currents (McCool *et al.*, 2008, 2009; Moran, 2006; Goya *et al.*, 2011). Australian statistics show that 85% of coastal drownings in 2011 were male (SLSA, 2011), and in the USA, males are 6 times more likely than females to be victims of rip currents (Gensini and Ashley, 2010).

McCool *et al.* (2009) conducted a study which drew upon the use of the Protection Motivation Theory to develop a greater comprehension of swimming behaviour among New Zealanders. The theory provides a framework to explore cognitive processes surrounding decision making with regard to risks, threats, and coping abilities. Gender differences found females were less able to identify safe bathing areas, undertake less risky behaviours (e.g. swimming at depth), can better identify a need to be rescued if in difficulty, and generally, were more concerned by the risk of drowning.

1.9.3 Risk Communication

Borodzicz (2005) outlines that risk communication materialised because of the concerns over technical information from experts being misunderstood by laypeople. Arnoldi (2009) states that communication about risk will only succeed if the people who receive the information can relate to it and interpret it easily.

Slovic (2000) discusses that perceptions vary widely between inaccuracy, being anxious or disturbed by information, having strong prior beliefs, or easily swayed naivety. Ultimately he adds that without knowing a little of the culture or language of the environment one is operating in, it is hard to communicate. Yet this is exactly what risk managers attempt to achieve with the public because they are under the impression that they share the same

theoretical and cultural background in the sphere of risk. This is where communication of risk fails and the communicators need first to understand the cultural and societal context in which they are working to be successful. This thesis aims to understand these contexts within the UK, and to be able to effectively communicate information about the rip current risk around the coastline.

1.10 Rip currents – social research

In the social science faction, rip current studies are utilising the physical studies mentioned previously to understand the human interactions with rips (Sherker *et al.*, 2008). It is thought that by investigating how people behave on the beach and in rip currents, and how they perceive the risk of rip currents, strategies can be implemented to change behaviours and educate beach users (Ballantyne *et al.*, 2005; Sherker *et al.*, 2008; McCool *et al.*, 2009; White and Hyde 2010; Brander *et al.*, 2011; Drozdowski *et al.*, 2012; Caldwell *et al.*, 2014).

1.10.1 Beach safety and rip current knowledge

Several studies conducted in Australia found that beach users have a poor knowledge of rip currents (Ballantyne *et al.*, 2005; Williamson *et al.*, 2008; 2012; Sherker *et al.*, 2010). Almost 80% of Australians surveyed by Williamson *et al.* (2008) were aware of common beach safety advice such as swimming parallel to the shore to escape, but only 40% could identify a rip current despite the majority of 80% saying they could. In addition, half the respondents indicated that rip currents were the safest place to swim. Some people find swimming in waves difficult, and quite often enter the water to swim in the seemingly ‘calmer’ rip current due to its lack of waves. Ballantyne *et al.* (2005) reported 20% of respondents as saying “calm water means it is safe to swim”.

Different methods to assess rip current knowledge include using pictures of rip currents (Sherker *et al.*, 2010; Branstromm *et al.*, 2014), by asking people to draw their interpretation of a rip current (Caldwell *et al.*, 2014), and by assessing rip current ‘survivors’ (Drozdowski *et al.*, 2012). In drawing rip schematics, Caldwell *et al.* (2014) acknowledged, those producing a more accurate drawing had a greater knowledge of rips and were also more able to identify a rip current. Ballantyne *et al.* (2005) discovered that 62% of respondents knew what a rip current was, but the majority could not actually recognise one.

Drozdowski *et al.* (2012) found that knowledge of rip currents is greater in people who have experienced being caught in a rip current. They argue that experience of a rip current is the best way to avoid one in the future, because there is an expectation as to what may happen and can therefore remain calm. This is echoed by Sherker *et al.* (2010) who found those with rip experience are better placed to make decisions about where to enter the water, and are more confident in their reaction if caught in one. Despite some beach users having knowledge of rip currents and hazards, it is clear that this knowledge is not always put into practice (Ballantyne *et al.*, 2005).

More recently, research in the US highlighted a generally poor public understanding of rip currents (Caldwell *et al.*, 2013; Branstromm *et al.*, 2014). Caldwell *et al.* (2013) noted respondents had a poor knowledge of rip current dynamics, identified that less than 20% were able to identify rip channels and currents, and were found to be overconfident in their ability to do so. Branstromm *et al.* (2014) found only 13% of respondents were able to identify a rip current, and of those people it was acknowledged that being able to notice wave patterns was crucial in identifying rip locations. Worryingly however, the study also found that people who go to the beach more often are less able to identify rips. It appears there is a slightly better understanding of beach safety issues in Australia (Ballantyne *et al.*, 2005) compared to the US, which shows a possible cultural difference.

Ballantyne *et al.* (2005, p.617) argue that to effectively raise awareness of rip currents through education and public available information “management needs to identify current knowledge and perceptions of beach environments.” Indeed this is reiterated by White and Hyde (2010) who concluded that the more effort put in to establishing behaviour of beach users will ultimately lead to more effective education campaigns to reduce fatalities and incidents.

1.10.2 Behaviour

Observing the behaviours of people at the beach is important because it can help us to understand why people act in certain ways – is it because of a lack of knowledge, is it thrill seeking, is it a desire for isolation, or is it defiance? On beaches around the world lifeguard patrols advise on the safest areas to swim, often placing red and yellow flags as a guide, or coloured flags to indicate levels of risk (Brander and MacMahan, 2011). International research on beach safety flags has shown that people are safest to enter the ocean between the

patrol flags, and that most fatalities occur outside these areas (Wilks *et al.*, 2007; Sherker *et al.*, 2010).

A large number of studies have shown that despite an understanding of the flag systems, there are still people who choose not to enter the water in these safe locations (Ballantyne *et al.*, 2005; McCool *et al.*, 2008; Sherker *et al.*, 2010; Branstromm *et al.*, 2014). The reasons for these behaviours are not fully understood, but some researchers relate it to psychological actions (White and Hyde, 2010) and wanting to exercise control over personal actions (Williamson *et al.*, 2012).

Ballantyne *et al.* (2005) discovered that 68% of respondents indicate they would swim between the flags on a patrolled beach, yet in reality only 32% actually did. The study identified differences between Australian and international students, and found 90% of the domestic students stated they would swim between the flags compared to 51% of the international students. Firstly, this highlights cultural differences, where Australians are mostly brought up with and surrounded by beach culture and lifesavers (Booth, 2001), but secondly that international visitors might not always understand the language and safety messages or signs (Ballantyne *et al.*, 2005). For these reasons, international tourists have long been a key target audience for Australian beach safety messages, and highlight the importance of using specific strategies for different groups (Williamson *et al.*, 2012).

The exhaustion which can overcome people swimming or paddling directly against a rip current back to shore (Drozdowski *et al.*, 2012) is a major hurdle for beach safety practitioners to address to prevent drownings in rips. One of the most clear and well promoted rip current safety messages is ‘don’t swim against a rip current’. This message is not always observed due to underlying psychological reasons and individual situations (Brander *et al.*, 2011) when experience a rip current.

The Theory of Planned Behaviour (TPB) is a conceptual model (Figure 1.10) for reasoned action providing a framework of understanding, predicting, and changing human social behaviour, brought to prominence by Ajzen (1991). The model displays the reasons behind decision making where the central factor of peoples’ behaviour is their intention to perform it (White and Hyde, 2010). This includes a risk versus benefit evaluation, any social pressures, and the ease or difficulty in which it can be carried out. TPB is particularly important to discuss because people’s attitudes towards beach safety, in addition to the decisions they make and behaviours they perform when at the beach, are central to the research within this thesis. Additionally, the TPB explains the steps towards behaviour change, which is the

ultimate goal for beach safety practitioners, such as changing motivations to attend a lifeguarded beach, or to swim between the flags. The TPB is also a consideration in the development of the rip current education pilot in Chapter 6. White and Hyde (2010, p.1832) describe the foundation of the model:

Intention is influenced by attitude (positive or negative evaluation of performing the behaviour), subjective norm (perceived social pressure to perform or not perform the behaviour), and perceived behavioural control (perceptions or ease of difficulty in relation to behavioural performance; also said to impact directly on behaviour).

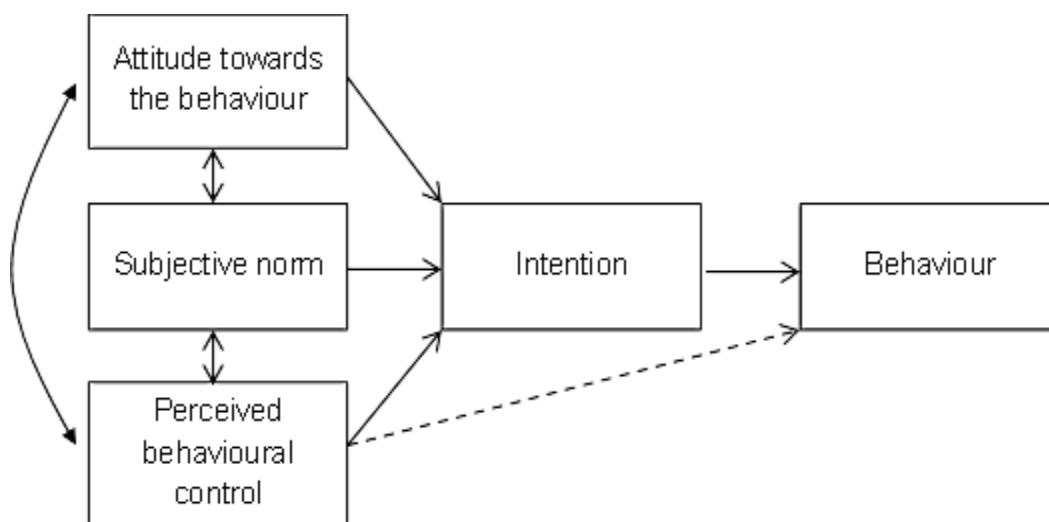


Figure 1.10 - The Theory of Planned Behaviour showing the influences on a person and the steps they take to perform a specific behaviour (Adapted from Ajzen, (1991)).

This is linked to the earlier discussion that risk is driven by society, culture, and bias, and how influences of perceived and acceptable risk impact on peoples’ behaviour. White and Hyde (2010) found that the TPB model allows risk perceptions to be incorporated when predicting swimming behaviours and intentions at the beach, and that attitudes, subjective norms, pressure from others and underlying cultural factors all influenced behaviour.

1.11 Rip current education

There is widespread belief, enhanced by recent research, that rip current education is the key to keeping people safe at the beach and preventing lives being lost. There has, however,

only been one published rip current specific education strategy that was undertaken by Hatfield *et al.* (2012) where a study into the effectiveness of a rip current campaign was conducted. Their intervention was informed through Sherker *et al.* (2010) revealing Australians behaviour and beliefs about safety flags and rip currents, and through cognitive theories of behaviour. The intervention highlighted the identification of rip currents through recognition of darker gaps of ‘calm’ water between breaking waves. It showed that the ‘don’t get sucked in by the rip’ brochures achieved the highest message recall, and that females and English speakers were most likely to see intervention materials. Despite a relative success however, the intervention did not seem to target males, who are known to be the most at risk and account for the most rip current fatalities. Hatfield *et al.* (2012) concluded that their campaign was a success in that it effectively warned people about the dangers of calm looking rip currents. They argue that increasing knowledge about such a particular hazard can alter a person’s behaviour to avoid the hazard and chose a safer action.

Rip currents account for a large number of fatalities and rescues in Brazil. A successful generic beach safety campaign led to an 80% reduction in fatal accidents on beaches (Klein *et al.*, 2003). This project highlighted a lack of knowledge or respect for flag systems, and subsequently used videos, newspapers, signs, and leaflets to promote safety messages, and encouraging increased preventative measures by lifeguards for a successful outcome.

Both Ballantyne *et al.* (2005) and Sherker *et al.* (2010) advocate rip current education, in particular the identification of rips, to avoid entering one in the first place. Caldwell *et al.* (2014) suggest that education can improve beach safety as their study found that knowledge of rip currents allowed people to be able to identify them more easily and avoid the hazard.

Branstromm *et al.* (2014) concluded that beach users are able to identify topographic rips more than erosional beach rips, and the education of this type of rip is potentially easier. In addition, they argue a case for educating beach users to become familiar with simple patterns in the surf zone that may help them look for rip currents, rather than try to spot the rip outright.

In the USA, the NOAA Sea Grant programmes have used signage, brochures, posters, videos, and public service announcements using the ‘Break the Grip of the Rip!’ slogan to raise awareness (Figure 1.11) (Carey *et al.*, 2006), but to date, have not measured how successful these schemes have been. The United States Lifesaving Association has researched the chance of a person drowning while at a lifeguarded beach in the US is 1 in 18 million (USLA, 2010) and persistently tries to reduce the number of rip related incidents through public safety campaigns.

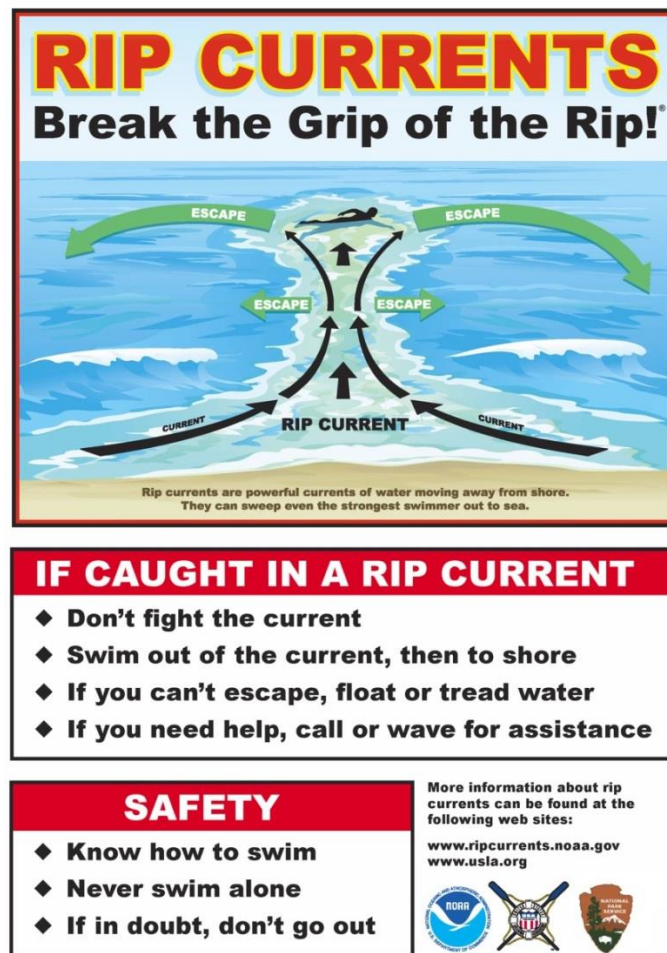


Figure 1.11 – ‘Break the grip of the rip’ public education poster promoted in the USA by the USLA and NOAA Sea Grant programmes (USLA, 2014).

Leatherman and Fletemeyer (2010) argue that the lack of evidence of effective public education is due to the detachments between the education campaigns and research. This is reiterated by Brander and MacMahan (2011), who debate that there has been a disconnect between researchers, practitioners and the public, but that through collaborative projects this is beginning to change. This is where this thesis will attempt to bridge the gap between research, practice and the public through collaboration, insight into beach users, and ultimately a research led education campaign.

1.12 Summary

This review gives an insight into the complex physical and social components of rip currents. Rip currents and the subsequent hazard they present are widespread. The solutions to preventing incidents and fatalities can be drawn from research from the international scientific community. Social research of rip current behaviour, knowledge, and education can highlight general recommendations and insights. Where the solution breaks down is in the regional and national differences in beach safety practices, beliefs, understanding and culture. This is why this study is important; it adds to the small but growing number of social rip current studies, but provides that unique insight needed at a national level, and so presents the UK perspective.

Australia has long pioneered beach safety and its subsequent lifesaving history, and has led the way in social and behavioural rip current studies. From the works of Sherker *et al.* (2008) who identified that people need to know what rip currents look like in order to avoid getting caught in one, to Hatfield *et al.* (2012), who evaluated a successful print based awareness campaign, among others, we can infer these practices can be drawn upon worldwide. However, Australia is very different in society, culture, beach safety practices, climate, and beach use to the US, which is in turn different to Brazil, to France, to New Zealand, and to the UK. Drawing on the international research and focussing it on a specific socio-cultural system is where the gaps in prior research will be filled.

Added to this, the environmental and morphodynamic conditions of beaches worldwide are also different, meaning the rip current hazard varies between beach type and swell window. A meso-tidal beach in Australia will have different rip circulations that are more prevalent at certain states of the tide, operating under specific wave conditions, than to a European macro-tidal beach. The physical system is important; it is the environment into which we place ourselves and subsequently present ourselves to an inherent rip current risk, by becoming interlinked within the system.

We are in a fortunate position in the UK where the physical morphodynamics of rips are well known through the studies of Scott *et al.* (2007, 2009a, 2014) and Austin *et al.* (2009, 2010, 2012). The rip current hazard is heightened at times of spring low water, when waves are small to medium in height, and intermediate beaches display well defined rip channels. This is key to informing beach safety patrols and implementing resources, but may also be useful information to include in education programmes.

Increased understanding of physical rip current dynamics, gaining numbers in the social and behavioural sciences, and a constructive link between scientists and practitioners is a positive position for rip current research to be in. We are now at a plateau of information which needs to progress towards rip current education where there is presently a dearth of evaluated research. This project attempts to address this gap and begin the next stage of the study.

We have gained an insight into the relationship between society, culture, behaviour and understanding of rip currents with beach users in countries around the world. We don't, however, know anything about British beach users in relation to rip currents. We know that rip currents are responsible for the majority of rip current rescues in the UK (Figure 1.1), but we don't know the details of these incidents – who is getting caught, where, how, and when. We also don't know the levels of rip current understanding in the UK, nor what experiences people have had with rips. This thesis aims to address these questions in a unique social investigation into the specific problems of rip currents in the UK.

Chapter 2

Methodological Approach

2.1 Introduction

This chapter outlines the methodological approach taken which informs the choice of methods for collecting and analysing data. Creswell (2009) states research design “is the plan or proposal to conduct the research, and involves the intersection of philosophy, strategies of inquiry, and specific methods” (p.5). This is shown in Figure 2.1, where these three main parts of the research design are shaped by the research questions as they evolve throughout the process. The research questions of this thesis have been presented in Chapter 1 (Figure 1.3), but are further explored within this chapter to provide a rationale behind the methods and techniques used to answer these questions. The research questions aim to further our understanding of why people are caught in rip currents in the UK.

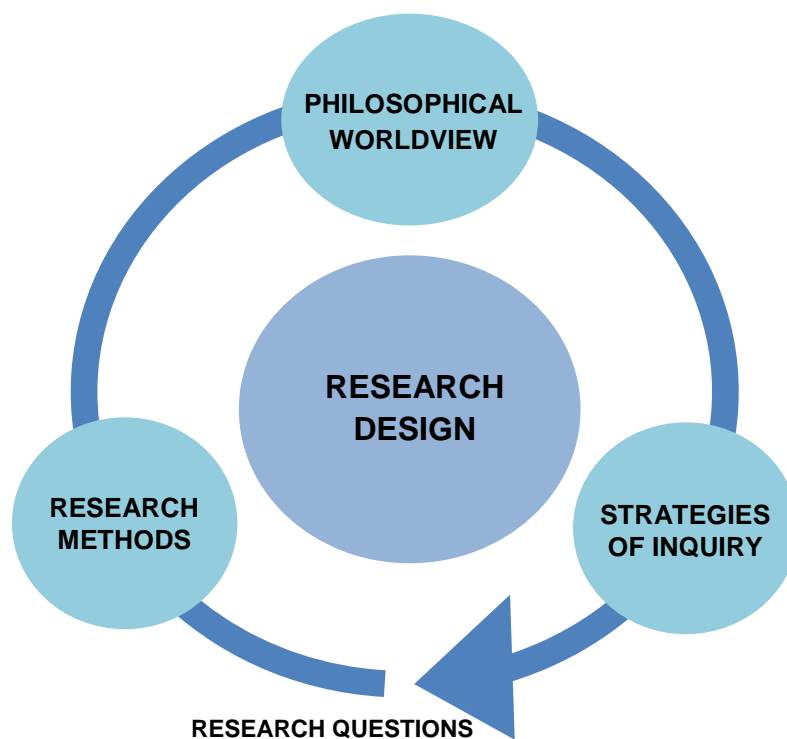


Figure 2.1 - A framework for research design – the interconnection of worldviews, strategies of inquiry, and research methods. (Adapted from Creswell, 2009, p.5).

It is important to understand underlying principles and philosophical assumptions adopted by the researcher as it will guide the actions and inform the research within this thesis. The philosophical worldview of the researcher, therefore, is discussed to illustrate the rationale of the chosen methods and strategy of inquiry. The integration of quantitative and qualitative methods complement each other within the social nature of this PhD and a mixed methods approach is presented. The research methods for each line of inquiry within this thesis are identified and discussed, as well as the sampling and data analysis.

2.2 Philosophical Worldview or Paradigm

The term ‘philosophical worldview’ was coined by Creswell (2009) to label what Guba (1990, p.17) initially described as “a basic set of beliefs that guide action” and otherwise known as a paradigm, epistemology or ontology. Sandelowski (2000) presents the idea that a paradigm is a ‘viewing position’ where different paradigms entail contradictory views, framing issues differently and prompt different questions. Strauss and Corbin (1998, p.128) state that a particular ‘paradigm’ provides a “perspective towards data”, allowing the combination of data organisation and procedures to follow a pre-defined logical viewpoint. Patton (2002, p.69) presents the idea that “paradigms tell us what is important, legitimate, and reasonable” and provides a basis from which to embark on a research study.

Philosophical worldviews, or paradigms, therefore are important ideologies to follow, providing a guiding framework for research. Strauss and Corbin (1998, p.33) argue that “the researcher will not be able to enter into the project with a set of pre-established concepts or with a well-structured design” - something that exploring specific worldviews will enable a researcher to begin structuring their research. Creswell (2009) believes that the worldview a researcher holds, their past experiences, those advising the researcher and the environment under study will direct the study towards specific approaches and research designs.

Philosophical worldviews have been taken into consideration when devising the strategy of inquiry for this PhD. It helps to frame the beginnings of the study in a way that help structure and organise data to ensure the correct methods are being used, and the right data is being collected to answer the research questions. The right framework for this study must take the complex interactions of physical and human systems into consideration.

Both the postpositivist and interpretivist paradigms in their purest forms are not seen as individually appropriate for this study. Positivism follows the ‘cause and effect’ way of

thinking, and is bound by structured methods and rules to conducting studies and testing theories generally found in quantitative research. Although some of the research questions of this study warrant following this quantitative worldview, such as discovering the demographics of rip current victims through analysis of an incident database, it will not give a needed flexibility or depth required to understand the social side of the study.

This depth will come from a constructivist or interpretivist paradigm, which is mainly associated with qualitative research and “seeks understanding of the world in which they live or work” (Creswell, 2009, p.8). The role of the researcher is very important, often interacting with research subjects and people to gain a better understanding and social construct of the environment under study. This worldview is important to answer some of the more social oriented research questions, such as seeking to explore the experience of people caught in rip currents.

It is the belief of the researcher, however, that in order to study, observe, and understand a topic completely and holistically, the research has to be adaptable and pluralistic in its development. For this study, therefore, a mixture of these two paradigms is needed, where the differing methods and techniques used to collect and analyse data is the most comprehensive way to fully understand the interaction of people and rip currents. This view can be placed firmly in the ‘dialectic stance’ which “assumes all paradigms offer something and that multiple paradigms in a single study contribute to a better understanding of the phenomenon being studied” (Tashakkori and Teddlie, 2010, p.14). In this respect, it is the researcher’s belief that pragmatism is the best worldview to adopt for this PhD.

2.2.1 Pragmatism

Pragmatism focusses on the practical implications of the research, and is an approach whereby the researcher does not have to engage in “deep epistemological reflection and philosophical study” (Patton, 2002, p.69) and is instead “free to choose the methods, techniques, and procedures of research that best meet their needs and purposes” (Creswell, 2013, p.28). This is further enhanced by Johnson and Onwuegbuzie (2004, p.17) who state that pragmatism:

Offers a practical and outcome orientated method of inquiry that is based on action and leads iteratively to further action and the elimination of doubt; and it offers a method for selecting methodological mixes that can help researchers better answer many of their research questions.

Pragmatists contemplate the practical outcome of their research and place the problem being studied at the heart of the research with a focus on asking the right questions to address it (Creswell, 2013).

Pragmatism, therefore, can be deemed appropriate for this study as it has a practical outcome in the form of a rip current education scheme. Additionally, the question of why people are caught in rip currents in the UK is very much a central problem that needs constant attention throughout the thesis. Denzin and Lincoln (1998) also emphasise the importance of versatility of the researcher and their ability to adopt many methods of inquiry to ensure the robustness of the research. As this study progresses, more questions will become apparent, and the flexibility of a pragmatic approach allows methods and techniques to change to answer these emerging questions.

2.3 Quantitative, Qualitative, and Mixed Methods

Denzin and Lincoln (2000, p.19) assert “strategies of inquiry put paradigms of interpretation into motion” and therefore the discussion of the paradigm in the previous section provides the basis for the research methodologies discussed here.

Research studies need to select an appropriate method to answer the research questions, and follow specific procedures to ensure who, or what, is being studied in the most effective way (Creswell, 2009). The main three methods available to researchers are quantitative, qualitative, and mixed methods. The former two methods have, in the past, been firmly set within the boundaries of social or physical science respectively (Denzin and Lincoln, 1998; Rossman and Wilson, 1985; Steckler *et al.*, 1992). There has been a shift, however, towards integrating the two strategies in an attempt to combine the strengths and weaknesses of each faction for more robust research studies. Gummesson (2003, p.487) concludes “whether research is labelled quantitative or qualitative is immaterial. There is no genuine conflict; we should use whatever tools are best suited to assist us.”

Quantitative and qualitative methods are more effective for certain types of research, and that the research question is the most important aspect towards choosing the methods (Creswell, 2009). The research questions of this study demand investigation of rip current incidents, the exploration of the knowledge people have of rip currents and beach safety, and their experiences of being caught in a rip current. In order to answer some of these questions, a quantitative approach can be used to measure attitudes, understanding and opinions of a

population. In addition, qualitative methods must be adopted to explore the social world of human experiences and behaviours at the core of the study, and when studying people there is always be a need for qualitative research (Sandelowski, 2000). Creswell (2009) argues that a qualitative approach should be used when limited prior research has been done on a concept, which is true of the social aspects of rip currents, particularly within the UK. Steckler *et al.* (1992, p.1) neatly summarise the strengths of the two stances of research:

The strengths of quantitative methods are that they produce factual, reliable outcome data that are usually generalizable to some larger population. The strengths of qualitative methods are that they generate rich, detailed, valid process data that usually leave the study participants' perspectives intact.

Both approaches will need to be used and integrated in tandem, and utilising the pragmatic view, the most suitable approach would be to use a mixed methods research design. The most appropriate mixed methods procedure for this PhD study is the concurrent mixed methods approach. Creswell (2009, p.15) summarises that “the investigator collects both forms of data at the same time and then integrates the interpretation of the overall results”, essentially merging the two types of data for a more thorough grasp of the research questions.

This integration of quantitative and qualitative data provides a stronger and more complete understanding of a research problem (Tashakkori and Teddlie, 2010). The idea that the results of one method can inform another is a central tenet of the mixed methods approach, and is particularly relevant in this PhD study as results from Chapter 3 identify methods and locations used in Chapter 4, and the participants chosen in Chapter 6. Additionally, the opinions and suggestions of participants in Chapter 5 assist the design and delivery of Chapter 6.

2.3.1 Reliability and validity

Research studies need to be of high quality and consistency, which is achieved through validity and reliability. Creswell (2009) states that the validation of findings will occur throughout each process of a research study, and the meaning and processes are different between quantitative and qualitative research. Quantitative studies place an importance on the measures it creates, where validity asks whether the instruments measure what they were supposed to, and reliability asks if the measure will obtain the same results if it is repeated (Hesse-Biber, 2010). Oppenheim (1992, p.144) presents this subject neatly, stating:

Reliability refers to the purity and consistency of a measure, to repeatability, to the probability of obtaining the same results again if the measure were to be duplicated. Validity on the other hand, tells us whether the question, item, or score measures what it is supposed to measure.

Qualitative studies take on a different approach, whereby validity means certain procedures are employed by the researcher to ensure the findings are accurate, and reliability is achieved being consistent across different researchers and projects (Creswell, 2009). Lincoln and Guba (1985) provide alternative terms for qualitative research by stating that ‘trustworthiness’ consists of four aspects: credibility, transferability, dependability, and confirmability. Credibility and confirmability in this thesis can be gained through triangulation of multiple data sources, for example face-to-face questionnaires and online questionnaires, to assess consistency of findings (Patton, 2002). Additionally, peer debriefing can be used in the development of the education pilot to uncover biases of the researcher, and test emergent assumptions (Lincoln and Guba, 1985). Transferability, or external validity, can be achieved through thick description, whereby describing a phenomenon in sufficient detail to create patterns between cultural and social relationships (Holloway, 1997), such as a thorough exploration of rip current experiences. Dependability within this thesis can be achieved through an external audit, where a researcher external to the project can examine the processes, findings, and interpretations to assess whether they are supported by the data.

Mixed method projects need to consider both the quantitative and qualitative strands of validity and reliability, and trustworthiness; often called ‘legitimation’ (Onwuegbuzie and Leech, 2006). The correctness of the research design in a mixed methods study is the principle component to the validation of the study, rather than the findings (Creswell, 2009). The link between the research questions and the method is important – do the methods provide a ‘goodness of fit’ to answer the aims of the study? Did the research capture an understanding of the issue? How well did the researcher answer the research question? (Hesse-Biber, 2010, p.87).

This important link between the research question and the methods as the ‘legitimation’ process is constant throughout this thesis. For example, to discover what people know about rip currents, a questionnaire uses quantitative measures of reliability and validity, but also uses the qualitative procedure of engagement and observation in the field, whilst continually linking with the research question.

It is argued that the use of multiple methods is a validation in itself, and the switch between quantitative and qualitative procedure provides a greater depth of understanding of

the research topic adding “rigor, breadth, complexity, and richness to any inquiry” (Denzin and Lincoln, 2000, p.5). Rossman and Wilson (1985, p.631) conclude that “a variety of different approaches greatly enhances the credibility of research results”.

2.4 Methods

Although analysing incident data, questionnaires, and testing knowledge are all quantitative in nature, there is an opportunity to obtain qualitative data through the use of open-ended questions, participant observation, and allowing the data to emerge from the study rather than be regimented to a pre-determined approach. Methods for each piece of data collection are discussed here and then in more detail within the relevant data chapter.

2.4.1 Incident database

The RNLI incident database is a record of every incident attended to by lifeguards during the operational season (Chapter 3, Figure 3.1). Each incident is associated with an event containing one or more individuals that require RNLI lifeguard assistance beyond preventative actions and incorporates the following information:

- Date and time
- Region, beach and location on the beach
- Distance from the lifeguard patrol both along the water’s edge and out to sea
- Rescue, assistance, major or minor first aid, near miss or search
- Method of rescue and equipment used
- Demographic breakdown of casualties
- Activity and numbers of people involved for each activity
- Cause of incident: environmental, physical, or behavioural
- Environmental conditions: weather, wave height, state of tide, wind conditions
- A narrative of the incident

For the purpose of this study, all incidents relating to rip currents were selected from the overall incident database. Analysis was conducted on records from 2006-2013 operational seasons, and all the people recorded within these incidents, consisting of 16,777 individuals. This information was used in this study to indicate the proportion of rip current incidents

compared to overall incidents, and to discover who is caught in rip currents, when, where, and how.

2.4.2 Questionnaires

Questionnaires have long been established in social research as they are a useful tool for measuring individual and group attitudes, beliefs, behaviours, and reasons for action towards the subject under examination (Bird, 2009). More pertinent to this study and in the field of natural hazards research, Bird (2009) adds that questionnaires are a popular and essential instrument for obtaining information on knowledge and perception.

2.4.2.1 Face-to-face questionnaires

Face-to-face questionnaires are used in Chapter 4. Bird (2009) states that in general face-to-face interviews gain data that is more insightful and valid. Complex questions can be asked, and where misunderstood, the questions can be clarified. Additionally, interviewers can motivate or prompt respondents should they need it. A better observation of behaviour can also be made, in particular how respondents draw on their surroundings during an interview, which is important for this study as we are seeking to understand how people behave at the beach. High response rates can also be achieved via face-to-face questionnaires, which are needed in this study to ensure the beach going population is sufficiently represented.

There are, however, some disadvantages to face-to-face questionnaires such as they can be spatially restricted, costly, time consuming, interviewer biased, and filtered answers. The questionnaires for this study, however, were small scale and undertaken by volunteers from within the researchers research group to keep costs down. Time taken to undertake the survey was deemed valuable to the PhD thesis because the researcher will gain a better understanding of the environment and people under study. Every care was taken to ensure the interviewers were trained properly so as not to inflict bias into questions and to elicit honest answers from respondents.

2.4.2.2 Online questionnaires

An online questionnaire is used for data collection in Chapter 5. Designing a questionnaire and delivering it via the internet provides a fast, low cost way to reach a lot of participants

over a large geographical area. Other advantages include the elimination of interviewer bias as the survey is seen on the screen the same way every time, and is therefore interpreted by the participant, creating a greater depth to the response. Phellas *et al.* (2012) commented that “participants are also often more willing to give more honest answers to a computer than to a person or on a paper questionnaire” and often gives rise to longer responses to open ended questions. This does however provide a more time consuming analysis.

An online questionnaire in this study was deemed advantageous as the purpose of locating a broad range of people across the UK who have been caught in rip currents is best done via the internet. Although missing an interviewer, the virtual interface can provide a personal way for the participants to remember their experience and provide richly detailed answers. One of the research questions asks what people’s reactions were, both physically and emotionally, when caught in a rip current, and it is hoped that this questionnaire can provide additional qualitative analysis for a rounded mixed method study.

Participants, however, may be distributed based on their computer use, and does not necessarily reflect the population under investigation as not everyone has access to the internet, or will ever see the survey advertised. This was overcome by using other methods to approach those who have been caught in a rip current, such as lifeguards distributing leaflets on the beach, advertising the survey link on national television and finally through the use of social media to promote the survey.

2.4.2.3 Open and closed ended questions

Open and closed questions were used within the two questionnaires within this study as they elicit different results, analysis, and investigation of a topic. On the one hand closed questions provide a choice to respondents, and on the other open questions allow free response or opinion that is outside any scales or rules (Oppenheim, 1992; Reja *et al.*, 2003). Closed questions provide highly quantitative results and are able to be analysed statistically, whereas open questions provide qualitative results that require detailed analysis and coding of responses. It is advised that both the face-to-face and online questionnaire combine both forms of question, as is normal within a mixed method approach.

The advantages of using closed questions are that they require little time to ask and respond to, require no extended writing, make group comparisons easy, and are relatively easy to process. The disadvantages, however, are that these questions often lose spontaneous responses, can be too simple, and can create a bias in the answer categories. It is important to

have these closed questions within this study to generate numerical responses for statistical analysis, allowing a deeper scrutiny between groups.

Open ended questions also need to be included as the “detailed, descriptive data deepens our understanding of individual variation...adding depth, detail, and meaning at a very personal level of experience” (Patton, 2002, p.15). The advantages of open ended questions are that they give a freedom and spontaneity, and an opportunity to probe respondents for deeper answers, and they are useful for testing hypotheses about ideas or awareness. The latter, in particular, is essential for this study, as rip current awareness of UK beach users is one of the main research questions. Open ended questions, however, can be time consuming and demanding to both ask and respond to, and the coding process in analysis can be laborious and slow.

This study will use both types of question, as within the realms of a mixed method study, collecting quantitative and qualitative data will assist to answer the research questions appropriately. Creswell (2009) emphasises that quantitative statistics can be reinforced by qualitative quotes to ensure a more rigorous approach to data analysis, a relevant procedure within this study.

2.4.3 Education pilot

The rip current education pilot will be developed from the results of Chapters 3, 4, and 5. Firstly, Chapter 3 identifies the target audience to deliver the pilot to, as the demographics of rip current incidents become apparent. Secondly, Chapter 4 will present the levels of beach user understanding of rip currents, and will provide the baseline knowledge levels from which to pitch the education pilot. Thirdly, Chapter 5 explores the educational recommendations of people who have been caught in a rip current. It is envisaged that the development of the education pilot will emerge as the data is collected, following the adaptable ideology of pragmatism. Williamson *et al.* (2012) concluded that beach safety and rip current education must refine strategies to specifically target those at risk using evidence based interventions. The education pilot in this study, therefore, aims to be as informed as possible through the data collected in the first three chapters of this thesis, and details can be seen in Chapter 6.

2.5 Participants and sampling

2.5.1 Calculating questionnaire sample size

A sample will need to be taken to find a representative group of the overall population under study (e.g. beach users or people caught in a rip current). The margin of error, or the extent of sampling error, is the percentage that describes how closely answers given by the sample are to the ‘true value’ of the population; the smaller the margin of error, the closer to having the exact answer. The confidence level is a measure of how certain the researcher is that the sample accurately reflects the population. In this instance, for example, if 57% of our sample pick an answer, we can be 95% sure that if we ask the question of the entire population, between 52% and 62% of people would pick that answer. The sample size can be calculated using the following formula:

$$\text{Sample Size} = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p(1-p)}{e^2 N}\right)}$$

Population Size = N, Margin of error = e, z-score = z

e is percentage, put into decimal form (for example, 3% = 0.03).

The z-score is the number of standard deviations a given proportion is away from the mean.

At the 95% confidence level, the z score = 1.96

This calculation is used in Chapters 4 and 5 to gain representative samples for each survey. For Chapter 4, the sample is drawn from the Visit England (2012) statistics, which estimated 37 million people visited the beach in 2012. In Chapter 5, the target population will be people in the UK who have been caught in a rip current. Between 2003-2013 the RNLI rescued 7909 people from rip currents, an average of 988 per year. The population size for our online survey, therefore, is 988 from which we need to draw a sample. The sample size representations, confidence levels, and margins of error are reported in Chapters 4 and 5 respectively.

2.5.2 Beach questionnaires

The target population is all people who visit the beach in the UK during the summer. The locations where this population was targeted is further defined from the results of Chapter 3, which outlines the beaches where most rip current incidents occur. The four beaches chosen from results in Chapter 3, and through convenience sampling, were two rural beaches - Chapel Porth and Constantine Bay, and two resort beaches – Perranporth and Croyde.



Figure 2.2 – Sampling ‘cells’ on each of the four study sites ensuring all areas of the beach are covered to represent a typical beach user. The sub-areas chosen are access points, the upper beach, and the water’s edge (Adapted from Google maps).

A stratified sampling method was used by dividing the population into sub-areas or ‘cells’, based on areas of the beach where visitors naturally congregate such as access points, the upper beach, and the water’s edge (Figure 2.2). An area was then assigned to interviewers, who selected people at random within these sub-areas. Oppenheim (1992) states that to select the necessary people, interviewers have to use their initiative in this type of sampling, Interviewers, therefore, were tasked with selecting both male and female respondents, all age

groups, and both water based and beach based activity users, to ensure the typical beach user was represented.

The questionnaires were collected using Apple iPads as they are easy to use, eliminate paper transfer, and are appealing to respondents (Figure 2.3). The iSURVEY application was used, which is an offline data collection app that supports unlimited devices. Once within range of an internet connection, the survey responses can then be downloaded directly onto a computer for data processing.



Figure 2.3 – Images from the field of face-to-face questionnaire data collection (E. Woodward, personal photograph, July 2012)

2.5.3 Online questionnaire

The target population was people in the UK who have been caught in a rip current. Non-probability sampling was used because the probability that every respondent will be included in the sample cannot be determined. Quota sampling was adopted, where specific people needed for the survey are targeted by interviewers (Oppenheim, 1992). In this instance, the ‘interviewers’ are the RNLI who advertised the survey online, through their media channels and lifeguards who handed the details of the survey to people they had rescued.

2.5.4 Education pilot

The population studied was teenagers between the ages of 13-18 within secondary schools and community groups in Cornwall and Plymouth in the Southwest of the UK. Initially schools within Plymouth and Cornwall were approached and invited to take part within the

study which received minimal response. Using the researcher's links with some of these schools, communicating and gaining access to run the pilot was made easier. The Scout groups were more flexible with their timetables and were enthusiastic to receive external speakers for their sessions. The schools assigned 30 minute sessions per group within class time, and the scout groups allocated as much time as necessary within their evening meetings.

2.6 Analysis

2.6.1 Incident analysis

Rip current incidents were analysed using Microsoft Excel 2010, where filters were applied to the data for specific years and independent variable such as age, gender, beach location etc. Descriptive statistic techniques were used to classify characteristics of location, demographics, activity and physical hazards.

2.6.2 Questionnaire analysis

Questionnaires were used in Chapters 4, 5, and 6, where analysis of both closed and open questions were undertaken. Open ended questions are analysed using coding, which is discussed in the next section. Closed questions were analysed using standard statistical techniques such as descriptive statistics, comparisons of the mean and tests for revealing characteristics of respondents, where trends can be identified, and to determine the significance of relationships between variables.

The data processing for each questionnaire was different due to the manner of data collection. The face-to-face questionnaire was undertaken on a tablet computer where responses were simply transferred electronically into a spreadsheet for analysis. The online questionnaire resulted in each response being automatically recorded into spreadsheet format and stored until the survey was closed. The questionnaires in Chapter 6 were undertaken on paper by the participants and manually entered into an electronic spreadsheet by the researcher.

Once within these spreadsheets, each survey was assigned a code book where each question is assigned a numerical value or shorthand text label, and the response categories are also assigned a number. Each questionnaire is therefore reduced to numbers, where the numbers in each question relate back to the original question (and the raw answers) and are

recorded in the code book. Once entered as numbers, statistical analysis took place using IBM SPSS Statistics 21 and Microsoft Excel 2010.

2.6.3 Coding

Open ended responses were analysed using a mixture of latent and inductive content analysis, where the themes are derived from the data and placed into identifying groups with a label known as a 'code' (Denzin and Lincoln, 1998). Although arguable that content analysis is a qualitative form of analysis, some argue that it is quantitative because in manifest content analysis code frequencies are counted (Berelson, 1952), an additional technique which has been used in Chapters 4 and 5 to provide deeper analysis.

The practice of coding was borne out of grounded theory (Glaser and Strauss, 1967), where this systematic gathering and analysis is used "to investigate interactions, behaviours, and experiences as well as individuals' perceptions and thoughts about them" (Holloway, 1997, p.80). Coding is thought of as analysis, insofar as sifting through responses or narrative allows the researcher to gain detailed insight into respondents' answers whilst simultaneously categorising the data. The purpose therefore, is to reduce people's experiences and valued ideas into concepts that link together around a core theme running through the main study.

In coding there should be a focus on the meaning participants assign to events and experiences – how individuals construct their view of a phenomenon, and the words and phrases they use to describe it, to reflect 'reality' (Ryan and Bernard, 2000). In this way, open ended questions do not have pre-defined categories allowing participants a freedom to narrate their experience, a key concept of Grounded Theory, and in turn the data guides subsequent themes and constructs to emerge from the study (Denzin and Lincoln, 2000).

Due to the qualitative nature of both the face-to-face and online questionnaires, and the number of open ended questions eliciting a number of multiple response answers, quantitative analysis is difficult, hence this inductive method was chosen. Each open ended question was extracted from the main spreadsheet along with the respondent ID and assigned a new file. Each question was checked for spelling and typographical errors, before being meticulously read through and assigned a code. In this respect, the analysis process of coding is extremely thorough and it allowed the researcher to fully understand the respondents' knowledge and experience of rip currents at the heart of the study.

2.6.4 Statistical Analysis

When analysing data using statistics, it is assumed that the data is normally distributed about the mean. A Shapiro Wilks test was performed in each chapter on specific datasets to assess whether the data was normally distributed, which then establishes which statistical test is appropriate for the data (Table 2.1), where $p > 0.05$ equates to a normal distribution and $p < 0.05$ the data deviates from a normal distribution.

Table 2.1 – Outline of the different types of statistical tests used on specific kinds of data within this thesis, and why they were chosen (adapted from UCLA Statistical Consulting Group, 2015).

The data under comparison	Dependent variable	Independent variable	Parametric test (normally distributed)	Non-parametric test (non-normally distributed)
The means of 2 independent groups	Interval/ Continuous/ Scale/	Categorical/ Nominal	Independent t-test	Mann-Whitney U test
The means of 2 paired samples (e.g. before and after)	Interval/ Continuous/ Scale/	Time variable (time 1= before, time 2= after)	Paired t-test	Wilcoxon Signed Rank test
The means of 3+ independent groups	Interval/ Continuous/ Scale/	Categorical/ Nominal	One-way ANOVA	Kruskal-Wallis test
The 3+ measurements on the same subject	Interval/ Continuous/ Scale/	Time variable	Repeated measures ANOVA	Friedman test
Assessing the relationship between two or more categorical variables	Categorical/ Nominal	Categorical/ Nominal	Chi-Squared test OR Fisher's exact test (if expected frequencies of 5 or less)	

The Chi-square test for association (χ^2) was used to determine whether nominal (or categorical) variables were statistically independent or if they were associated. The null hypothesis is that the classifications are independent, i.e. that there is no relationship between

classifications. The alternative hypothesis is that the classifications *are* dependent, i.e. that a relationship or dependency does exist. This was used on questions where a mean was not available such as multiple choice questions or pre-defined nominal categories, and comparisons of groups such as gender. A Chi-Square test assumes that each cell has an expected frequency of five or more, where cells that do not meet this requirement result in an invalid Chi-Square test. In this instance a Fisher's exact test is used because it can be used no matter how small the expected frequency is.

An Independent t-test or Mann-Whitney U test is used for the comparison of the mean between a dependent variable and an independent variable with two samples such as gender. A one-way ANOVA or a Kruskal-Wallis test was used to test the differences of the means of a dependent variable and an independent variable with more than 2 samples, such as age or group. A Wilcoxon Signed Rank Test (*W*) was performed in Chapter 6 on the pre-talk and post-talk knowledge. This test was used because the data deviated from a normal distribution, where a Paired t-test would be used for normally distributed data. This test is used to determine whether the mean of a dependent interval (or continuous) variable is the same in two related samples.

Example results – $\chi^2(20)=37.604, p=0.010$. Where χ^2 =Chi-square value, (20) is the degrees of freedom (*df*) - the number of independent values or quantities that can be assigned to a statistical distribution, and where *p*= the level of significance value, where less than 0.05 means we can be 95% confident that the relationship between the two variables is not due to chance, and can be deemed statistically significant.

2.7 Summary

This chapter has outlined the philosophical worldview that supports the exploration of the research questions within this thesis, providing a framework for the research design. Methods, data collection and analysis techniques have also been discussed, providing a detailed description of how the data in this thesis will be undertaken and presented. The following four chapters detail each stage of data collection and present the main results of the thesis.

Chapter 3

Rip current incident analysis

3.1 Introduction

Material in this chapter has been adapted from:

Woodward, E.M., Beaumont, E., Russell, P.E., Wooler, A., and Macleod, R., (2013). Analysis of Rip Current Incidents and Victim Demographics in the UK. *Proceedings 12th International Coastal Symposium, Plymouth, England. Journal of Coastal Research*, SI(65):850-855. (Appendix 9)

This chapter presents analysis of rip current incidents on UK beaches. This examination is a unique social study of lifeguard rip current incident data and is the first study of its kind in the UK. Incidents were comprehensively analysed for the 2006-2013 operational seasons where the specific aims were:

- To discover the key demographic characteristics of people involved in rip current incidents.
- Analyse the spatiotemporal variation in rip current incident locations on beaches around the UK coastline.
- Determine whether specific activities are more or less likely to be associated with rip current incidents.
- Examine the location of individual rip current rescues in proximity to the lifeguard patrol areas.
- Provide a basis for further exploration within the thesis.

The work of Scott *et al.* (2007) scrutinised the RNLI lifeguard incident dataset in 2005 for all physical environmental causes of lifeguard incidents in the southwest of the UK, concluding that rip currents represent the greatest number of incidents (68%), and that beach morphologies and hydrodynamics significantly alter hazard type. This chapter builds on the physical environment studied by Scott *et al.* (2007) and provides a unique insight into the social aspect of people being caught in rip currents around the UK coastline. Events relating specifically to rip currents have been extracted from the 2006-2013 lifeguard incident

database and comprehensively analysed to discover the demographics of people involved in rip current incidents, as well as additional information such as location and activity.

Rip currents represent the greatest risk to water users worldwide (Brander and MacMahan, 2011). The UK possesses a dynamic coastal setting presenting a variety of beach types, many of which demonstrate prime rip current forming environments (Austin *et al.*, 2009, 2010; Scott *et al.*, 2011a). In particular the popular tourist beaches on the Atlantic coast of Devon and Cornwall typically exhibit a low-tide bar-rip classification according to Masselink and Short's (1993) beach classification model. These beaches receive an annual swell height of 1-1.5m and a mean spring tidal range of 4.2-8.6m (Scott *et al.*, 2011a). The large tidal range allows a full range of water coverage from reflective upper beaches to the intermediate lower beach where exposed low tide bar and rip systems are often well developed (Austin *et al.*, 2010).

The UK coast and its beaches are a popular natural resource for recreation and tourism throughout the year. Approximately 37 million people visited UK beaches in 2013 (Visit England, 2013), thus a large population is potentially exposed to this significant rip current hazard should they enter the water. The RNLI has managed the beach lifeguard service in the UK since 2001 and in 2013 it operated 202 lifeguard units. The service aims to reach any beach casualty up to 300m from the shore within the patrol flags within 3½ minutes (RNLI, 2010). Risks posing a threat to beach users are therefore mitigated by lifeguards between April and October, and rip current rescues are carried out every year during operational hours. Outside these hours the risk is heightened, making water users more vulnerable, and as watersports popularity rises and wetsuit technologies advance, people are increasingly using the coast all year round. This population, as well as seasonal beach users, can benefit from rip current and beach safety education as a number of rip current rescues and fatalities occur outside lifeguard hours. These incidents are potentially preventable by notifying beach users of the rip current risk and allowing them to make informed decisions on their water based activity. These issues will be addressed in Chapters 4 and 5.

Published reporting of rip current incidents and fatalities worldwide is limited. Lushine (1999) originally estimated 150 people drowned in rip currents annually in the United States. This figure was significantly reduced after Gensini and Ashely (2010) analysed historical hazard data and concluded that an average of 35 people drown in rip currents annually. These studies however, do not analyse lifeguard incident data to assess the number of preventative actions taken by lifeguards in relation to rip currents. Brighton *et al.* (2013) analysed rescue service data in Australia between 2004-2011, concluding that on average 21 people drown in

rips each year, and that 48% (n=602) of rescues were attributable to rip currents in Australia. All these studies, however, attribute rip currents to the majority of lifeguard rescues and coastal fatalities worldwide, and agree that detailed analysis of these databases is needed to fully understand the impact of rip currents on public safety.

The work in this chapter therefore provides a unique cultural perspective specific to the UK on rip current incidents. This study not only identifies who is caught in rip currents, but also where, how, and when. This demographic and spatiotemporal information is important to begin to explore the social interactions with rip currents in the UK. The work in this chapter emphasises the importance of analysing rip current incidents to ensure education is evidence based and targets the correct people. The analysis of these incidents adds to the efforts of researchers and practitioners worldwide to reduce the number of rip current fatalities.

3.2 Method

This chapter uses the RNLI incident reports collated for the 2006-2013 lifeguarding seasons. Every beach operated by the RNLI in the UK records all water and beach based responses to incidents, ensuring detailed information is obtained to provide a comprehensive dataset. During this period the RNLI expanded operations to several different areas in the UK from 62 beaches in 2006 to 202 beaches in 2013. A straight analysis of the incident numbers would therefore be biased towards those areas which have been operational since 2006, so for the purpose of unbiased analysis, the incident data has been normalised to show differences in rip current incident numbers over years of operation and per beach. This normalisation is acknowledged in the relevant section of the results.

The incident database contains all rescues performed by lifeguards over a season and can be caused by several aspects of which rip currents is one. For the purpose of this study, incidents where rip currents were the main reason for rescue were extracted from the overall database for analysis. The incident report form records a number of factors during one rescue event which may include both multiple victims and activities, and can be seen in Figure 3.1.

The RNLI (2012) define the following normal operational procedures:

- Lives saved – where, if a lifeguard had not intervened, life would have been lost.

- Rescue – where a lifeguard responds to a person at risk and physically returns them to shore or transfers them to another rescue craft.
- Assistance – when a lifeguard aids a person in the sea who is at very little risk but would be at risk later if left.

A rip current incident is defined as when a lifeguard assists or rescues a person from a rip current and returns them to shore often using rescue equipment. We cannot be certain of the accuracy of the recordings as there have been no studies or observations on RNLI lifeguard incident reporting. There may be occasions where a lifeguard has recorded an incident as a rip current when it was not, or miscalculated the number of people involved or type of activity, and we can only speculate on the accuracy. We can be sure, however, that RNLI lifeguards receive rigorous training on how to report incidents and the value of these statistics. Where possible, statistical tests are reported for the accuracy of the means within this sample.

The main information examined from this dataset was:

- Location: the beaches where rip current incidents occurred and subsequently where rip current incidents were absent. Investigation was also made into annual differences between beaches, proportion of total beaches, and specific regional variation.
- Activity: the activities people were participating in at point of rescue, and whether there was any regional or demographic variation.
- Incident location: the area of the beach in which the incident occurred, from the lifeguarded patrol flags to other areas of the beach.
- Demographics: the age and gender of those people caught in rip currents to determine a ‘typical’ rip current victim.
- Physical hazards: any physical geological features such as rocks or cliffs, or man-made structures such as piers, groynes, seawalls etc. that may create a topographical rip current and be a feature within an incident.

Descriptive statistical analysis was undertaken on the data to summarise the main features of rip current incidents ensuring the aims of this chapter were met, and specifically to provide an overview of relationship between gender, age, activity, and geographical location.

Incident Report

Basic Info SIS only: SAP no. _____

Lifeguard Area _____ Lifeguard Unit _____ Date / / Time : _____

Red flagged at time of incident Orange windssock flying Were any specific warnings/prev actions given UIIN Number _____

Alerted to incident coordinated Other SAR Units

LG CG RNLI ILB RNLI ALB Police Ambulance Air Ambulance
 Fire SAR Helo Casualty Public Other _____

Location

Craft/surf zone Red/yellow zone
 Outside of zones Other _____

Distance from LG patrol both along the beach and out to sea.

Along beach (distance from red and yellow flags)

Within the red/yellow flags 0-50m 51-200m
 201-500m 501-1,000m 1,000m+

From water's edge

0-50m 51-200m 201-300m 300m+

Method of transport to incident used by

1st LG on Scene other responding LGs On Foot 4WD ATV as per rescue Other _____

Nature of Incident

Number of people	Method of rescue/assist	Male			Female		
		Child (0-12)	Teen (13-17)	Adult (18+)	Child (0-12)	Teen (13-17)	Adult (18+)
Rescue	Not a rescue/assist						
Assistance	Swim - no equipment						
Major First Aid	Swim with tube						
Near Miss	Rescue Board						
Other:	IRB						
Animal Rescue:	RWC						
	Other						

Activity & Numbers of People (enter numbers)

Activity	Number	Activity	Number	Activity	Number	Activity	Number
Bodyboarding		Bodyboarding with fins/flippers		Climbing		Fishing	
Kayaking (sitting in)		Kayaking (sitting on top)		Kitesurfing		Powered craft	
Surfing (with school)		Swimming		Walking		Walking (with dog)	
						Windsurfing	
						Inflatable (craft)	
						Inflatable (toy)	
						Relaxing/passive	
						Surfing	
						Other	

Cause of Incident

Environmental

Rip Currents
 Other Currents
 Tidal Cut Off
 Winds
 Surging Waves
 Plunging/Dumping Waves
 Other _____

Physical

Cliffs Rocks (natural) Promenade
 Piers/jetties - Pylon Structure
 Sea Defence - Solid Structure
 Other _____

Behavioural

Violent/threatening
 Act of daring
 Caused by another person
 Inexperienced
 Self Harm / Suicide
 Believed under influence of alcohol
 Believed under influence of drugs

Equipment (used by casualty)

Equipment failure Inappropriate equipment

Environmental Conditions

Weather	Wave Height	State of Tide	Wind Conditions
Clear/sunny <input type="checkbox"/>	0.0 - 0.5m <input type="checkbox"/>	Ebbing <input type="checkbox"/>	Onshore <input type="checkbox"/>
Part cloudy <input type="checkbox"/>	0.5 - 1.0m <input type="checkbox"/>	Flooding <input type="checkbox"/>	Offshore <input type="checkbox"/>
Overcast <input type="checkbox"/>	1.0 - 1.5m <input type="checkbox"/>	High <input type="checkbox"/>	Crossshore <input type="checkbox"/>
Rain <input type="checkbox"/>	1.5 - 2.0m <input type="checkbox"/>	Low <input type="checkbox"/>	Wind Force _____
Fog/Mist <input type="checkbox"/>	2.0m+ <input type="checkbox"/>		

Does this incident warrant investigation for either:
 Health & Safety Meritorious recognition
 Safety/Education Other _____

Were any photographs or video footage taken of this incident? Yes No

Narrative

Do you consider a life has been saved , expand narrative on separate form.

Lifeguard (Print name) _____ Lifeguard Signature _____

Figure 3.1 – RNLI lifeguard incident report form showing the information recorded allowing thorough analysis of incident statistics (A. Wooler, personal communication, January, 2012).

3.3 Results and Discussion

This chapter provides new information about rip current incidents in the UK, with specific insight into the geographical location, demographics, and activities associated with these incidents. The analysis of the RNLI's incident data has discovered some significant themes for discussion that will also be taken forward throughout this thesis. Discussion of the main results is expanded in the subsequent subsections.

Table 3.1 - Overview of the number of rip current incidents responded to by RNLI lifeguards between 2006-2013.

Year	Lifeguarded beaches	Rip current incidents	Individuals rescued from rip currents	% of individuals rescued attributable to rip currents*
2006	62	676	1352	59.9
2007	69	908	1989	76.0
2008	107	1007	2161	73.7
2009	141	1046	2638	70.5
2010	152	1077	2262	57.3
2011	163	1084	2205	62.1
2012	183	1055	2098	57.2
2013	202	1056	2072	51.3
Total	202	7909	16777	
Annual Average		988.6	2097.1	63.5

* Percentage of individuals rescued from a rip current as a proportion of all rescues by RNLI lifeguards in the UK.

3.3.1 Overview

Between 2006-2013, RNLI lifeguards assisted 16,777 people from 7909 rip current incidents, an annual average of 2097 people from 989 incidents (Table 3.1). The number of rip current incidents has increased over the 8 year period, but this can be attributed to the RNLI's expansion of lifeguarded beaches. Rip current incidents were recorded on 162 beaches for the entire period, which represents 80% of all RNLI operated beaches, with an

annual average rip current incident total of 66% of all beaches. These figures show how prevalent rip currents are around the UK coastline, and how dominant they are to lifeguard incident numbers. Figures from the USA (Lushine, 1991; Gensini and Ashley, 2010) and Australia (Brighton *et al.*, 2012) support these UK findings showing that rip currents are the main cause of rescue worldwide.

Accuracy of the annual figures for all RNLI beaches that recorded rip current incidents is shown in Table 3.2, where confidence intervals of the mean have been calculated. For example, for 2006, the margin of error at the 95% confidence interval is ± 3.30 . Therefore we can be 95% certain that the mean number of rip current incidents for each beach in 2006 is between 8.158 and 14.758.

Table 3.2 – Annual average number of incidents for each beach that recorded a rip current incident, and the measurement of the 95% confidence interval.

Year	2006	2007	2008	2009	2010	2011	2012	2013
Total	676	908	1007	1046	1077	1084	1055	1056
Mean	11.45	13.969	9.970	8.109	7.748	7.425	6.720	6.519
St. Dev	12.933	26.104	19.754	14.330	16.229	16.951	14.885	12.654
Count	59	65	101	129	139	146	157	162
Conf. level	1.96	1.96	1.96	1.96	1.96	1.96	1.96	1.96
Margin of error	3.300	6.346	3.853	2.473	2.698	2.750	2.328	1.949
Upper Bound	14.758	20.315	13.823	10.582	10.446	10.174	9.048	8.467
Lower Bound	8.158	7.623	6.118	5.636	5.050	4.675	4.391	4.570
Max	66	138	150	81	121	145	135	89
Min	0	0	0	0	0	0	0	0
Range	66	138	150	81	121	145	135	89

3.3.2 Location

Analysis of the incident data shows a variation in geographical distribution of rip current incidents around the UK coast. Figure 3.2 displays all the RNLI beaches where a rip current incident occurred and the average number of incidents for each beach. The detailed inset in Figure 3.2 shows the beaches on the Southwest peninsula, where there is a particularly high concentration of patrolled beaches and that display higher numbers of rip current incidents. A Chi-Square Goodness of Fit test analysed the whether the observed incident numbers differ from hypothesised proportions, where the null hypothesis is that each region, lifeguard area, and beach are expected to have equal chance of rip current incidents. There is a significant difference ($\chi^2(17)=46699.639$, $p<0.0005$) in rip current incidents across the regions of the UK, where North Cornwall (+4202.6), North Devon (+910.6), and South Devon (+98.6) recorded more rip current incidents than expected, and all other regions have less than expected. There is also a significant difference between observed and expected values for beaches, where $\chi^2(164)=35721.160$, $p<0.0005$, indicating that beaches in the Southwest record more rip current incidents than in other regions of the UK.

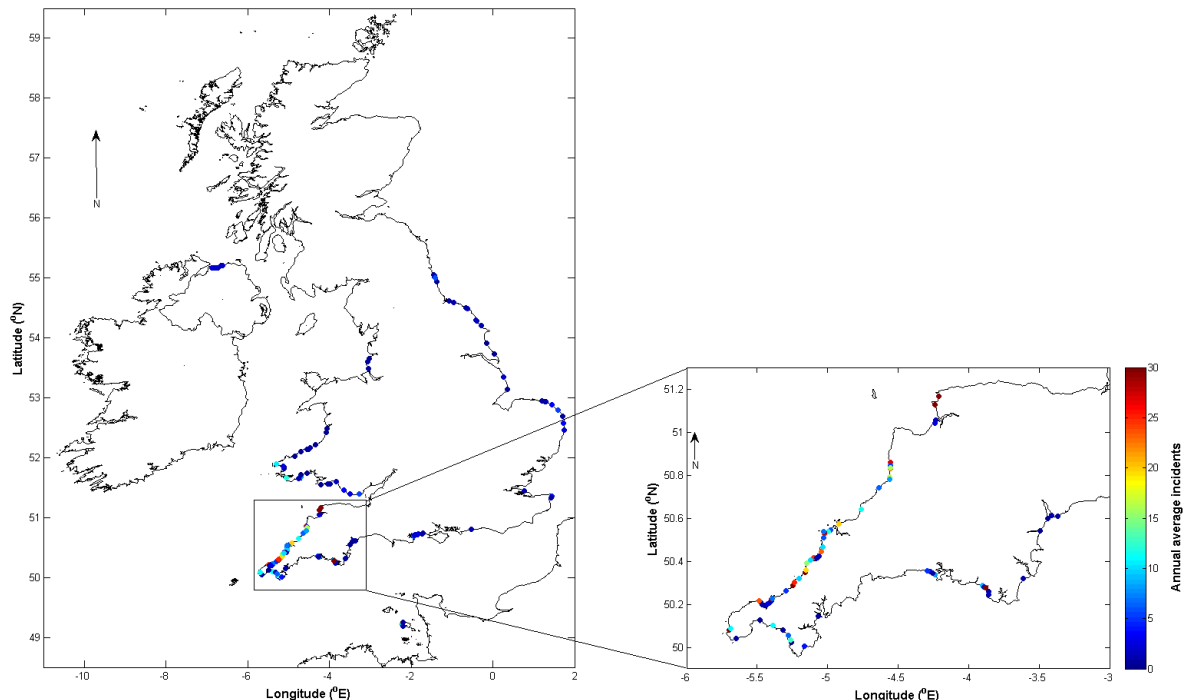


Figure 3.2 – Map of the UK showing all RNLI lifeguarded beaches where rip currents have occurred (2006-2013) and their subsequent annual average incident number, with inset of the southwest peninsula showing the dense beach concentration more clearly.

The west coast of the UK, specifically Devon and Cornwall show 15 beaches with an annual average of ≥ 20 rip incidents per year (UK annual average=7). There are 31 beaches with an annual average of ≥ 10 rip incidents, of which 23 are located on the north coast of Devon and Cornwall, 4 on the south coast of Devon and Cornwall, 2 on Jersey in the Channel Islands, 2 in Pembrokeshire in west Wales, and 1 in Tyne and Wear on the north east coast.

It is evident that rip current incidents occur around the entire UK coastline (Figure 3.2), yet 20% of the RNLI's beaches have never recorded a rip current incident. The 80% of beaches where rip incidents occur vary in beach morphology and physical hazards. Therefore, certain regions exhibit beach types which are more prevalent to rip current formation, and others provide an environment more prone to topographically driven rip currents.

Devon and Cornwall contain 74 out of 202 (37% of RNLI total) patrolled beaches in the UK. 6911 rip current incidents were recorded on 72 beaches in these two counties, indicating an 87% share of rip incidents on just over a third of all UK beaches patrolled by the RNLI. More specifically, there are 47 beaches (29% of RNLI total) on Devon and Cornwall's north coast, where a total of 5991 incidents were recorded; 76% of all rip current incidents. This highlights a substantial concentration of rip current incidents within Devon and Cornwall. A Kruskal-Wallis test was undertaken to assess whether the distribution of incident numbers is different between the counties. A statistically significant ($\chi^2(18)=66.940$, $p<0.0005$) difference between the counties was found, with a mean rank score of 114.28 for Cornwall, and 93.90 for Devon, compared with a mean rank of 46.75 for Lincolnshire and 23.33 for Kent, for example.

Beach morphodynamics are the main factor for rip currents in this Southwestern region. Exposed intermediate and dissipative beaches, typically exhibiting 'Low Tide Bar/Rip' and 'Low Tide Terrace and Rip' morphologies (Scott *et al.*, 2011a), are prime rip current forming environments already investigated by Scott *et al.* (2007) to have the highest rip risk ratings in the UK. The results also show that the lowest incident numbers occurred on beach types or areas with reflective beaches presenting little or no rip hazard, or on ultra-dissipative beaches that lack intense rip systems.

In addition, the Southwest peninsula has the highest concentration of lifeguarded beaches and therefore produces more rip current incident data compared to the rest of the UK. In this respect there is a regional bias towards areas with a greater number of RNLI operated beaches. Refinement of incident numbers from regions and counties to individual beaches revealed that nearly half (47%) of all RNLI rip current incidents occurred on only ten beaches (5% of all RNLI operated beaches). These beaches are located in Devon and Cornwall

(Figure 3.3) and are popular and consistent surf beaches open to the Atlantic swell featuring bar/rip morphology.

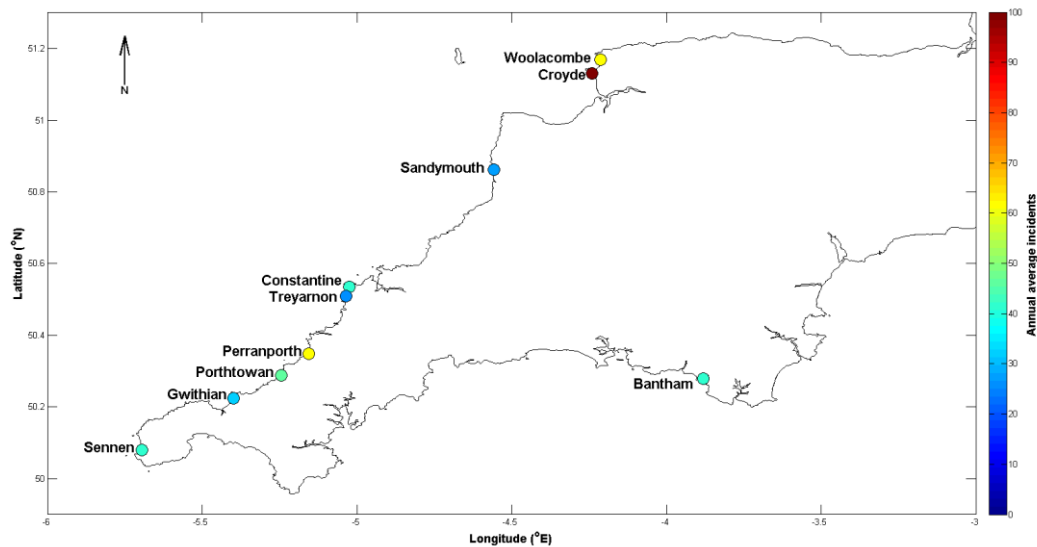


Figure 3.3 – Map showing the geographical location of beaches with the top ten highest annual average incidents 2006-2013.

These ten beaches have an annual average of >25 incidents and nine beaches are located on the north coast of Devon and Cornwall, with Bantham on Devon’s south Coast (Figure 3.3). This result is staggering as it shows that nearly half of all RNLI rip incidents are undertaken on just 5% of their beaches. This figure not only underlines a distinct geographical concentration, but also identifies these ‘hot spots’ to be prime educational control sites.

Figure 3.4 show the incident range over eight years on these beaches. However, Gwithian and Sennen Cove became operational in 2008 so their annual average is based on six years not eight years like the eight other beaches. The popular surf beach of Croyde in north Devon accounts for 10.46% of all UK rip incidents, recording 872 incidents the 8 year period (annual average=103) over, with a maximum of 150 incidents in 2008.

The statistics presented here are enhanced by the high seasonal visitor population. On average, between 2011-2013, Devon and Cornwall combined received 63 million day visitors each year, accounting for the third and fourth highest UK holiday destinations respectively (Visit England, 2013). In the UK, 37 million people visited a beach in 2013, and 17 million (30% of all trips) people chose to holiday at the seaside, with 11 million heading to the

Southwest (19% of trips). These figures highlight the hazardous combination of increased numbers of beach users and dynamic physical processes, amplifying the potential for increased lifeguard response in the area.

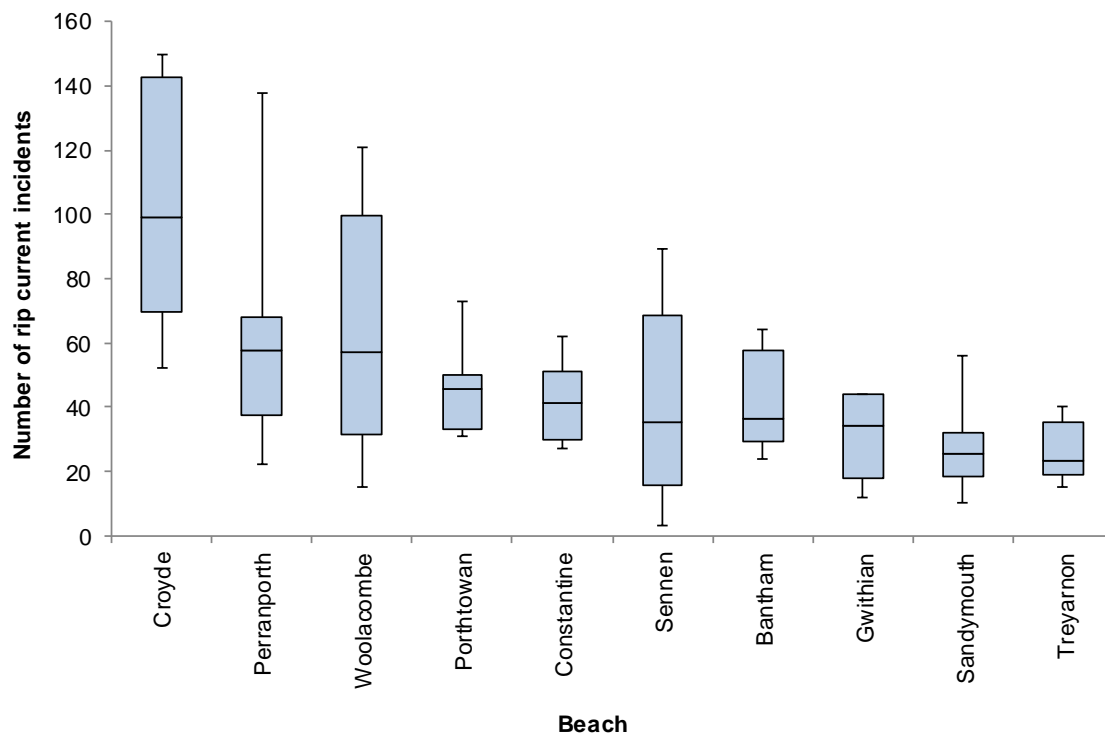


Figure 3.4 – Box plot showing the beaches with top ten annual average incident numbers. Whiskers show the maximum and minimum number of incidents recorded, and the boxes show the interquartile range and median incident numbers.

The number of beaches in each region or county varies, with annual average incident numbers per beach highest in Devon, where 15 beaches recorded 1888 incidents, giving an average of 126 per beach in Devon. This high average is mainly due to the high incident numbers from Croyde, Woolacombe, and Bantham. Cornwall has an annual average incident number per beach of 88, followed by Dorset (n=22) and Pembrokeshire (n=16). Regionally, as previously stated, the Southwest has the highest annual average of 82 (56%) incidents per beach in the region, with the East and the Channel Islands both with an annual average of 13 (8%), followed by Wales and the Northeast with 11 (7.6%) and 10.6 (7.1%) respectively.

Although beaches on the south and east coasts receive less swell than the west coast of the UK, they are still subject to southern swells and localised wind waves in the English Channel, and shorter fetch swell originating in the northern North Sea to reach the UK’s eastern coast.

Also, these beaches are more prone to topographically driven rip currents due to the number of man-made structures such as groynes and seawalls. Surfing is popular on the east coast, even though waves are less consistent than other parts of the UK. The waves are high-quality, and with a prevailing south-westerly wind, provide breaks with offshore conditions allowing waves to break at their best. The results show the west coast to have the highest number of rip current incidents, yet the risk still remains around the entire UK coastline, and other areas should not be ignored.

3.3.3 Activity

Lifeguards record what activity those needing assistance were undertaking at the point of rescue, with some incidents involving multiple casualties and multiple activities. 23 different activities (e.g. 1 or more of swimming, kayaking, kitesurfing, surfing, canoeing...) were recorded, with a total number of 10,167 activities involved in the 7909 rip current incidents. Figure 3.5 shows the activities most commonly associated with rip current incidents were bodyboarding (without fins) at 52% (n=5290), swimming at 26% (n=2572), and surfing at 18% (n=1797).

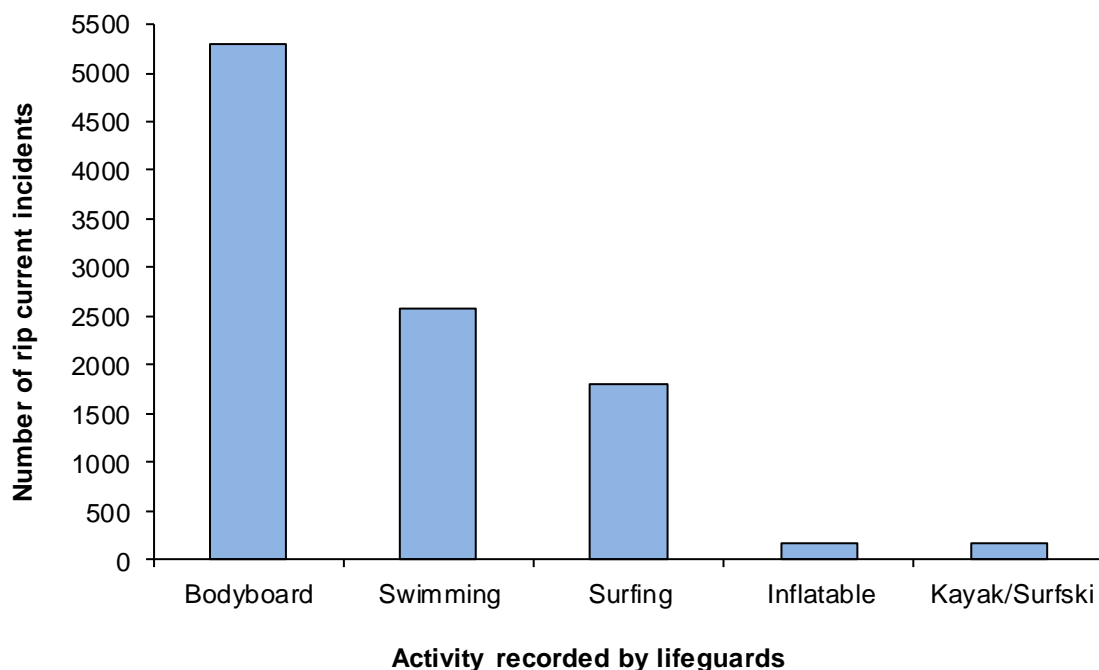


Figure 3.5 – Type of activity undertaken by people caught in rip currents at point of rescue (2006-2013).

Just over half of all people rescued from a rip current were using a bodyboard. The majority of the RNLI's beaches are exposed to surf (whether swell or wind driven) where bodyboarding can be undertaken. It is an extremely popular wave riding activity, driven by low-cost and widely available equipment. Bodyboards are highly susceptible to nearshore currents, and anecdotally lifeguards state that a large proportion of users tend to float on the boards, becoming part of the current movement. Lifeguards encourage bodyboard users to remain in contact with the seabed unless catching a wave in order to minimise the pull of rips. Collaboration between equipment suppliers and rip education practitioners could be beneficial to ensure a joined-up approach to reducing the number of bodyboarders becoming victims of rip currents. Arguably, however, bodyboarders are safer than swimmers due to the bodyboard providing a source of buoyancy (Morgan *et al.*, 2008).

Surfers have larger boards which they can float on should they become caught in a rip current, yet there is an argument that surfers who are away from the lifeguarded areas **are** generally more experienced (Morgan *et al.*, 2009). Those undertaking surfing lessons will always be supervised by a lifeguard qualified instructor (UK legal requirement) which should reduce the risk of them being caught in a rip current. It could be argued that intermediate self-taught surfers or beginners hiring a surfboard with no prior experience, are at most risk of being caught in a rip current. Lifeguards record any equipment hazards associated with incidents such as equipment failure, equipment misuse, hired equipment, inappropriate equipment or inexperience. Inexperience of the activity and equipment accounts for 61% (n= 4797) of rip current incidents (33% not recorded), with 37% (n= 2937) of all bodyboarders caught in rips lacking experience of their equipment. This unfamiliarity of their equipment and the environmental conditions contributed to their need for assistance. A minority of swimmers and surfers were also found to be inexperienced at 16% (n= 1290) and 14% (n= 1139) respectively. LeBlanc (2011) states that the popularity of bodyboarding is due to the desire to catch waves by inexperienced people because it is easy to learn, and who may not wish, or have the time or funding, to learn to surf.

It was questioned whether specific areas or beaches were more prone to certain activities. A Chi Square test found a statistically significant difference between regions and bodyboarding incidents ($\chi^2(224)=641.873$, $p=0.028$), yet no significance was found for swimming and surfing incidents. Analysis shows that 52% (n=84) of beaches recorded the most bodyboarding rip current incidents, and 28% (n=45) of beaches recorded no bodyboarding incidents. 42% (n=68) of beaches recorded more swimming incidents (n=33, 20% none), and 5% (n= 8) of beaches recorded more surfing incidents (n=88, 52% none).

The beaches recording bodyboarding incidents are distributed with a slight concentration bias in the Southwest and Wales on west facing beaches (Figure 3.6). Swimming incidents are more spread out across the UK with a higher number on the east coast and the more sheltered beaches on the west and south coasts. There are only eight beaches which recorded the greatest surfing related rip incidents and they have an irregular distribution around the UK coastline.

The discovery of bodyboarding as the main activity associated with rip currents has not been exposed before in other rip current studies. Rip current incident data analysed in the USA by both Lushine (1991) and Gensini and Ashely (2010) did not measure any specific activity from the datasets in their investigations. Data examined by Brighton *et al.* (2012) does not separate bodyboarding and surfing within the database. They found swimming accounted for 83% of all rip incidents, and 'craft' (surfing *and* bodyboarding) accounted for 12%. This is a significant difference to the UK results presented in this section, and highlights the cultural difference between the two countries.

Bodyboards are best used in the surf, and where the surf beaches in the UK are popular tourist destinations, might be the equipment of choice for the sea condition as it is harder to swim in waves. Australia also has consistent surf where bodyboarding is still a popular pastime (Choo *et al.*, 2002), but there are no studies that detail this popularity and thus comparisons to other countries is difficult.

Without specific evidence we can only speculate that the Australian beach culture may nurture more competent ocean swimmers compared to people in the UK, thus emphasising that the popularity of bodyboards in the UK might be a function of poor surf swimming skills. Although not a study on public swimming ability, Tipton *et al.* (2008) tested UK lifeguards from surf and non-surf environments. They found, despite similar pool and flat water swimming times, those from surf beaches with experience of surf swimming were faster and more efficient at swimming in the surf than those from a non-surf environment. This confirms that those who have been exposed to swimming in surf are stronger and quicker, and links can be made to the difference in beach cultures between Australia and the UK, where, in Australia, surf lifesaving and ocean swimming is promoted, and more available (Booth, 2001).

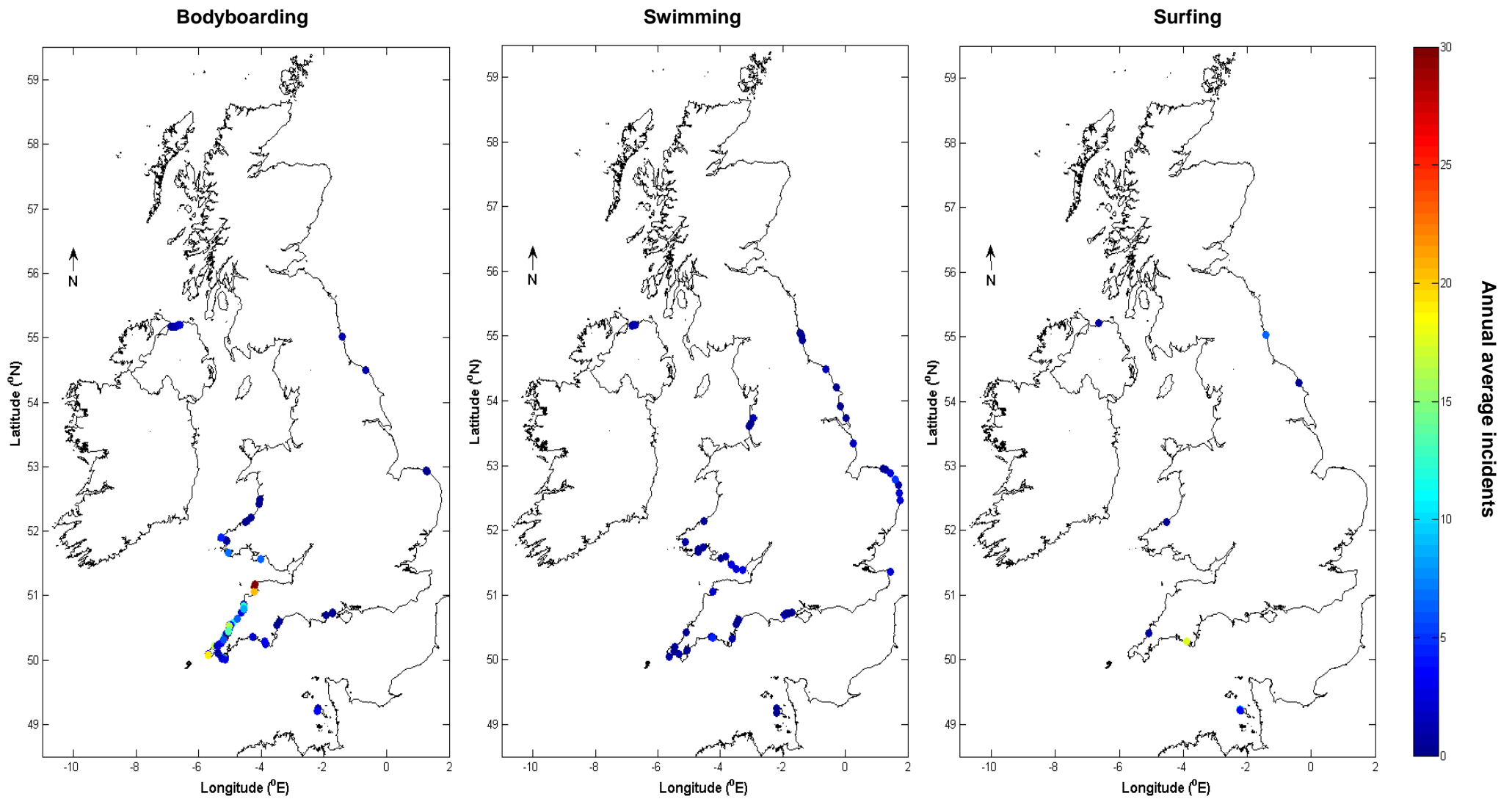


Figure 3.6 – Spatial distribution of beaches and their highest recorded rip current rescue activity numbers. Beaches which recorded the most bodyboard rescues are in the panel on the left, swimming in the centre, and surfing on the right.

3.3.4 Incident location

The area of the beach in which an incident occurs is recorded by lifeguards, and can be within the red and yellow bathing zone, the black and white craft zone, a non-zoned area of the beach, or another area, possibly outside of the lifeguards' operational area. Over half (n=4302, 54%) of rip current rescues were undertaken in non-zoned areas of the beach away from lifeguard patrols. In addition, 30% (n=2358) were recorded within the red and yellow flag vicinity, 9% (n=698) in the craft zone, 5% (n=399) in an unknown location, and 2% (n=147) other. No significant differences were found between incident location and age, gender, and activity, with all demographic groups and activities following the trend described above. Swimmers and bodyboarders are encouraged to remain within the red and yellow flags, learner and less confident surfers and hard craft such as kayaks, to stay between the black and white flags.

This is a key result to inform the education strategy as it places influence on adhering to the safety flag system, and highlights the dangers of entering the water outside these areas. Lifeguard best practice dictates that flags are placed on sandbanks flanking rip currents, and it is perhaps unsurprising that people are caught outside these areas. The location of the bathing areas in these aspects can also have an impact on people within these flags as littoral and feeder currents can sweep people towards the rip channels, which is perhaps why a high percentage (30%) are caught in the red and yellow flagged zone. Additionally, the high volume of people between the flags often contributes to an overflow into the hazardous areas. Swimming outside the flags also exposes water users to the risk of being caught in rip currents. Drozdowski *et al.* (2012) reported that 73% of rip current survivors were outside of patrolled areas at the time of incident

International research on beach safety flags has shown that people are safest to go in the ocean between the patrol flags and that most fatalities occur outside these areas (Sherker *et al.*, 2010). There is some discussion as to whether people are ignorant of the flag system or if they purposefully choose to be outside the flags, where complex psychological reasons associated with intentions and decision making can be inferred (White and Hyde, 2010). Sherker *et al.* (2010) has shown that in Australia people outside the flags are more likely to be more experienced or have knowledge of rip currents. Chapter 4 attempts to examine these behaviours and the level of rip current knowledge in the UK, in order to understand why so many people (n=4302, 54%) are outside patrolled areas.

The state of the tide at point of rescue varied between incidents depending on beach type and environmental conditions such as wave height and wind. The incident report forms changed in 2012, so for the purpose of the tide, analysis was undertaken on the 2006-2011 data. The majority of rip current incidents occurred at low tide (n=2439, 42%), with 30% (n=1743) on a spring low tide, and 12% (n=696) on a neap low tide. Mid tide accounted for 29% (n=1692) of incidents, and high tide 20% (n=1161) (n=647, 12% neap high, n=502, 9% spring high). The flooding tide accounted for 41% (n= 2391) of incidents, ebbing, 34% (n=1978), and slack water 25% (n=1426). On a north Cornwall intermediate beach, Scott *et al.* (2014) found that the majority of rip currents occurred in water levels around mean low tide, and Austin *et al.* (2014) found the fastest rip current flow speeds occurred 1.5 hours before and after spring low tide. The incident results in this chapter corroborate with the findings of Scott *et al.* (2014) and Austin *et al.* (2014), highlighting that times around low water on the flooding tide are prone to heightened rip current risk. However, the basic measurement scales of the incident report form for the state of tide is not robust enough to firmly conclude these findings and differences in tidal regimes around the UK coastline adds further inconsistencies within the data.

Physical hazards present on the beach can create and exacerbate topographically driven rip currents. Geological features such as cliffs and large rocks, or man-made structures such as sea and harbour walls, groynes or piers had an effect on 16% (n=1230) of recorded rip incidents; 84% incidents had no apparent physical hazard, and were driven by environmental factors. Large rocks accounted for 42% (n=521) of these recorded physical hazards, with other hazards including breakwaters (n=238, 19%), cliffs (n= 204, 17%), and groynes (n=140, 11%).

3.3.5 Demographics

A one sample Chi-Square test (goodness of fit) was undertaken to assess whether each demographic category occurs with equal probabilities. The level of significance for all categories is $p < 0.0005$ indicating a significant difference between demographic categories and recorded rip incidents. The demographics of people caught in rip currents can be seen in Table 3.3., and are as follows: 67% (n=11,074) are male, with the age group category 'adult male' yielding the highest number of incidents (n=5145, 31%). The largest proportion of female victims is 'teenagers' with 11% (n=1810) of total individuals rescued from rip currents. It is worth noting, however, that the total of all females caught in rips equals that of

the ‘adult male’ category with 31% (n=5186). An Independent t-test found that there were significant differences between the mean incident numbers of adult males and females ($t(13336)=-29.002, p<0.0005$), teenage males and females ($t(14075)=-8.905, p<0.0005$), and child males and females ($t(14469)=-14.753, p<0.0005$). A 1-way ANOVA test found that there was a statistical significance between the mean incidents numbers of male categories ($F(2,23724)=184.390, p<0.0005$), but no significance between the females, indicating variances between genders as well as within genders.

Table 3.3 – Table showing the total number of rip current incidents for each age and gender category, and the normalised data values.

	Female adult	Female teen	Female child	Male adult	Male teen	Male child	Other
Total	1729	1810	1647	5145	2906	3023	518
Percentage	10.3%	10.8%	9.8%	30.7%	17.3%	18.0%	3.1%
Annual average	216.1	226.3	205.9	643.1	363.3	377.9	64.8
Normalised total	36.8	362.0	137.3	109.5	581.2	251.9	11.0
Normalised percentage	2.5%	24.5%	9.3%	7.4%	39.3%	17.0%	0.7%
Normalised annual average	4.6	45.3	17.2	13.7	72.7	31.5	1.4

These demographic statistics can be compared with other rip current statistics worldwide, particularly those of Australia where 85% of coastal drownings were male (Brighton *et al.*, 2013), and in the USA where males account for 84% of all rip current fatalities (Gensini and Ashley, 2010). Research indicates that males are more likely to report a higher level of water confidence, overestimate ability and underestimate risk (Gulliver and Begg, 2005; McCool *et al.*, 2008; Goya *et al.*, 2011; Moran, 2011) and that gender differences play a key part in risk taking and levels of confidence in relation to personal risk assessment (Lupton, 1999; Slovic, 2000).

Relating this research to a coastal, beach and leisure environment, Morgan *et al.* (2009), attribute the gender bias towards men in coastal incident statistics to increased frequency and exposure to water based activity, as well as using surf craft and venturing further into the surf

zone. Males attempt to verify their masculinity, either in an attempt to prove their worth within a male hierarchy, or to impress females, often in a competitive way that ignores rules, social controls, and surrounding danger (Moran, 2006, 2011c).

There are no statistics in the UK to show the ratio of males to females entering the water, however anecdotally from lifeguards it is estimated that males heavily outweigh females entering the water, particularly when surfing, in the UK. Moran (2011c) concluded that males interpret water safety and drowning risk very differently to females, and education is needed from an early age to help combat these risky masculine tendencies.

The RNLI records four age group categories which have an uneven number of ages within each category; Children (0-12), Teenagers (13-17), Adult (18-64), and Senior (65+) (since 2012, Senior was removed leaving only 3 categories, so for the purposes of this chapter, only these 3 categories have been used: Child, Teenager, Adult. This gives a large proportion (47 years) to the adult category and hence the large number of incident numbers. The data was normalised (to ensure an even and unbiased scale) by dividing the number of incidents for each age group with the number of years within each category, to find an average of rescues per age group. The normalised data (Figure 3.7 and Table 3.3) shows that in fact ‘Teenagers’ is the category with the highest margins at 63%; 39% males, 24% females. The adult category is notably reduced but males still represent the greatest number of individuals rescued from rip currents across all age groups.

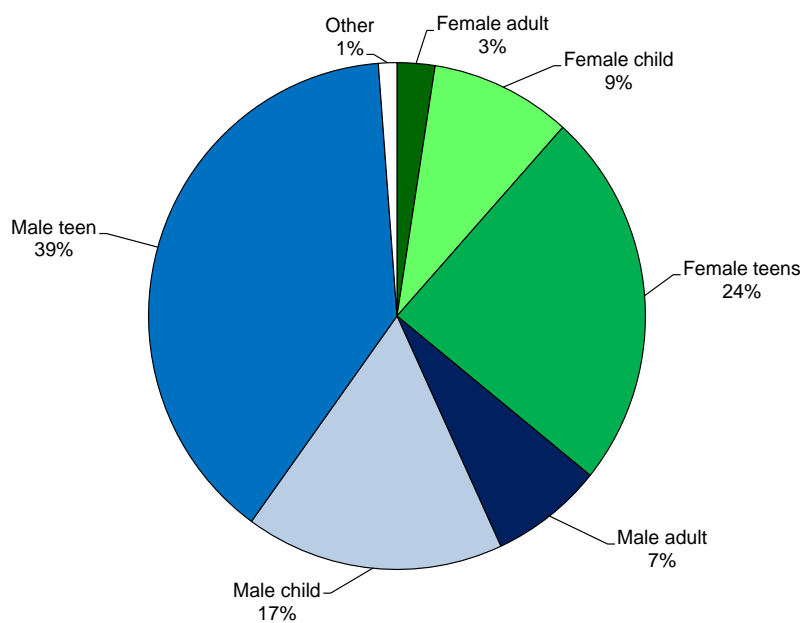


Figure 3.7 – Age and gender categories with the greatest average rip current incidents per age group.

This finding is supported by Gensini and Ashley (2010) who reported that teenagers in the USA make up the highest percentage of rip current fatalities, specifically those aged 10-19 and male. It has been observed that teenagers, especially males, enter the sea more than other age groups, and spend more time in the water (Morgan *et al.*, 2009), so is no surprise that this age group is overrepresented in incident statistics. Whether teenagers are unaware of any rip current risk, are overwhelmed by peer pressure, actively seek risks, or like the thrill of being in the ocean is something to be explored in further detail in Chapter 4. What is clear, however, is that this age group is a key target audience for a rip current intervention programme.

Another important topic to examine in Chapter 4 is the relationship between knowledge and age group. For example, are children and teenagers caught in a rip current more than adults because their understanding of the hazard is not as developed? There is currently no measure for this in the UK or worldwide, so we can only speculate whether adults take fewer risks - Do adults go in the water less? Are adults less adventurous? Are adults more able to self-rescue because they have more experience or ability?

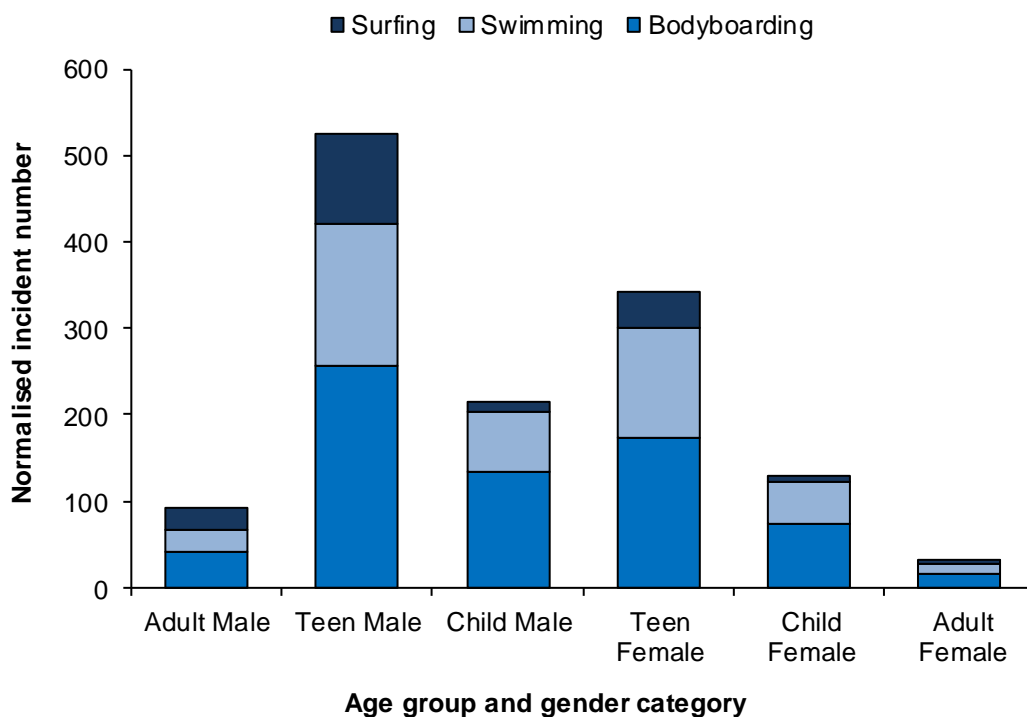


Figure 3.8 – Normalised data figures for the age group and gender categories of rip current victims and the corresponding activities they were undertaking at point of rescue.

The analysis compares demographics and what activity people were participating at the time of rescue from a rip current (Figure 3.8). Results show that teenagers were bodyboarding (n=1281, 34%), swimming (n=828, 23%), and surfing (n=513, 12%) respectively at the point of rescue, with a higher male to female ratio. This trend continues through all other demographic groups, apart from adult males where surfing incidents rank higher than swimming incidents.

3.4. Conclusions

This is the first piece of work to investigate the demographics of rip current victims in the UK. Incident data is recorded by RNLI lifeguards where location, activity, demographics, distances from patrols, physical hazard, and environmental conditions are documented. This unique national dataset is one of the most comprehensive of its kind worldwide due to the consistency of reporting and depth of information. Rip current incident data was analysed for the 2006-2013 operational seasons, where the main findings are:

- A total of 7909 rip current incidents were recorded, involving 16,777 individuals, which indicates an annual average of 63.5% of all individuals rescued by RNLI lifeguards over this period were attributable to rip currents.
- There is a significant geographical concentration of rip current incidents; Southwest England, particularly Devon and Cornwall pose a substantial rip current risk (n=6911, 87%) to beach users, and the north coast of these counties alone account for 76% (n=5991) of rip current incidents.
- Rip current incidents are affected by beach type, environmental conditions and visitor numbers; intermediate Low-Tide Bar-Rip beach types exposed to greater waves heights, combined with busy summer populations pose the greatest rip current risk, and are coincidentally located within the southwest region of the UK.
- The main demographic of people caught in rip currents are teenagers aged 13-17 years old (n=4716, 63%), with a higher ratio of males (n=2906, 39%) to females (n=1810, 24%). The incident dataset is dominated by males; 67% (n=11,074) of all rip current incidents involved men.

- Over half (n=4302, 54%) of rip current rescues were undertaken in non-lifeguarded areas of the beach, away from the patrolled swimming or craft areas. This emphasises the importance of going in the water between the flags, and highlights that rip current risk is increased outside of the patrolled areas, thus providing a key result to inform education strategy.
- The activity most associated with rip current incidents is bodyboarding (n=5290, 52%). This is the first study worldwide that can specifically state the activity involved in rip current incidents due to the validity of the dataset, and the first time bodyboarding has ranked the highest in any country. Inexperience of the activity and equipment accounts for the majority of bodyboarders caught in rip currents. This major finding provides the UK with a prime target audience for public education.
- This chapter identifies the age and gender of people who are caught in rip currents in the UK, their beach destination, and what activity they were undertaking at the time of incident. This analysis has provided the key target audiences for rip current education measures.

These results from the UK contribute new findings to the emerging field of human interactions with rip current hazards worldwide by providing a complete breakdown of rip current incidents. Reporting the highly detailed nationwide beach lifeguard incident statistics is advantageous to the deployment of beach safety resources and lifeguard provisions. In addition, it offers statistical comparisons to enable a global approach to facing the challenges of rip current incident reduction.

This chapter identifies a link between rip currents and demographics. The exploration of incident data has provided the overall study with the ‘who’, ‘where’, ‘when’, and ‘how’ of rip current incidents, but which does not sufficiently address ‘why’ people are caught in rips. In addition, several questions have been raised, such as rip current knowledge, beach choice, decision making when entering the water, and activity levels of beach users. These questions and issues are investigated in more detail in the next chapter.

Chapter 4

Public understanding and knowledge of rip currents and beach safety

4.1 Introduction

Material in this chapter has been adapted from:

Woodward, E.M., Beaumont, E., Russell, P.E., and Macleod, R., (2015). Public understanding and knowledge of rip currents and beach safety in the UK. *International Journal of Aquatic Research and Education*, 9, pp.49-69 (Appendix 10).

This chapter connects the previous chapters' rip current incident statistics with what the beach going public know about rip currents, further exploring the human interaction with rips in the UK. Results are presented from the data collected through a face-to-face questionnaire, highlighting what people know about rip currents, what awareness they have of beach safety issues, and their attitudes towards the rip current hazard. This builds on evidence to inform the rip current education pilot in Chapter 6.

The specific aims of this chapter are:

- To determine levels of knowledge and understanding of rip currents and beach safety of a typical summer beach user through the use of face-to-face questionnaires.
- To establish where individuals obtain their knowledge about rip currents.
- To assess the effectiveness of how and where rip current knowledge was obtained.
- To recommend how, if any, rip current education strategies need to be developed or improved.
- Provide further evidence for a pilot rip current education scheme.

Lifeguards have patrolled beaches in the UK since the late 1950s when volunteer lifesaving clubs were established, to the present day where the RNLI operate the largest proportion of beaches. The beaches with higher levels of risk are lifeguarded, and in some areas of the country it is difficult not to be at a beach unpatrolled by lifeguards. Safe bathing

areas are denoted by red and yellow flags, in accordance with the International Life Saving Federation recommendations, with lifeguard patrols present at the water's edge (Figure 4.1). Due to the large tidal ranges in the UK, bathing areas may vary in position during the course of the tide, and as hazards become exposed or disappear depending on conditions.



Figure 4.1 Image of low tide Perranporth Beach, UK, showing multiple sand bars and rip currents (yellow arrows), lifeguard flag placement and location of bathers (T. Scott, (personal photograph, October, 2012).

Public knowledge of rip currents has, in more recent years, been studied by researchers predominantly in Australia and the USA in an attempt to study the social and behavioural sciences surrounding rips, and following on from the rigorous research on the physical dynamics of rip currents. A need for rip current intervention programmes and research on beach users attitudes, behaviours and understanding of beach safety and rip currents has been highlighted (Sherker *et al.*, 2010; Brander and MacMahan, 2011).

Researchers in this field agree that beach users need to know how to identify a rip current in order to avoid swimming in one (Sherker *et al.*, 2010), and that rip identification needs to be a crucial part of rip education (Williamson *et al.*, 2012). Social rip current research is

developing and improving as studies such as those investigating how people behave in rip currents (Drozdowski *et al.*, 2012), and in the USA where it was highlighted that there is generally a poor public understanding of rip currents (Caldwell *et al.*, 2013; Branstromm *et al.*, 2014).

Hatfield *et al.* (2012) concluded that education and targeted campaigns do improve rip current awareness. It is important, therefore, to establish what the UK public know about rip currents to develop a pilot education scheme. There has been no domestic measure of rip current awareness in the UK, so there have been no comparisons of this knowledge with other countries. The work in this chapter, therefore, not only provides this first examination of public rip current awareness in the UK, but adds to the international efforts of social rip current researchers worldwide.

4.2 Method

4.2.1 Pilot study and ethics

A pilot study was undertaken on 22nd June 2012 at Perranporth (one of the beaches with highest rip current incidents) to test the initial survey design in practice, and to identify any issues. The application of the questionnaire, script, length, content, and question type were scrutinised to make sure the overall survey measured the necessary aims and objectives of the study. From the pilot, the questionnaire was refined into a final version to use in the field.

Ethical approval was granted by the Human Ethics Committee of the Faculty of Science and Technology at Plymouth University on 28/05/2012.

4.2.2 Study sites

Beaches were selected based on findings from Chapter 3, where beaches with high rip current incidents were identified, and subject to beach rips rather than topographically controlled rips. Two rural beaches and two resort beaches were chosen as convenience samples on the north coast of Devon and Cornwall in Southwest England (Figure 4.2) due to ease of access and exposure to large numbers of people: Croyde (A) in Devon, and Constantine Bay (B), Perranporth (C), and Chapel Porth (D) in Cornwall. These four beaches account for approximately one quarter of all UK rip incidents over an eight year period

(2006-2013). The beaches are macrotidal and are exposed to Atlantic swell and wind waves from the prevailing westerly winds. Each site was visited twice over a two week period with the exception of Croyde which was visited once, and Chapel Porth which was visited three times. The physical characteristics of each site are outlined in Table 4.1 (page 77).

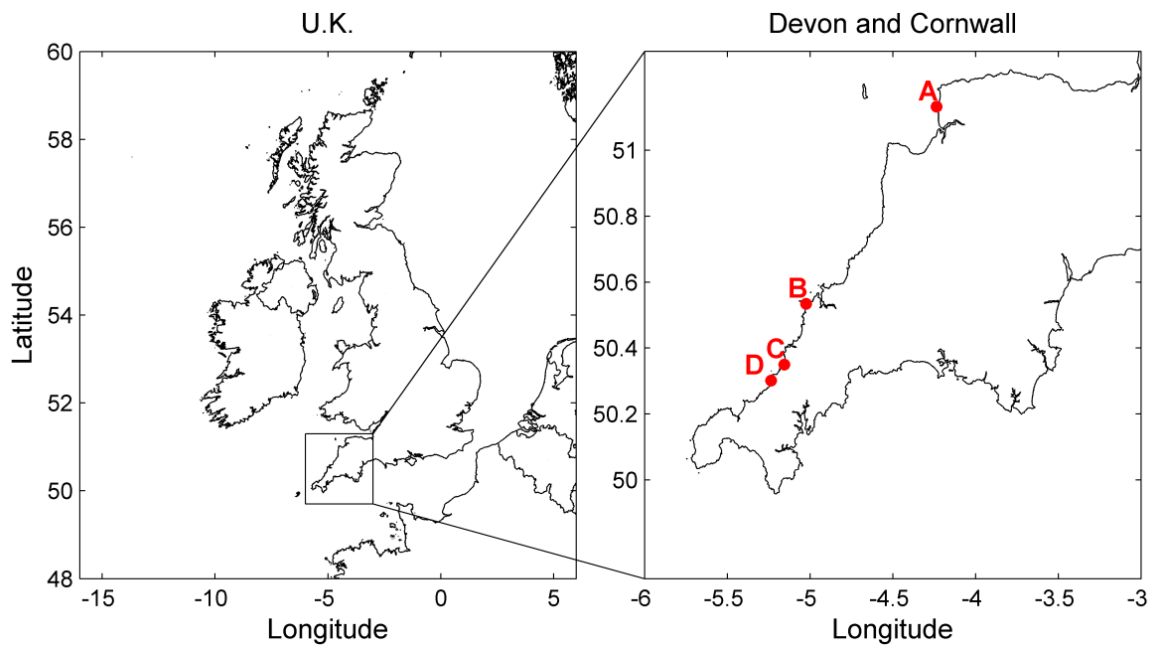


Figure 4.2 - Map showing location of study sites within the UK; A - Croyde, B – Constantine Bay, C- Perranporth, and D – Chapel Porth

4.2.3 Survey design and analysis

The public beach user questionnaire was semi-structured with a mix of 26 closed and open ended questions to generate quantitative and qualitative data. It was comprised of six sections: general beach background, beach safety knowledge, rip current knowledge, rip current experience, rip current education, and demographic information. This was designed as a face-to-face survey to maximise the quality of data collected and to obtain the highest response rates. A copy of the questionnaire can be seen in Appendix 1.

Open ended responses were analysed using a mixture of latent and inductive content analysis, where the themes are derived from the data and placed into identifying groups with a label known as a ‘code’ (Denzin and Lincoln, 1998). These codes can then be used as subjects in analysis, where weightings are assigned to each group, in order to compare the values of each code.

4.2.4 Procedure

The research team were present on the beach from 11:00-17:00 (Table 4.2). A random sampling method was selected whereby a team of 2-4 interviewers approached beach users situated within a chosen transect, anywhere between beach access points and the water's edge (Chapter 2, Figure 2.1). Interviewers spent an average of 10 minutes with each participant, on occasion longer if there were questions or explanations needed after the survey. The questionnaires for this study were conducted during the summer, between 30th July and 9th August, 2012, to coincide with peak summer beach populations, ensuring higher survey responses.

Table 4.1 - Physical characteristics and public amenities of questionnaire study sites. The two beach morphologies are LTB/R = Low Tide Bar and Rip, LTT+B/R = Low Tide Terrace + Bar and Rip.

Beach and morphology	Description	Rip incidents (2006-13)
Perranporth. Resort beach. LTB/R	Large exposed west facing sandy beach bounded by headlands either end of a 3.5km beach backed by dune system (0.5km at high tide). Resort town with several large car parks serving the high volume of seasonal visitors. RNLI lifeguards.	Total = 492 UK % = 6.22
Chapel Porth. Rural beach. LTB/R	Small rocky cove at high tide becoming large sandy beach at low tide (1.25km). Joins with Porthtowan to the south at spring low tide and bounded by headlands (2.5km). National Trust beach and car park with limited numbers, other car park 10 minute walk up hill. Small café and public conveniences. RNLI lifeguards.	Total = 200 UK % = 2.53
Constantine Bay. Rural beach. LTT+B/R	Large sandy beach backed by dune system with rocky outcrops to the south and headland to the north. Joins with Booby's Bay at low tide (1km). Small car park in quiet village popular with seasonal visitors. RNLI lifeguards.	Total = 336 UK % = 4.59
Croyde. Resort beach. LTB/R	Large sandy beach backed by dune system bounded by headlands (0.8km). Resort village popular with seasonal visitors, accommodation close to the beach and several car parks and beach entrances. RNLI lifeguards.	Total = 827 UK % = 10.46

Table 4.2 - Daily study site information where estimated beach population* (minimum, maximum and mean per day), weather, and surf conditions were recorded every hour.

Beach	Estimated beach populations			Proportion sample (%)	Responses	Refusals	Response Rate (%)	Personnel	Weather
	Min.	Max.	Mean						
Perranporth	150	5500	4000	2	72	3	95.83	4	Sun-cloud
Chapel Porth	70	400	249	26	65	1	98.46	3	Cloud-sun
Constantine	25	550	338	19	63	4	93.65	3	Rain-cloud-sun
Croyde	800	3000	1820	2	36	3	91.66	3	Sun-heavy rain
Perranporth	200	4500	2783	2	64	2	96.87	3-2	Cloud-sun
Chapel Porth	0	40	19	42	8	1	87.50	1	Rain-drizzle
Constantine	300	900	658	6	38	1	97.36	2	Cloud-sun
Chapel Porth	180	800	588	10	61	1	98.36	3	Sun
	1725	15690	10,455	4	407	16	96.06		

*Note: Proportion sample = Proportion of the beach sampled (% of responses per mean beach population), Responses = Number of responses, Refusals = Number of refusals, Response Rate = Response rate (completed questionnaires/number of people approached), Personnel = Number of interviewers on research team.

4.3 Results and Discussion

4.3.1 Respondent profile

A total of 407 beach questionnaires were conducted, which gives a margin of error of $\pm 5\%$ at the 95% confidence interval (Chapter 2, p.43), and the survey recorded a 96% response rate owing to large receptive audiences (Table 4.2). The mean age of respondents was 39 (median=42, range=9-75), and a near even split between males (n=198) and females (n=209). Of those surveyed, 83% (n=337) were on holiday, and those with postcodes corresponding to the beaches surveyed (TR, PL, EX) were deemed to be 'local', and made up 14% (n=58). The remaining respondents were from the rest of the UK (n=341, 83%) with a small proportion from overseas (n=8, 2%).

Participants mainly enter the water during the summer months (n=239, 59%), with 16% (n=65) entering the water all year round. Year round water use and the respondents' regions were tested for association, where a significant relationship was found ($\chi^2(36)=140.774$, $p<0.0005$), where over half (n=31, 53%) of 'local' respondents enter the water all year round. The Southwest (but not 'local') region has a broader spread throughout all seasons, whereas the Southeast regions' respondents enter the water most during summer months (n=45, 19%). This regional disparity may be a result of proximity to the coast, beach and surf culture, water and atmospheric temperatures, or holiday trends. During winter months (December – February) 84% (n=340) of survey respondents do not go in the sea. Only 5% (n=22) never enter the water for any activity or at any stage of the year. Participants undertook a variety of water based activities throughout the year; during the summer months swimming (n=250, 29%), bodyboarding (n=247, 28%), and paddling (n=161, 19%) are mainly participated in. Conversely, in the winter months 16% (n=67) undertake watersports: 7% (n=32) surf and 4% (n=16) bodyboard. Males enter the water more year round (n=38, 59%) than females (n=27, 41%), and more females do not enter the water at all (n=16, 73%) compared to males (n= 6, 27%), but no statistical significance was found.

Participants gave 1313 responses to what influenced their choice of beach when asked to give three main reasons (multiple choice, so values can total more than 100%). It was noted that waves (n=106, 26%), sand (n=105, 26%), and cleanliness (n=77, 19%) were the key influences upon respondent's beach selection. These initial 1314 responses were later grouped into 19 themes where sea conditions (n=171, 42%), physical features (n=156, 38%), and safety (n=64, 16%) then became the main categories of influence.

4.3.2 Rip current knowledge

Open ended questions were used to gain participants understanding of ‘what a rip current is’ which gave a richly detailed response, and were analysed and ranked on a scale of 1-5 (Table 4.3). Beach users’ level of rip current knowledge was generally lacking (Figure 4.3a), with those giving entirely ‘incorrect’ (n=128, 32%) and ‘poor’ (n=135, 33%) answers combining to account for 65% of respondents. Those who gave a ‘good’ (n=37) or ‘excellent’ (n=3) answer totalled 10%.

Table 4.3 - Examples of respondents’ descriptions of their understanding of ‘what a rip current’ is and subsequent coding for knowledge scale. (Num. scale = Numerical scale)

ID	Description example	Scale words	Scale	Num. scale
375	<i>“Undercurrent which you can’t see”</i>	Undercurrent, invisible – both incorrect	‘Incorrect’	1
355	<i>“Currents under the water that pull you out or under and down”</i>	Undercurrent is incorrect, but stated direction	‘Poor’	2
006	<i>“When the current goes back out to sea, can drag you out”</i>	Stated flow speed and/or direction, or hazard	‘Satisfactory’	3
173	<i>“Water pushes you out, too strong and can’t get back in, swim around the current”</i>	Stated flow speed, direction and hazard	‘Good’	4
125	<i>“An offshore directed flow, driven by waves and controlled by beach morphology, can be dangerous”</i>	Stated direction and flow speed, mechanism of rip fed by waves, morphologically controlled, and hazard	‘Excellent’	5

Differences in gender and rip current knowledge tested using the Mann-Whitney U test, which found significant values ($U=16725.000$, $Z=-3.495$, $p<0.0005$) as male respondents had a higher knowledge level (mean=2.14) than females (mean=1.51). ‘Incorrect’ and ‘poor’ answers for males and females were 58% (n=115) and 71% (n=148), and ‘good’ and ‘excellent’ answers 14% (n=27) and 6% (n=13), respectively. Age group differences were not as pronounced as gender, reporting no statistical significance in a Kruskal Wallis 1-way

ANOVA test, however analysis found those aged 8-12 to have the highest number of ‘incorrect’ and ‘poor’ answers (n=16, 84%), followed by those aged 36-45 (n=79, 68%). Those aged 26-35 were most knowledgeable, having the most ‘good’ and ‘excellent’ answers (n=7, 18%). Statistical significance were not found between study sites and knowledge, however cross-tabulation found respondents on Chapel Porth beach to have the greatest number of ‘good’ and ‘excellent’ knowledge levels (n=19, 14%).

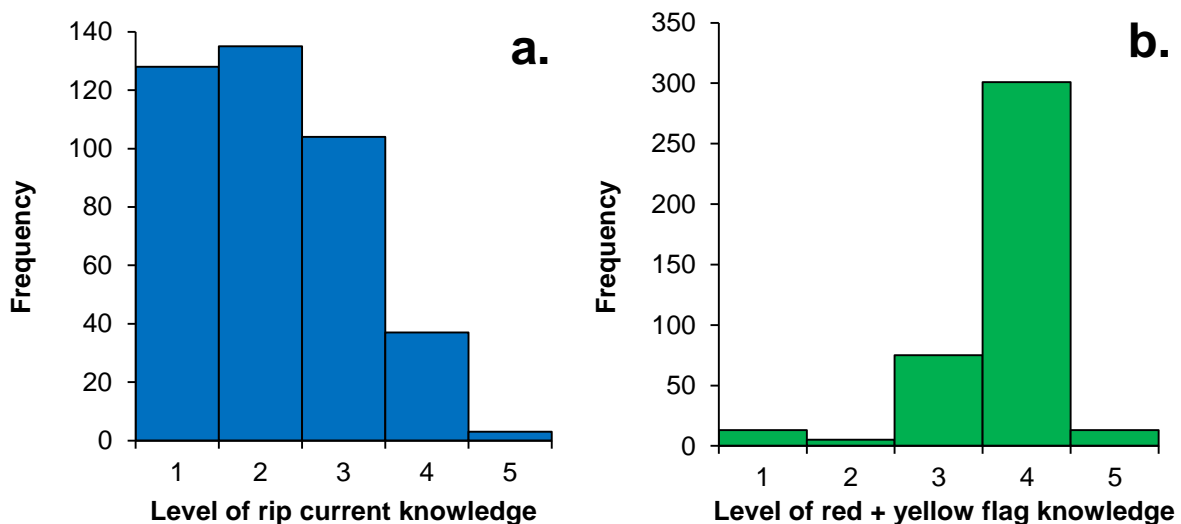


Figure 4.3 - Histograms showing frequency of responses for a) Level of rip current knowledge, and b) Level of red and yellow flags knowledge. Note 1=Incorrect, 2=Poor, 3=Satisfactory, 4=Good, 5=Excellent

It was noted in the previous section that safety was a concern among the respondents. Rip currents account for the highest number of lifeguard rescues in the UK, and worldwide, yet beach users are typically unknowledgeable or even unaware about them. It is of concern, therefore, that such a high proportion of those surveyed on popular surf beaches, with some of the highest rip current incidents, have a poor understanding of what a rip current is.

Those within the ‘incorrect’ category generally stated that a rip current is invisible, an undercurrent, or something that will drag you under, whereas those with a ‘poor’ answer included an incorrect description counterbalanced with a correct statement such as offshore flow direction. A quarter of beach users gave a ‘satisfactory’ response which included a statement that was correct but did not explain enough detail of the mechanics behind a rip current to be a ‘good’ answer. Consistent with the findings of those in Australia (Sherker *et*

al., 2010; Williamson *et al.*, 2012) and in the US (Caldwell *et al.*, 2013; Branstromm *et al.*, 2014), this study adds to worldwide research that identifies a typical beach user to have a poor knowledge of rip currents.

The activities and frequency of water use were analysed to investigate whether rip current knowledge is affected by time in the water and type of activity. Respondents were asked to state which activities they undertook throughout the year, broken down into the four seasons. The majority of people only go in the water in the summer months (n=239, 59%), and those who participate in water based activities on a year round basis mostly surf. A Kruskal-Wallis test found a significant association ($\chi^2(4)=41.704, p<0.0005$) between rip current knowledge and water use, with the following mean rank scores: all year=268.75, 3 seasons=249.01, 2 seasons=208.93, summer only=183.94, and never=143.23. This is shown in Figure 4.4 where the greater frequency of water use increases rip current knowledge. The type of activity however, does not appear to have a bearing on rip current knowledge.

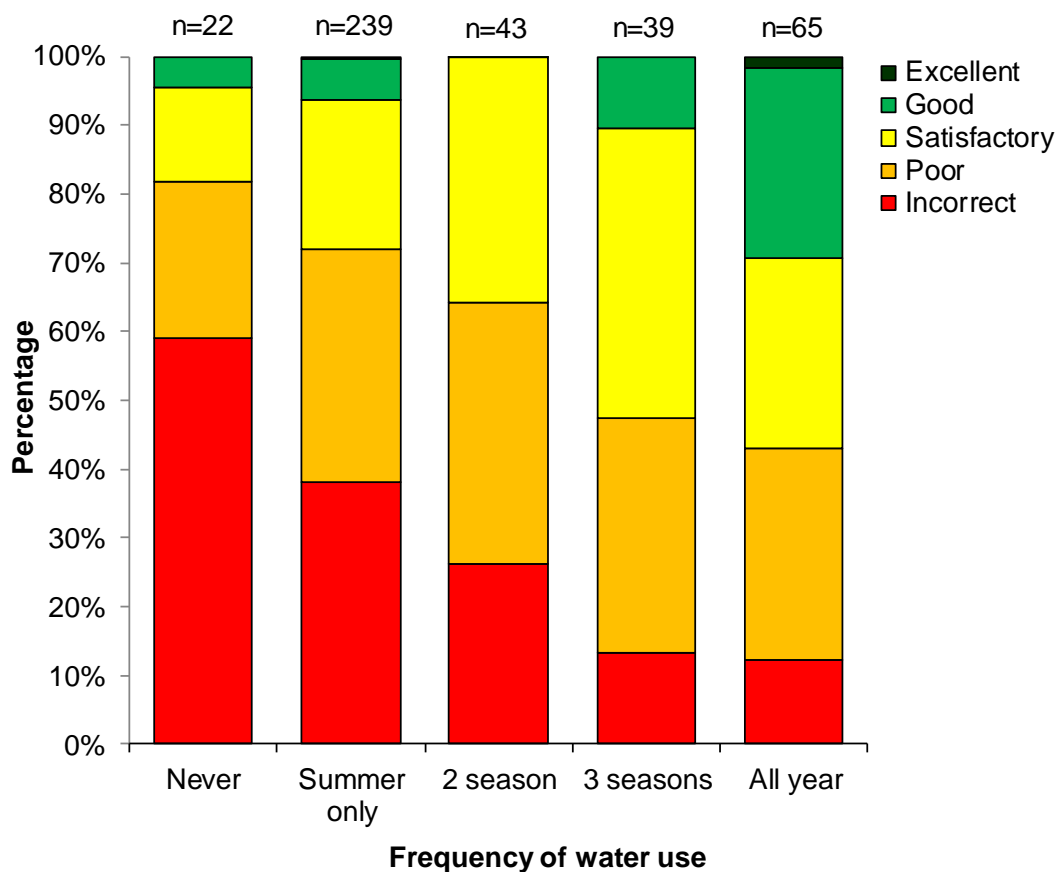


Figure 4.4 - Stacked bar showing levels of respondents' rip current knowledge levels per scale category against frequency of water use per year

4.3.3. Beach safety knowledge

Rip current knowledge levels were compared with knowledge of the beach flag system, where responses were again assigned a score from 1-5 on a knowledge scale (Table 4.4). A Wilcoxon Signed Rank test found the mean difference between rip current knowledge and safety flag knowledge was statistically significant ($Z=-15.711$, $p<0.005$) highlighting beach users are more knowledgeable on what the red and yellow flags denote, compared with their understanding of what a rip current is (Figure 4.3b).

Table 4.4 Examples of respondents’ descriptions of their understanding of the red and yellow flags and subsequent coding for knowledge scale. (Num. scale = Numerical scale)

ID	Description example	Scale words	Scale	Num. scale
346 096	<i>“Can’t remember”</i> <i>“Don’t know”</i>	Incorrect statement, don’t know, unsure, or no.	‘Incorrect’	1
257 003	<i>“Safe surfing area”</i> <i>“Surfers to stay inside”</i>	Incorrect activity, but with one of correct action or indicated safety	‘Poor’	2
122 319	<i>“You can swim”</i> <i>“Stay between”</i>	Stated 1 of correct activity <u>or</u> location between the flags <u>or</u> indicated safety	‘Satisfactory’	3
320 229	<i>“Swim between them”</i> <i>“Safe to swim”</i>	Stated <u>combination</u> of correct activity, that it should be carried out between the flags, indication of safety	‘Good’	4
018 391	<i>“Swim in between the red and yellow flags, it’s the safest place”</i> <i>“Safe to bathe between, and the lifeguards are watching you there”</i>	Stated <u>all</u> of correct activity, that it should be carried out between the flags, and indication of safety	‘Excellent’	5

Analysis found the majority of beach users had a good understanding of what the red and yellow safety flags meant on the beach. Those who were ‘incorrect’ or gave a ‘poor’ answer combined to represent 4% (n=18) of respondents, and those with a ‘good’ or ‘excellent’ knowledge level accounted for 77% (n=314) of respondents. Those with a ‘poor’ knowledge totalled 1% (n=5) and were only deemed ‘poor’ due to stating an incorrect activity. Those with an ‘incorrect’ response totalled 3% (n=13) and could not give, or even attempt, an answer to the question. In comparison to the rip current knowledge, there was no statistical significance between safety flag knowledge and age, gender, or the beach respondents were surveyed at.

The proportion of respondents with a ‘good’ or ‘excellent’ knowledge were able to state what activity should be undertaken, that the flags indicated a zone within which to stay, and that it was safe and patrolled by lifeguards. These flags denote the safest areas of the water between which to swim or use bodyboards, and also highlight that there is a lifeguard patrol present on the beach. Beaches with a high hazard rating will support a lifeguard patrol, and generally coincide with popular tourist destinations, therefore the high percentage of ‘good’, and even ‘satisfactory’ understanding of the flags is expected due to the high presence of lifeguard patrols on UK beaches.

These high figures of good safety flag knowledge are consistent with the findings of Caldwell *et al.* (2013) in the US, but are not as impressive as Australian beach users where a study found all but one respondent was correct (Ballantyne *et al.*, 2005), perhaps showing a cultural difference, where beaches and surf lifesaving are such a major part of Australian coastal life.

Sixty four percent (n=259) of respondents said they always went to a lifeguarded beach. Cross-tabulation and Mann-Whitney tests were run and found that attending a lifeguarded beach has no statistically significant bearing on rip current or safety flag knowledge. The majority of respondents (n=582, 97%) were able to give at least one reason (multiple choice) why the lifeguards placed the red and yellow flags where they do on the beach, with 61% (n=366) outlining that they are placed in the safest areas of the beach and to avoid strong currents:

“Because they would have monitored the currents to see what they are doing and picked the place the currents are not the strongest” (#18)

“Taking a view on what tide and currents are doing, taking safety first” (#128)

Acting on this knowledge was similar, where 83% (n=339) of those who go in the water are compliant with the safety system stating they always go between the designated flagged zones for their chosen activity. A significant association (Fisher's Exact test =45.744, $p<0.0005$) was found between always attending a lifeguarded beach and staying within the designated areas. Of those respondents who always attend a lifeguarded beach, 93% (n=240) will go between the safety flags, compared with 70% (n=99) of respondents who don't always attend a lifeguarded beach. This suggests that, firstly, those who attend non-lifeguarded beaches may enter the water away from the safety flags more than those who always attend a lifeguarded beach, and secondly, that the lifeguards are effective at ensuring people enter the water in the safest part of the beach.

The main reasons respondents gave for staying within the designated areas were predominantly safety, reassurance of a constant lifeguard patrol, and believing it is best for their children and family:

"Safety, there's an extra pair of eyes, it's reassuring, and if I need help the lifeguards are there" (#286)

"I want to be rescued if I get into difficulties, I want to be safe" (#407)

Those who sometimes enter the water between the flags (n=43, 11%) stated they went outside mainly due to the type of activity they undertook, where on occasion sea conditions were better in areas of the beach away from the flags, such as those going surfing. Others venture into the water away from the flags because they sometimes believe the zones to be too busy with people and equipment. Individuals who typically do not go between the flags stated they would go to patrolled areas when they were with their children or family members wanting to set a good example.

Going to a lifeguarded beach is a conscious decision for 64% (n=259) of respondents, although coincidence and chance play a part for some:

"Depends on where in the country you are, some beaches have no lifeguards and it's just chance, but it is a bonus if there are lifeguards" (#49).

"Everywhere we go has them [lifeguards], but we don't actively seek out a lifeguarded beach" (#112).

Once at the beach, RNLI lifeguards anecdotally report (and statistically reported above) that British beach users are generally compliant with the safety flags and adhere to lifeguard

advice (Figure 4.1). This could be due to a ‘herd’ mentality, or perhaps because people don’t know differently or because most just do as they are told:

“They are there for a reason, you’d be daft to disregard them” (#118).

“I’m not stupid! Why risk it, you can’t legislate for idiots” (#102).

“Normally I would stay away but I don’t want to be shouted at, so it’s easier to stay between the flags” (#139).

This speculation is in part due to a lack of depth when asking about lifeguard flag placement within the questionnaire. Respondents provided an answer which was not wrong, but the hesitance in their answers suggested they might not have known *why*, and possibly guessing: *“I just presume it’s the safest”* (#89). What is known is that red and yellow flag knowledge among the group of beach users surveyed is good, and that there is a general respect for the lifeguards who are extremely preventative in their approach to keeping beach users safe.

In comparison, actions of individual beach users with a negative behaviour and attitude towards safety flags in this survey (i.e. do not go between the flags) vary with experience, activity, the occupation of the flagged area, and levels of application in freedom of choice:

“Because it’s busy, or there is better surf elsewhere” (#350).

“I’m experienced, so can handle it” (#229).

Although this study does not provide enough evidence to investigate the psychological reasons behind beach users’ water based locations and their attitudes as to why they choose specific areas, the data does provide these short responses for going between the flags. Even with an understanding of the flag system, this minority don’t always act on their knowledge and still undertake risky behaviours such as going outside of lifeguarded areas, as supported by similar studies (Ballantyne *et al.*, 2005; McCool *et al.*, 2008; Sherker *et al.*, 2010).

Psychological implications for these actions are further found in studies by White and Hyde (2010) and Williamson *et al.* (2012) in relation to swimming location and rip current hazard. Fluctuations between conscious decisions, peer pressure, experience overruling subjective risk, and desiring a sense of control are known to be factors affecting these actions. The importance of understanding motivational factors, intentions, and risk perception of beach users is therefore paramount in managing beaches effectively and developing education materials, and deserves a study in its own right.

4.3.4 Rip current experience

When asked if the respondent had ever been caught in a rip current, 98 (24%) stated that they had, with more males answering ‘yes’ than females (n=69, 70% vs. n=29, 30%). The age group with the highest proportion of respondents caught in rips were the 13-18 year olds (n=20, 37%), with 0-12 year olds accounting for the lowest proportion (n=1, 5%). Statistically significant relationships were found between being caught in a rip current and gender ($\chi^2(2)=26.652$, $p<0.0005$) and age group ($\chi^2(14)=24.793$, $p=0.037$). The main activities at the time of incident were bodyboarding (n=34, 35%), swimming (n=30, 31%), and surfing (n=21, 21%). These results are consistent with findings from the incident statistics in Chapter 3 which outlined males and teenagers to be the greatest demographic of people caught in rip currents, and bodyboarding to be the main activity associated with rip incidents (Woodward *et al.*, 2013). Additionally, literature in this field has long established a male dominance in drowning and incident statistics. There is a strong relationship between males having overconfidence in their abilities and an underestimation of the risk (Gulliver and Begg, 2005; McCool *et al.*, 2008; Moran, 2011). Males are also exposed to rip currents more than females by spending more time in the water and venturing further out to sea (Morgan *et al.*, 2009).

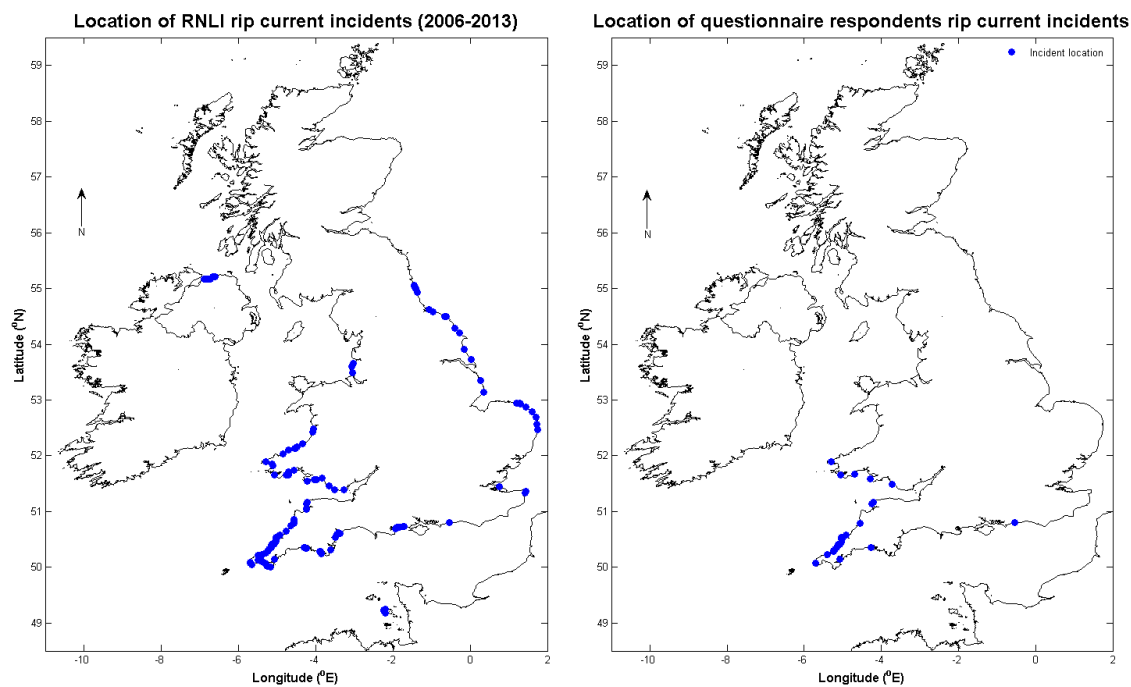


Figure 4.5 – A comparison of the UK locations of rip current incidents between the RNLi incident data and the beaches where questionnaire respondents were caught in rip currents.

The highest number of the incidents described by respondents occurred in the UK (n=74, 76%) mostly on Perranporth, Chapel Porth, and Constantine Bay beaches, with 9% (n=9) stating they were caught in Australia. Figure 4.5 shows where in the UK respondents were caught, and provides a comparison of rip current incident locations between the RNLI statistics analysed in Chapter 3, and the respondents of this questionnaire. Respondents' incident locations are concentrated on the Southwest peninsula and west Wales, which relates to the RNLI statistics, yet could be a result of sampling bias, whereby the greatest incident numbers were on the beaches sampled.

A significant association (Fisher's Exact test =6.613, $p=0.035$) between being caught in a rip current and attending a lifeguarded beach was found, where 70% (n=182) of those who always attend a lifeguarded beach have been not caught in a rip current. Conversely, 78% (n=116) of respondents who *do not* always attend a lifeguard beach have not been caught in a rip current. This would indicate that people are caught in rip currents at lifeguarded beaches more than non-lifeguarded beaches. This might be expected as lifeguards are placed on beaches with higher risk ratings due to environmental hazards such as rip currents, and as concluded in Chapter 3, half of lifeguards rescues are outside of the safe bathing areas. It is not clear from these results, however, whether respondents were caught on a lifeguarded beach, or if it was out of hours/season, or if they now always attend a lifeguarded beach *because* they have been caught in a rip current in the past. Those who were caught at a lifeguarded beach however, are possibly safer if they do get caught due to the lifeguard presence.

Rip current knowledge increases with water use (Figure 4.4). Subsequent analysis found a statistically significant relationship ($\chi^2(8)=64.914$, $p<0.0005$) between being caught in a rip current and frequency of water use. Figure 4.6 also illustrates this where the probability of being caught in a rip current does increase with water use. It is unsurprising that increasing exposure to the hazard raises the risk of being caught, but perhaps activity, location, and time of year can somewhat account for this.

Summer only water users (n=239) who have been caught in a rip total 14% (n=34), compared to 60% (n=39) of year round water users (n=65). The activity most participated in throughout the year is surfing, consistently averaging 22% (mean=35) of all activities per season, whereas bodyboarding and swimming peak in summer months but reduce for the other three seasons.

In the UK, waves for surfing are often more consistent and powerful outside the summer months due to more frequent mid-Atlantic depressions, and with a dedicated cold water

surfing community, exposes surfers to rip currents year round. In addition to this, lifeguard patrols cover beaches between the hours of 10:00-18:00 from April through to October, enhancing the risk to water users entering the water outside of these times. It is therefore even more important to promote water safety and rip current education to year round water users, especially novices and improvers, who will continually be exposed to the rip current hazard, particularly year round, when lifeguard patrols may be absent, and sea conditions more dangerous.

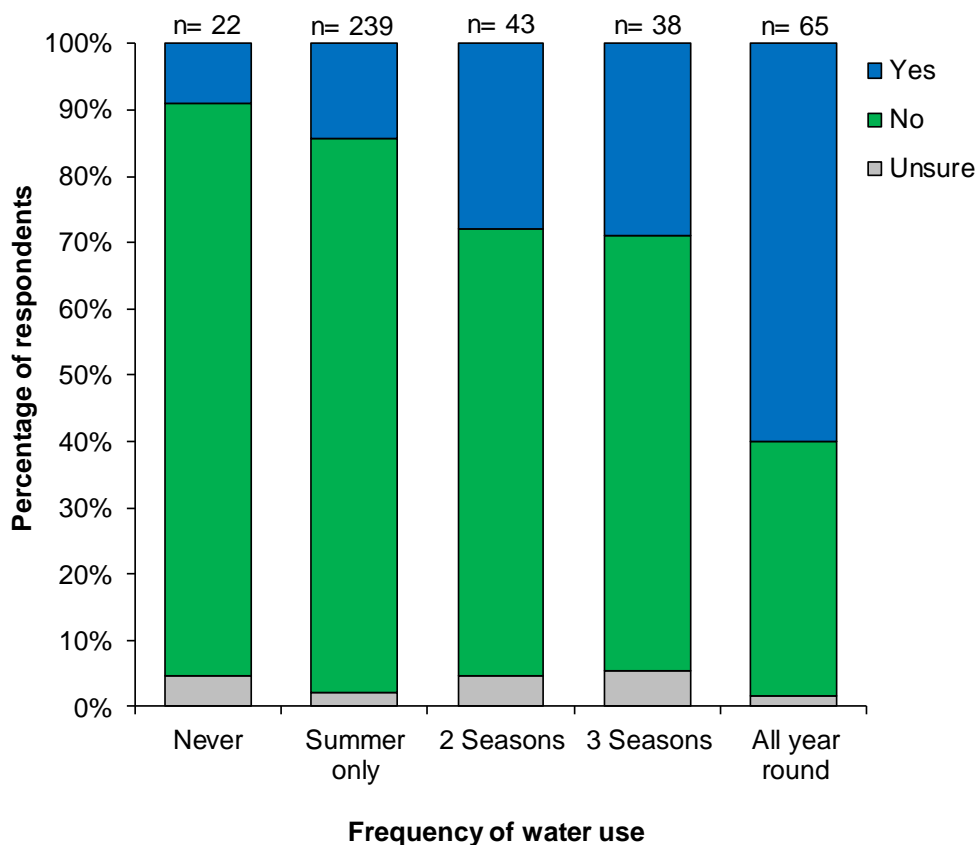


Figure 4.6 - Stacked bar showing percentage of respondents' frequency of water use throughout the year against their experience of being caught in a rip current, not caught, or unsure.

As frequency of water use increases, it appeared that water experience and possibly knowledge and identification of rips, also increased. It should also be noted that with more water experience and rip current knowledge, could come increased usefulness of a rip, i.e. for a surfer to get out beyond the break easily. The relationship between levels of rip current knowledge and respondents caught in a rip current was analysed using a Kruskal-Wallis test, and found a statistical significance ($\chi^2(2)=34.746, p<0.0005$) between the two, highlighting

that having experience of being caught in a rip current increases levels of rip current knowledge, where the mean rank of caught in a rip (256.16) is significantly greater than not being caught in a rip (190.71) and shown in Figure 4.7.

Those with the highest knowledge who have been caught ('good' and 'excellent', n=19, 19%) predominantly frequent the water all year round (n=14, 37%), and surf (n=139, 28%). There is still a high level of 'incorrect' and 'poor' knowledge of rip currents (n=48, 49%) among those who have been caught in a rip, but there is a definite shift from 'poor' to 'good' knowledge. Incidentally, there is no statistical significance between beach flag knowledge and being caught in a rip current.

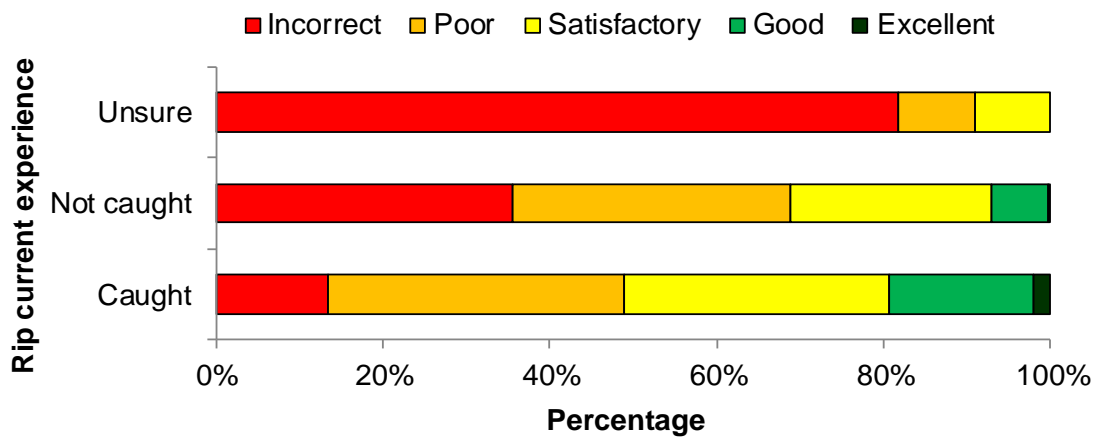


Figure 4.7 - Stacked bar showing percentages of rip current knowledge per scale category of those caught in a rip current, not caught or unsure.

This demonstrates that the experience of being caught in a rip current provides a greater level of awareness and understanding of the hazard, a finding similar to that of Drozdowski *et al.* (2012). This highlights the question whether rip victims have advanced levels of knowledge because of being caught in a rip, or if they are caught in a rip *because* of their advanced knowledge due to a developed water competence, confidence and rip identification skills. What can be inferred, and echoed by Sherker *et al.* (2010), is that those with rip experience are better placed to make decisions about where to enter the water, and are more confident in their reaction if caught in one. It is also of no surprise that increased participation in an activity will lead to a better understanding of the environment in which it is conducted.

Escape strategies were tested for statistical associations, where no significant relationships were found between escape strategy and gender (however, more males were using the rip

deliberately, swam against the rip, and went with the flow), age group, and rip current knowledge. There was also no statistical significance between signalling and gender, age group, or rip current knowledge. Escape strategies were chosen from a prescribed list, where 55% (n=54) of people self-rescued. Of this percentage 26% (n=25) swam parallel to the shore. Of those swimming, bodyboarding, and surfing, 80% (n=79) did not signal to anyone for help. Reasons why people did not signal for help were varied: 35% (n=34) felt confident and at ease with the situation, 5% (n=5) were using the rip deliberately for their activity, and 12% (n=12) were caught in a rip out of lifeguard hours or on a non-patrolled beach. Lifeguards saw 10% (n=10) of people, whereas 7% (n=7) were too busy swimming to be able to signal. Three percent were too proud to signal, of which two thirds were male under the age of 30, and corresponds with male bravado highlighted in section 4.3.3.

Additionally, 11 respondents were unsure whether they had been caught in a rip. Knowledge levels were analysed, with 82% giving an incorrect description of a rip current, potentially indicating that their uncertainty of the incident was due to poor identification. Water use analysis indicates 45% of those unsure if they were caught in a rip are summer water users and 9% don't go in the sea; whether their rip current experience put them off going in the sea or not is unknown.

4.3.5 Rip current education

Results from the questionnaire also established whether beach users had received or acquired any type of rip current education, and if so, where that education came from. Respondents were asked to state what form of rip current education they may have had, whether directly through being taught specific information during a course or from a lifeguard, or indirectly via signage, media, or entirely subliminally.

Just over three quarters (n=309, 76%) of respondents have never received any form of rip current education. Differences between gender show that 27% (n=54) of male respondents have received education compared with 21% (n=43) of females, and the age group with the highest proportion of education are 19-25 year olds (n=10, 37%), significant associations between education and both gender and age group were not found. Additionally a third (n=18, 33%) of 13-18 year olds, who were identified from UK rip current rescue statistics to be most at risk (Woodward *et al.*, 2013), had acquired rip current education, and those aged 65+ total the lowest proportion (n=1, 6%). Statistical significance ($\chi^2(9)=31.776$, $p=0.002$) was found between the region respondents live in and whether they had received any rip current

education. Nearly half (n=27, 47%) of all 'local' (TR, PL, and EX postcodes local to the beaches sampled) respondents have received some form of rip current education. Respondents in the Southwest (non-local) had the lowest proportion, where only 10% (n=5) had received rip current education, followed by those in the Northwest (n=7, 13%).

Of the 24% of respondents who have had some form of rip education, courses such as watersports lessons and surf lifesaving clubs yield the highest proportion of responses (n=30, 31%), followed by educational establishments (n=16, 16%) and lifeguards (n=14, 14%). The lowest, with less than 3% of responses, were signage (n=2), internet research (n=2), and television (n=3).

Analysis was done to establish which form of education yielded the highest and lowest rip current knowledge levels. A Mann-Whitney test found a statistical significance ($U=10755.500$, $Z=-4.518$, $p<0.0005$) between respondents who have received rip current education (mean rank=248.75), have not received rip current education (mean rank=189.81) and rip current knowledge. Respondents without rip current education returned 70% (n=216) 'incorrect' and 'poor' on the knowledge scale combined, compared with 48% (n=47) of those who have obtained rip current education. 'Good' and 'excellent' knowledge accounted for 6% (n=20) of those without rip current education, and 21% (n=20) of those with rip current education. These results show that those who have received some form of education about rip currents have higher knowledge levels of the subject. Receiving education from lifeguards yields highest knowledge levels with 36% of that group registering within the 'good' scale category. Inversely leaflets yield the lowest with 50% falling within the 'incorrect' scale bracket.

This provides support for the RNLI to continue to use their lifeguards to inform the public about rip currents on hazardous beaches. It is also noted that educating people in the environment where the hazard is present is successful, and could be a way to effectively reach specific audiences (such as teenage males). It has been shown by Klein *et al.* (2003) that an increase in lifeguard preventative actions, resources, and importance has positive results on incident and drowning statistics. A concentrated effort to reach certain demographics with cleverly designed marketing or incentives utilising lifeguards could be the key to rip current education.

Respondents were also asked to provide ideas for the best methods on how to educate the public about rip currents, what form of education that may be, how and where it could be delivered, as well as the form of education they personally would be most receptive to. Signage was suggested the most with 24% (n=148) of responses, 5% (n=31) of which were

specific ‘dynamic’ signs displaying rip current information as conditions changed throughout the day, mobile signs at the water’s edge, and beach specific signage that are highly noticeable:

“Information signs when you come on to the beach, but clearer explaining what a rip current is” (#154).

“Signs showing what a rip current is with visual clues on the signs” (#229).

Communication from lifeguards was the second highest response (n=62, 10%). When asked in the field, a vast proportion of people were very uncertain, often vaguely supposing some form of education would work:

“It’s difficult. What to do? Don’t know, but it’s so dangerous” (#102).

There were also, however, a small proportion of people who were firmly confident in their method suggestion:

“A two pronged strategy – early education at school should be a mandatory requirement in every primary school, and where possible have in-situ guidance at places of high rip current incidence” (#273).

Half of all respondents thought any form of education should be delivered on the beach, in the environment where the hazard is present.

Though a popular solution, signage only accounted for 0.5% of those who have received rip current education, and as 65% of these respondents had a poor knowledge of rip currents, they may have found it difficult to know the best methods to interpret the subject. Additionally some respondents were sceptical of signs suggesting that people don’t read them:

“Leaflets in holiday flats because people don’t read signs” (#3).

“People walk straight past signs” (#372).

“Not everybody reads them” (#116).

A study on beach safety signage undertaken by Matthews *et al.* (2013) suggests that this method is not as effective as authorities believe, implying that public awareness campaigns may be the best and only way to communicate hazards on beaches. However, when researched and implemented correctly, signage can have a positive impact on conveying information on hazards. Rousseau and Wolgater (2006), however, suggest the presence of warning signs have a significant effect on compliance behaviour, and that attempting to

communicate something is better than nothing. More importantly, successful signs will display information on what people already know rather than expecting people to learn something new.

Respondents in this study know more about beach flags than rip currents, which could be a consequence of signs at the beach displaying safety flags more frequently than rip currents. Information about the flags should be conveyed via signage, with more emphasis on *why* they are placed there, i.e. to avoid rip currents. Whether signage works effectively is uncertain, but studies undertaken on beach signage proves current safety signage is unsuccessful, and is clear more research needs to be done on this topic to ensure the most effective rip current signage is utilised.

Table 4.5 Methods of rip current education respondents would be most receptive to showing all respondents, those caught in a rip current, and those not caught in a rip current.

		Face-To-Face from lifeguards	Information booklets/leaflets	Internet	Radio	Beach based demonstrations	Signage	Smartphone app	Television	Other	Total
All respondents	Count	173	98	88	38	114	162	45	165	90	973
	<i>% of responses</i>	17.78	10.07	9.04	3.91	11.72	16.65	4.62	16.96	9.25	100
	<i>% of people</i>	42.51	10.07	9.04	3.91	11.72	16.65	4.62	16.96	22.11	239.06
Respondents not caught in a rip current	Count	110	67	65	29	72	120	31	134	62	690
	<i>% of responses</i>	15.94	9.71	9.42	4.20	10.43	17.39	4.49	19.42	8.99	100
	<i>% of people</i>	36.91	22.48	21.81	9.73	24.16	40.27	10.40	44.97	20.81	231.54
Respondents caught in a rip current	Count	55	28	22	6	39	39	13	28	29	259
	<i>% of responses</i>	21.24	10.81	8.49	2.32	15.06	15.06	5.02	10.81	11.20	100
	<i>% of people</i>	56.12	28.57	22.45	6.12	39.80	39.80	13.27	28.57	29.59	264.28

N.B. Respondents may tick more than one response, therefore ‘% of responses’ is divided by the total selections, and ‘% of people’ by number of respondents, hence why this can total more than 100%.

Respondents were asked to select, from a prescribed list, which methods of education they would find most favourable if there were to be a new rip current education scheme (Table 4.5). A preference for a face-to-face conversation with a lifeguard was selected by 18% (n=173), with 17% (n=165) choosing television and 17% (n=162) signage. Table 4.5 shows all respondents, and also gives a breakdown of answers from those caught and not caught in a rip current. The main differences between these two groups are that those who have been caught rank lifeguards above demonstrations and signage, and those who haven't been caught rank television above signage and lifeguards. Information via the radio or a smartphone app were the least popular methods.

The results in this chapter provide an argument in favour of beach safety education and more specific rip current material. The provision of such information will enable beach users to make safe decisions, and presenting them with options if a danger presents itself. Education is promoted by the findings of Klein *et al.* (2003), where a successful beach safety campaign led to an 80% reduction in fatal accidents, and Hatfield *et al.* (2012) where a campaign effectively improved beach users' knowledge of, and behaviours around, rip currents. This study, supported by these examples of successful beach safety campaigns, provides further evidence for continuing the process of creating and implementing a rip current education pilot in the UK.

4.4 Conclusions

A questionnaire was delivered to 407 beach users during the summer on UK beaches to determine the current levels of awareness of beach safety and rip currents. This chapter not only provides an insight into the UK beach user, but further contributes to the field of social rip current research. Additionally it presents a benchmark from which to progress the education of rip currents to the public. Education, in whatever form, must develop from evidence and provide the public with the best tools, communicated in the most effective way, to keep them safe at the beach. The effects of educating the public on beach safety, in particular rip currents, are positive, and can lead to reductions in incidents. Based on this study the following conclusions can be drawn:

- The level of rip current knowledge among UK beach users is poor (n=263, 65%), with only 35% (n=144) able to give a correct description of a rip current. This poor level of rip current knowledge indicates the need to increase education on the topic.
- Conversely, those surveyed have a higher knowledge of the beach safety flags with 96% (n=389) and were able to give a correct description of what the red and yellow flags indicate. Good knowledge of this topic accounted for 77% (n=314) of respondents.
- With a good understanding of the beach safety flags beach users comply with the flag system (n=339, 86%) and three quarters (n=309, 75%) have not been caught in a rip current. This demonstrates that entering the water between the flags reduces the risk of being caught in a rip current. This emphasises the value of general beach safety and the importance of attending a lifeguard patrolled beach during operational months and hours.
- A statistically significant relationship ($\chi^2(2)=34.746$, $p<0.0005$) was found to show that respondents who have been caught in a rip current have a greater knowledge (n=50, 51%) of rip currents than those who have not been caught (n=93, 31%). This provides further evidence that experience of being caught in a rip current is the best way to demonstrate the hazard, presenting victims with the physical and mental awareness of what a rip current does and how it can affect water users.
- Statistical significance ($U=10755.500$, $Z=-4.518$, $p<0.0005$) was found between respondents who have received rip current education and rip current knowledge. Lifeguards have proven to be the most effective form of rip current education and a popular source for disseminating future education. Lifeguards should therefore be included in any rip current education schemes that may be developed.

Concluding that rip current knowledge is presently poor, it can therefore be determined that education on rip currents *is* needed, and provides further justification for the education pilot presented in Chapter 6.

The results from this chapter provide important information on the UK beach user that can be added to the results from Chapter 3. We know from Chapter 3 the demographics of people caught in rip currents, the locations of incidents, and the activities people were undertaking. We now know that UK beach users have a poor knowledge of rip currents and the baseline levels needed to work with for education purposes. This chapter has marked the second of

three pieces of data collection, and the third is an exploration of people who have been caught in rip currents and is presented in the following chapter.

Chapter 5

Rip current perceptions and experiences

5.1 Introduction

Chapter 3 has illustrated who is caught in rip currents in the UK, the locations of incidents, and activities involved. Further investigation of UK beach users in Chapter 4 found that the public has a poor knowledge of rip currents. This fifth chapter now explores the experiences and perceptions of people caught in rip currents; how they felt, what they did, what they thought, and how much they knew about rip currents. This chapter presents the third and final piece of data collection to inform the education pilot addressed in detail in Chapter 6.

The aims of this chapter are:

- Increase our understanding of the elements that impact upon peoples' reactions, behaviours and attitudes when they are caught in a rip current.
- Assess the rip current understanding and perceptions of people who have been caught in rip currents.
- Examine the physical reactions of people caught in rip currents and their subsequent escape methods.
- Explore the effectiveness of current safety messages in consideration for future rip current education, taking into account the suggestions of those who have been caught.
- Consider any practical issues that may arise from this cohort of rip current 'victims' in relation to beach safety management.

This information is important to build up a picture of individual perceptions of the rip current hazard, and also to increase understanding of human responses when caught in rips to decipher the most effective techniques for communicating safety messages. Without an understanding of the existing knowledge, responses, and educational needs of target audiences, education strategies may not be effective.

A debate currently exists of effective rip current escape methods and subsequent safety messages that are currently promoted by beach safety practitioners (Brander and MacMahan,

2011). The exploration of rip current dynamics with in-situ drifter measurements (MacMahan *et al.*, 2010; Austin *et al.*, 2010; Miloslis and Stephenson, 2011) and human responses (McCarroll *et al.*, 2014) has allowed further worldwide comparisons of rip current flow characteristics. MacMahan *et al.* (2010) pioneered the ‘float’ escape strategy as an alternative to ‘swim parallel’, arguing that the recirculation pattern of rip currents will mostly transport swimmers back onto the sandbar allowing escape. This was challenged by Miloslis and Stephenson (2011) who suggested promoting a ‘do nothing’ strategy as there was no evidence that either tactic would produce a more effective escape.

These studies used GPS drifters, and whilst successful and representative of human behaviour in surf zone, did not physically measure a human body. McCarroll *et al.* (2014) has since used human participants to investigate how effective different escape strategies actually are. Where subjects were asked to utilise both the ‘swim parallel’ and ‘float’ strategies, the study concluded that neither method was dependable in a variety of rip current situations, with one working better than the other in certain conditions and vice versa. The study also took into account swimmer ability and experience, and the presence of lifeguard patrols, suggesting that the interaction of humans and physical rip current processes are complex and vary in individual situations.

Adding further components to this already complicated topic, Brander *et al.* (2011) presents the physiological and psychological aspects of experiencing a rip current, highlighting their importance during such an event. McCool *et al.* (2008) also iterates the importance of understanding behaviour and attitudes relating to safe swimming at beaches.

These factors are important considerations for this chapter as understanding the psychologies involved when people face an unknown, stressful or fearful situation such as being caught in a rip can assist the research. Not only can this information help lifeguards and safety management practices, but also identify the best methods of communicating the rip current hazard by appreciating the emotions and subsequent actions of individuals within that situation.

These intricacies of physical rip current dynamics, escape strategies, and human reactions are consolidated in one study by Drozdowski *et al.* (2012) that has been the only study to date to consider human experiences of being caught in a rip current. This study concluded that people caught in rip currents tend to panic and swim straight to the shore, despite being aware of and often utilising the ‘swim parallel’ escape strategy. That study provided the template for the work in this current chapter, which presents results from UK respondents’ rip current experiences, and provides further input for the education pilot.

5.2 Method

A questionnaire was developed by the RNLI and Plymouth University, following a template acquired from researchers at the University of New South Wales in Australia conducting similar rip current research (Drozdowski *et al.*, 2012). The survey was then published online on 25th July 2011 and remained accessible until 31st December 2012. Advertisement of the questionnaire was via the RNLI and promoted through their media channels, including online sources, local radio, and regional newspapers, as well as providing lifeguards with the survey details on cards to hand out to people rescued from rip currents. Additionally, a link to the survey was advertised on the BBC1 television programme ‘Bang Goes the Theory’ broadcast on 22nd August 2011, after a section on rip currents and the work of Austin *et al.* (2010).

The questionnaire consisted of 27 questions, providing a mixture of quantitative closed question responses and qualitative open-ended responses (Appendix 2). The survey was divided into three main parts: an initial respondent profile was built up through demographic information, swimming ability and experience; the second part sought to discover knowledge of rip currents and where information has come from, and the third section comprised questions on the experience of being caught in a rip current. The open ended questions sought to gain as much information as possible from respondents on their experiences and opinions through their own descriptions.

Open ended responses were analysed using a mixture of latent and inductive content analysis (Chapter 2, section 2.6.3), where the themes are derived from the data and placed into identifying groups known as a ‘code’ (Denzin and Lincoln, 1998). The codes are then used as subjects in analysis, where weightings are assigned to each group, in order to compare the values of each code. This allowed thorough exploration of respondents’ experiences of being caught in a rip current, gaining an understanding of their perceptions, behaviours, and psychologies.

5.3 Results and Discussion

5.3.1 Respondent profile

A total of 1257 people engaged in the survey online, of which 704 people were rejected because they had not been caught in a rip current, therefore 553 responses were analysed. The sample size was 553 people, which gives a margin of error of $\pm 3\%$ at the 95% confidence level (Chapter 2, p.43). Table 5.1 shows an overall respondent profile; the response rate is higher among males (69%, n=381) compared to females (31%, n=171). The over-representation of males within this survey is comparable to other aquatic studies such as those researching drowning trends, swimming behaviour, watersports participation, and rip current awareness among others (Ballantyne *et al.*, 2005; Morgan *et al.*, 2009; Sherker *et al.*, 2010). Chapter 3 highlighted 67% of all RNLI rip current incidents were male, which is compatible with the 69% who responded to this survey. A Chi Square goodness of fit test was run to test the observed and expected values, where expected gender values used the values from Chapter 3 (67% male, 33% female). Results established that gender does not differ significantly from the expected values, and the divide between males and females is therefore a representative sample of the wider rip current incident population.

As mentioned in previous chapters, males have been observed to participate more in watersports, particularly surfing, and have a tendency to do so further from the shore due to greater experience, skill or confidence (Gulliver and Begg, 2005; McCool *et al.*, 2008; Morgan *et al.*, 2009; Moran, 2011). For these reasons males are more exposed to the rip current hazard thus finding more incidents and fatalities involve males, and will therefore always remain a primary demographic target for aquatic safety education.

Age was grouped into five categories, where 31-59 year olds accounted for the largest group (n=248, 45%), these age group categories are uneven, however, so have been normalised by the number of years within each category. When normalised however, the 14-17 year age group are most represented (n=38, 62%), again corroborating with results from Chapter 3 where teenagers represent the greatest number of 'victims' of rip currents on RNLI patrolled beaches in the UK.

A third of respondents originate from the Southwest of the UK (32%, n=177), with some from non-UK countries (4%, n=19), and 10% (n=57) were unknown. There is a mixture of water use dependent on time of year (Table 5.1), with a shift from more frequent summer activity to less frequent in winter months as to be expected due to temperature and peak

holiday season. Respondents self-rated their swimming ability highly with nearly half stating they were ‘competent’ swimmers (n=268, 49%), and ‘highly competent’ (n=153, 28%), with only one person stating they were unable to swim.

Table 5.1 – Profile of online rip current survey respondents.

Gender	Freq.	%	Age group	Freq.	%
Male	381	68.9	0-13	26	4.7
Female	171	30.9	14-17	114	20.6
No answer	1	0.2	18-30	128	23.1
			31-59	248	44.8
			60+	37	6.7
Swimming ability	Freq.	%	Swimming lessons	Freq.	%
Unable to swim	1	0.2	No	37	6.7
Learning to swim	8	1.4	Yes, in a pool	330	59.7
Able to swim	122	22.1	Yes, in a pool and the sea	171	30.9
Competent swimmer	268	48.5	Yes, in the sea	13	2.4
Highly competent swimmer	153	27.7	No answer	2	0.4
No answer	1	0.2			
Activity in summer	Freq.	%	Activity in non-summer	Freq.	%
Everyday	46	8.3	Everyday	14	2.5
Several days a week	146	26.4	Several days a week	91	16.5
Several days a month	155	28.0	Several days a month	128	23.2
Once a month	33	6.0	Once a month	50	9.0
Several days a year	155	28.0	Several days a year	164	29.7
Never	16	2.9	Never	104	18.8
No answer	2	0.4	No answer	2	0.4
Region of respondent	Freq.	%			
Southwest	177	32.0			
Southeast	54	9.8			
London	35	6.3			
East	37	6.7			
Midlands	40	7.2			
Wales	25	4.5			
Northwest	29	5.2			
Yorkshire and the Humber	19	3.4			
Northeast	24	4.3			
Scotland	20	3.6			
Northern Ireland	11	2.0			
Channel Islands	5	0.9			
Non-UK	19	3.6			
Unknown	57	10.3			

5.3.2 Comparisons to Australia

To assess where the UK responses fit within an international context, a brief comparison to the only other ‘rip current survivor’ survey undertaken in Australia by Drozdowski *et al.* (2012) has been made. By using the Australian template for this UK survey, it is no surprise that results are similar because the same questions were used on a similar number of people. There are, however, some differences that will be highlighted, in addition to lines of inquiry that were not developed by Drozdowski *et al.* (2012). Table 5.9 outlines the main findings of Australian respondents’ rip current experience and the messages they remembered before and during the event, how they responded, how they escaped, and their suggested safety messages, with the UK results coloured in red. Differences in the order of responses between the studies are emphasised in bold.

5.3.2.1 ‘Float with the rip’

The option of floating with the rip current was stated far more in Australia than in the UK before being caught in a rip current, as an immediate physical response, and as an escape tactic. In contrast, UK respondents remembered this message *when* they were caught in the rip, and not before: 40% of Australian and 24% of UK respondents remembered the ‘float with the rip’ message before. Additionally, ~17% of Australian and 6% of UK respondents drifted or floated with the rip current when they were in it.

Different rip current safety messaging are used within the two countries which may account for these differences. The debate between swimming parallel and floating in a rip current is fairly recent within the scientific rip current community (Brander and MacMahan, 2011), and has been mainly discussed in Australia. The float option may be known and adopted more by Australian respondents because the majority (77%) resided in New South Wales and Sydney where surf lifesaving and beach culture is particularly prominent (Booth, 2001). This difference highlights that the float message is not as well-known to UK respondents compared with their Australian counterparts due to a possible difference in knowledge, and exposure to the message through a different beach culture.

Table 5.2 - A comparison of Australian (green) and UK (blue) rip current experiences highlighting messages survey respondents remembered before, during, and after being caught in a rip current, adapted from Drozdowski *et al.* (2012)*.

Messages	Response 1	Response 2	Response 3
Message remembered before caught in rip current	Swim sideways to rip/ parallel to beach ~78%	Float with the rip current ~40%	Don't panic/remain calm ~35%
	Swim sideways to rip/ parallel to the beach 70%	Don't fight the rip/swim against it 32%	Don't panic/ remain calm 26%
Message remembered when caught in rip current	Swim across rip/ parallel to the beach ~40%	Don't panic/remain calm ~28%	Don't swim directly against the rip ~26%
	Swim sideways to rip/ parallel to the beach 46%	Don't panic/remain calm 26%	Drift, float with the rip current 15%
Immediate physical response when caught in rip current	Swim against rip to shore ~20%	Swim across rip/parallel to beach ~13%	Drift, float with rip current ~9%
	Swim against rip to shore 2%	Swim across rip/parallel to beach 13%	Raise an arm/shout for help 6%
Immediate emotional response when caught in rip current	Panic/anxious/ distressed/fear ~33%	Calm/relaxed /confident ~15%	Surprised ~4%
	Panic/anxious/ distressed/fear 29%	Calm/relaxed/ confident 18%	Surprised 3%
How respondents got out of the rip current	Swam sideways/ parallel to the beach ~33%	Drifted, floated with rip current ~17%	Rescued or assisted ~16%
	Swam sideways/ parallel to the beach 50%	Rescued or assisted 27%	Swam hard to get back in 10%
Suggested safety message	Stay calm/don't panic	Knowledge of how to identify the rip	Seek help/raise arm
	Knowledge of how to get out of the rip	Stay calm/Don't panic	Knowledge of how to identify the rip

*NB: Australian survey, n=671, UK survey, n=553, percentages are a proportion of survey responses. Australian survey responses not known exactly hence ~%, bold indicates a difference in message recall between the two surveys.

5.3.2.2 Rip current escape

Knowledge of escape messages was then put to use when people were caught in the rip current. The majority of both survey respondents remembered the ‘swim parallel’ message before, and used this method to escape (Table 5.2). UK respondents, however, used this method more (50%) than Australians (~33%), which could again suggest Australian respondents were more aware of the different options.

UK respondents were rescued or assisted (27%) more than Australians (17%), which is possibly related to the UK having a higher coverage of lifeguarded beaches compared with Australia, where only 3% of beaches have lifeguard patrols (McKay *et al.*, 2014). However, 59% of Australians were at a lifeguarded beach, albeit 73% were outside of the lifeguard patrolled areas, which means that either the lifeguards did not see them, or people overestimate their ability to be able to swim outside the flagged area. In addition, it raises the question whether Australians are more able to self-rescue, and are perhaps encouraged because of this lack of lifeguard patrolled beaches?

5.3.2.3 Suggested safety message

Knowledge of how to get out of a rip current was a suggested safety message from 60% of UK respondents, but not mentioned by Australian respondents. This emphasises the points made above, where there is perhaps more awareness of rip current escape methods among Australians. Staying calm and not panicking was suggested in both countries as an important message to convey. Drozdowski *et al.* (2012) imply that this message is not always emphasised as the primary safety message (swim between the flags is the main aim). Staying calm is deemed important by rip current ‘survivors’ in these two surveys, who discovered that panicking lead to poor decision making. Knowing how to identify a rip current was suggested as a more important safety message to UK respondents.

5.3.3.4 Similarities

Differences between the sets of respondents have been highlighted in pre- and post-caught situations where rip current awareness, lifeguard patrols, and water confidence might have had an influence. The similarities come in what respondents remembered when they were caught in the rip current, and their physical and emotional response. Almost an identical number of both Australian and UK survey respondents remembered to swim parallel to the

shore, and not to panic, yet their initial physical response was to swim directly against the rip current back to shore. Additionally, their emotional response was also the same, where most panicked and were anxious, distressed, or fearful of the situation.

This emphasises a deeper psychological implication to these reactions, which is discussed further within this chapter. It also highlights that despite a difference in rip current awareness, or exposure to the beach and respective safety messages, human instinct provides the same reaction. It is extremely encouraging to find distinct similarities with the Australian survey, yet there are certain differences that highlight cultural disparities. It is important to compare datasets as it strengthens the worldwide understanding on how people react when caught in a rip current, as well as providing research on safety message distribution.

With an understanding of the main differences to Australia, the rest of this chapter explores the main findings from the UK, adding further consideration to matters not addressed by Drozdowski *et al.* (2012).

5.3.3 Rip current knowledge

5.3.3.1 Rip current identification

The sample group were asked if they could visually identify a rip current and, responses were coded into 10 themes. Answers could have been coded into more than one theme, such as:

“A rip can have discoloured water, foam on the surface extending beyond the break, possibly a rippled appearance with debris floating out to sea.” (#005)

This was coded into ‘Disturbed surface’, ‘Colour change’, and ‘Flotsam’. 366 people answered the question, and answers were coded 690 times (percentages derived from the number of respondents that stated each feature). Gender and ability to identify a rip current were Chi Square tested and found a statistically significant relationship ($\chi^2(1)=13.904$, $p<0.0005$), where more male respondents ($n=274$, 73%) stated they were able to identify a rip current were male, than females ($n=96$, 57%). This is either because males have a greater knowledge of rip currents, are more confident, or have greater experience. Results from Chapter 3 concluded that males are caught in rips more than females, and Chapter 4 highlighted that males have a greater knowledge of rip currents. The high proportion of male respondents in this study confirms that males have more experience of being caught in a rip

current. People most used the lack of breaking waves to describe a rip current (n=184, 50%), followed by a colour difference in the rip highlighted by churned water, darker blue, and streaks of white or foam (n=139, 38%). The frequencies of responses have been annotated onto a picture of a rip current in Figure 5.1. No significance was found between gender or age group and identifying features of a rip current, however, more females were unsure, stated ‘surf either side’, ‘sweeping water’, and ‘flotsam’ as opposed to males who stated ‘disturbed surface’, ‘no waves’, ‘looks calm’ and ‘colour change’ more than females.

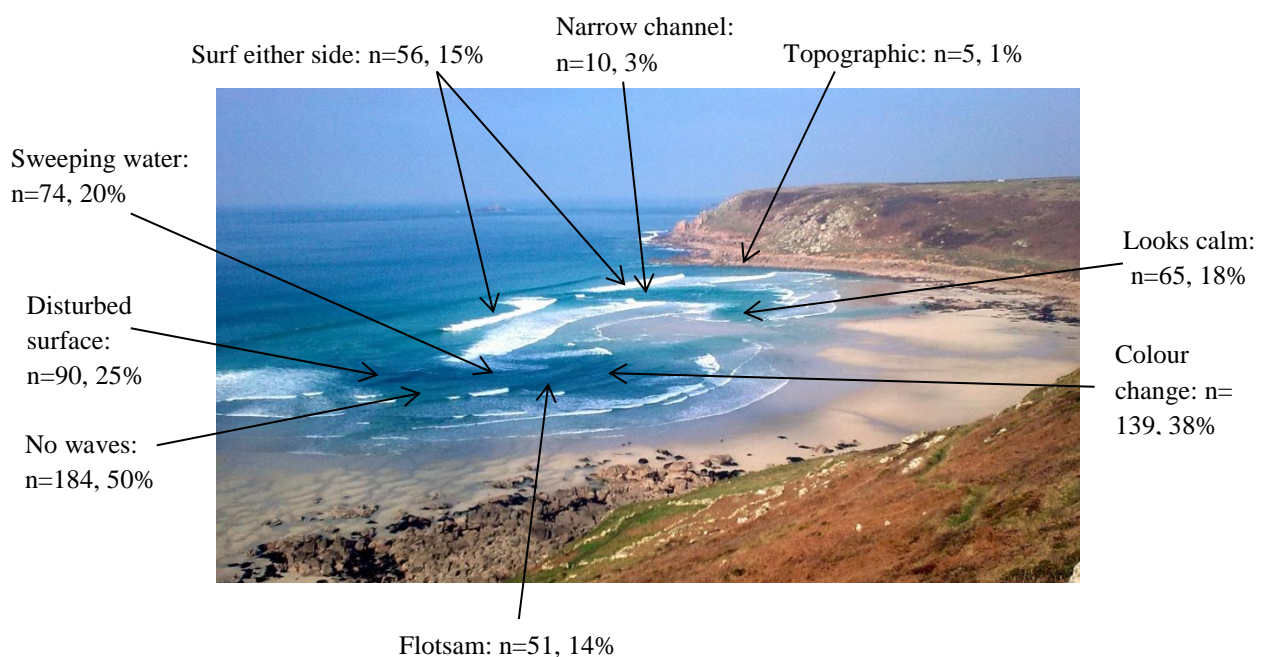


Figure 5.1 – Photograph of Gwenver beach, west Cornwall showing a rip current system and the corresponding identifying features described by questionnaire respondents (A. Thorpe (personal photograph, November, 2012)). NB: Percentage indicates what percentage of respondents used identifying features of each given type, and can total >100% because each respondent can state more than one feature.

Respondents gave a variety of ways to identify a rip current, with analysis finding some were more confident than others, for example one respondent stated,

“Sometimes, I’m a bit hazy on this. I think beach currents appear smoother than the surrounding surf, other rips can be identified by location, i.e. you can expect one alongside a cliff” (#61).

Despite the uncertainty, the respondent is correct in their identification, and stating a topographic feature not many people mentioned. This uncertainty was evident in a number of

respondents, despite generally naming multiple identifiers, with some adding that rips are easier to spot from a height and more difficult from the shore.

It is important to understand how people identify rips because it is believed that comprehending the distinguishing features of a rip current can initially stop people entering them by being able to seek out the safest areas to enter the water (Sherker *et al.*, 2010), and understanding why lifeguards place the patrol flags where they do – making these more attractive areas to swim. Interpreting what people already know - how they describe what they are seeing, the words they use, the features they remember - can further aid safety messages and campaigns insofar as it recognises the features people already use, promoting simple, easy to remember attributes.

However, as mentioned by some respondents, and testified to anecdotally by lifeguards, rip currents can be hard to spot even to the trained eye. Nevertheless, providing the public with some form of rip characteristic and encouraging identification when on the beach could help people to choose a safe place to enter the water or, failing that, at least get them thinking about rip currents, beach safety and dynamically assessing their own risk to the hazard.

5.3.3.2 Rip current knowledge levels

Rip current knowledge was determined from respondents' descriptions of rip currents, and was then scored on a scale from 1-5, 1 being 'incorrect' to 5 being 'excellent' (Table 5.3). Nearly two thirds of respondents were scored 'satisfactory', with more 'incorrect' to 'poor' answers combined (n=126, 23%) than those 'good' to 'excellent' (n=94, 17%), which shows 77% (n=426) of respondents gave correct descriptions of rip currents. A Mann-Whitney test was used as the data deviates from a normal distribution, and found no statistical significance was found between rip current knowledge and gender. A Kruskal Wallis one-way ANOVA test also found no significant differences between rip current knowledge and age group, region, or seasonal activities. The lack of significant differences suggests rip current knowledge is not a factor of demographics, the area where people live, or the frequency with which they participate in water based activities.

Table 5.3 – Examples of rip current descriptions and criteria for rank of knowledge on a scale of 1-5. N.B. 1 answer was missing for this question.

Score	Knowledge	Description	Count	%
1	‘Incorrect’	Undercurrent, invisible, all incorrect – wrongly described	67	12.13
<ul style="list-style-type: none"> • “I believe it is when two tides meet together” (#174) • “An underwater current, normally caused by movement of a large body of water e.g. Tides” (#003) • “It’s like quick sand twirling you down” (#374) • “Seawater in the wave area of a beach moving along the seabed in unusual patterns” (#235) 				
2	‘Poor’	States direction OR flow speed OR hazard, plus an incorrect measure - poorly described	59	10.68
<ul style="list-style-type: none"> • “The current under the surface of the water is going a different way and tried to drag you under” (#389) • “When the tide is going out and the drag pulls you out to sea” (#505) • “It is an undercurrent of water that sweeps you out to sea from underwater” (#039) 				
3	‘Satisfactory’	States 2 of direction, flow speed, hazard, mechanism, and morphology – suitably described	332	60.14
<ul style="list-style-type: none"> • “An outflow of water away from the beach” (#438) • “A rip current is a strong current which drags a swimmer away from the beach and out to sea” (#216) • “It is a high speed current in the sea which may be moving parallel to the shore or heading out to sea” (#029) 				
4	‘Good’	States 3 of direction, flow speed, hazard, mechanism, morphology – well described	81	14.67
<ul style="list-style-type: none"> • “Movement of water away from the beach caused by water brought in by waves taking the easiest route back out to sea, could be via a gutter or along a headland” (#010) • “An area of water on a beach where there is a channel in the bottom that causes the water over it to suck out backwards much more strongly than other part of a beach. Found under piers and by cliffs as well” (#494) • “The water that comes to shore need some where to go do is carried along the shore line until it finds an exit and flows back out to sea causing a rip current” (#508) 				
5	‘Excellent’	States all of direction, flow speed, hazard, mechanism, morphology – excellently described	13	2.35
<ul style="list-style-type: none"> • “It is a strong current formed when beach formation (sand banks for example) means that there's an imbalance of water in the surf line. Water levels rise and a current form to carry that water back out beyond the breaking waves. Often next to headlands or large rocks but also sometimes where hidden beach rivers or depressions cannot be seen beneath the surf. Usually at low tide or a little before or after low tide.” (#551) • “A current where the waves don't break and the water is pulled back out very quickly to the sea. This is where there are sandbanks and the water tries to find a gap between the banks. When it does, the water flows through it rapidly.” (#243) 				
			552	100

This same analysis was done in Chapter 4, which found that 35% (mean=2.14, SD=0.991) of general beach users had a good knowledge of rip currents – lower than the respondents of this chapter (mean=2.84 SD=0.903), and comparison between datasets can be seen in Table 5.4. Respondents in this survey stated their greater knowledge was due to their experience of being caught in a rip current, and may be why there is a no significant association between groups. For example, “*I do [know] now after my experience*” (#116), and another thought that “*Until you experience it yourself, I don't think people understand what they are*” (#44). This is further verified by results in Chapter 4 and Drozdowski *et al.* (2012) which found people who have been caught in a rip current do have an enhanced comprehension

Table 5.4 – Comparison of mean rip current knowledge of respondents in the beach user questionnaire in Chapter 4, and the rip current ‘victim’ questionnaire in Chapter 5.

	Chapter 4 – beach user questionnaire	Chapter 5 – rip current ‘victim’ questionnaire
Mean	2.14	2.84
Median	2.00	3.00
Mode	2	3
Std. Error of the Mean	0.049	0.038
Std. Deviation	0.991	0.903
Variance	0.981	0.815
Skewness	0.454	-0.496
Std. Error of Skewness	0.121	0.104
Kurtosis	-0.652	0.399
Std. Error of Kurtosis	0.241	0.207
Sum	873	1571
Incorrect	128 [31.4%]	68 [12.3%]
Poor	135 [33.2%]	59 [10.7%]
Satisfactory	104 [25.6%]	332 [60.0%]
Good	37 [9.1%]	81 [14.6%]
Excellent	3 [0.7%]	13 [2.4%]

5.3.3.3 Nationwide rip current knowledge

Analysis into levels of rip current knowledge in relation to respondents’ home location was undertaken to assess whether coastal inhabitants in the UK had a higher knowledge of rip currents. Figure 5.2 shows a broad spatial variation in knowledge levels, outlining that there is a slight trend for higher levels of knowledge to be in coastal areas, and lower to be inland such as a blue cluster in the Midlands. There are some anomalies, however, at both ends of

the scale. For example there is a small cluster of blue on the Southeast coast, Pembrokeshire and Cornwall, and some dark red and orange in London, and the Manchester/Leeds area, and the Northeast.

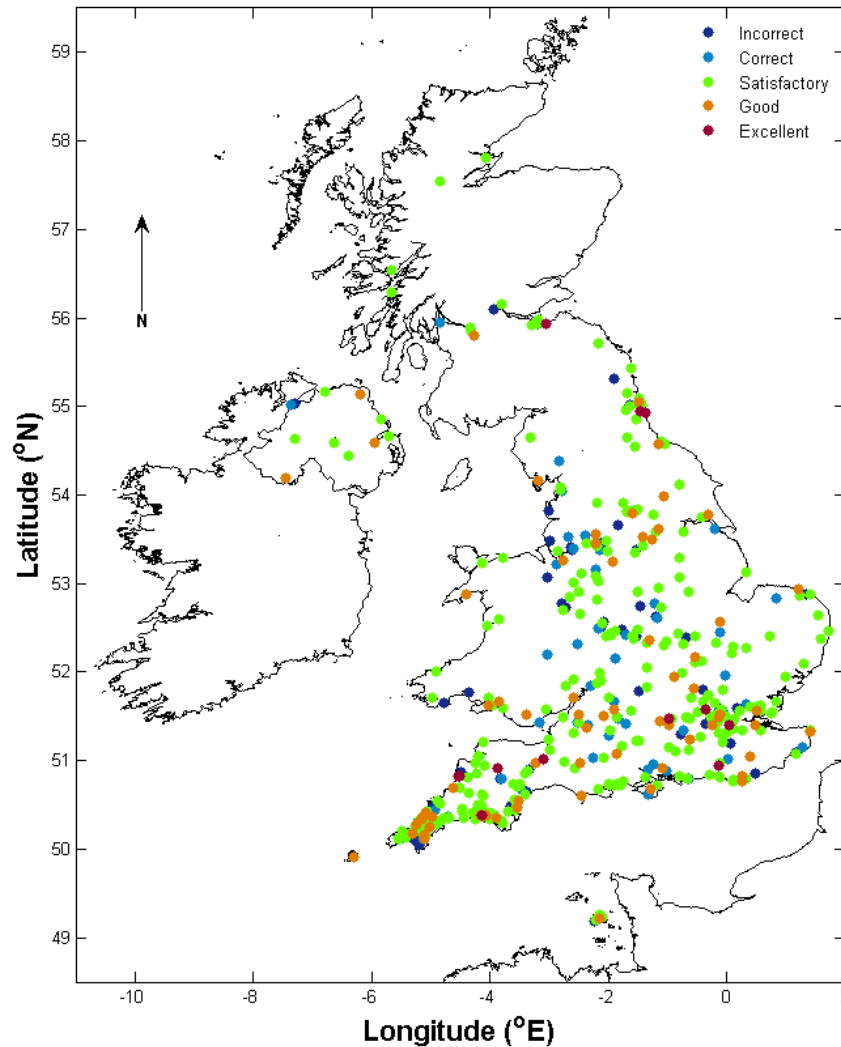


Figure 5.2 – Map of the UK showing the home location of each respondent and their corresponding level of rip current knowledge (dark blue: Incorrect – dark red: Excellent) shown by different coloured spots.

This analysis was undertaken to see whether distinct regions of the UK had poorer knowledge and could therefore be the target of rip current education. The mean knowledge (1-5) ranged from 2.40 in the Channel Islands to 3.45 in Northern Ireland, but no statistical significance was found. There is no clear pattern; suggesting that any future rip current education or messaging should be disseminated nationwide.

5.3.3.4 Knowledge of what to do when caught in a rip current

When asked if respondents knew what to do when caught in a rip current 85% (n=468) of respondents stated they knew what to do, where the majority (n=332, 70%) of people stated they would swim parallel to the beach or sideways out of the rip (Table 5.5). Additionally, 32% (n=152) said not to fight the current or swim against it, and 26% (n=121) mentioned ‘don’t panic and stay calm’. Whether respondents knew these escape strategies *before* they were caught in the rip current is unclear, as this survey was conducted post rip current experience. No statistical significance was found between knowledge of what to do when caught in a rip current and gender, age group, swimming ability or region.

Table 5.5 – Knowledge of what to do if caught in a rip current. (474 respondents answered)

	Responses (n)	Percent of responses	Percent of people
Swim parallel to the beach	332	34.0	70.0
Swim diagonally (45° to the beach)	52	5.3	11.0
Don’t fight/swim against	152	15.6	32.1
Don’t panic/stay calm	121	12.4	25.5
Go with the flow/wait until power lessens	113	11.6	23.8
Signal for help	65	6.7	13.7
Keep hold of floatation aid	46	4.7	9.7
Swim towards waves	71	7.3	15.0
Other	27	2.6	5.3
	977	100	206.1

5.3.4 Rip current incident location

5.3.4.1 Incident location

It is important to investigate incident location to help inform the rip current education pilot. The analysis was undertaken to assess where respondents have been caught, and whether any correlation can be made to the incident statistics in Chapter 3, and results from questionnaire respondents in Chapter 4. The 553 respondents in this survey were caught in rip currents on 224 different beaches (46 did not specify a beach, only an area/region/country, and 102 provided no answer), with 166 (74%) of those beaches in the UK and Republic of Ireland,

and 58 (26%) in other countries worldwide, predominantly Europe, USA, Australia, New Zealand and South Africa.

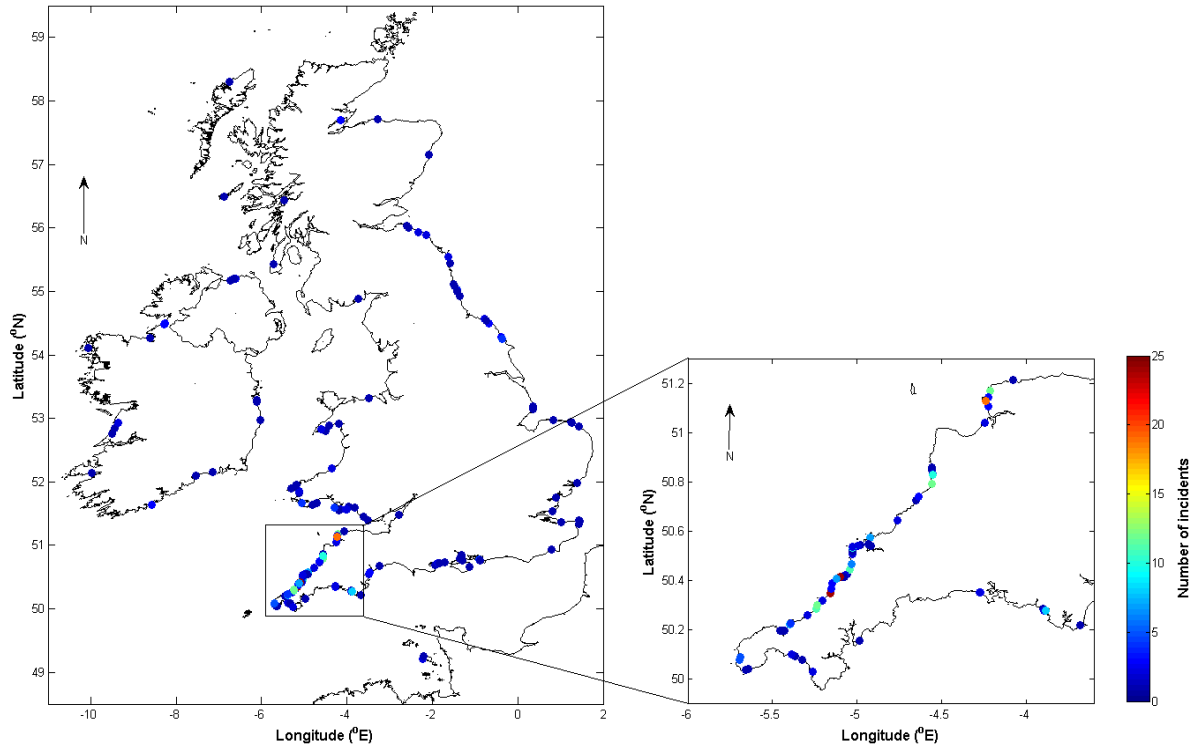


Figure 5.3 – Location map showing the beaches where respondents were caught in rip currents and their frequency.

The incidents in the British Isles are shown in Figure 5.3, and illustrates that respondents were mostly caught on beaches in the Southwest of the UK. The ten beaches with the highest frequency are all located on the north coasts of Devon and Cornwall and account for 28% (n=141) of all beaches mentioned by respondents. Fistral (n=24, 11%), Perranporth (n=23, 10%), and Croyde (n=19, 9%), accounted for over 15 incidents respectively, which as previously mentioned, provide the ideal environment for rip current formation (Scott *et al.*, 2008; Austin *et al.*, 2010), and some of the highest incident numbers in the UK (Scott *et al.*, 2007, 2009a; Woodward *et al.*, 2013). There is also a cluster of incidents in West Wales and along the Northeast coast where beaches are popular tourist and watersports destinations.

These incidents can be compared to those from Chapters 3 and 4, and shown spatially in Figure 5.4. Incidents recorded from respondents in this survey show the greatest variance as they were not limited to RNLI lifeguarded beaches or a small survey population on Cornish

beaches. This result provides additional validity to strengthen the analysis of the RNLI incident database, in particular the ‘hot spots’ in the Southwest, which consistently record the highest incident numbers. Additionally, there are smaller but meaningful numbers on beaches in the Northeast, as well as on beaches that are dominated by groynes and man-made structures in the South, Southeast, and East Anglia. The implication of this finding is that there should be provision of useful, and suitable, in-situ rip current safety messages, information, and education on these beaches, particularly in the Southwest.

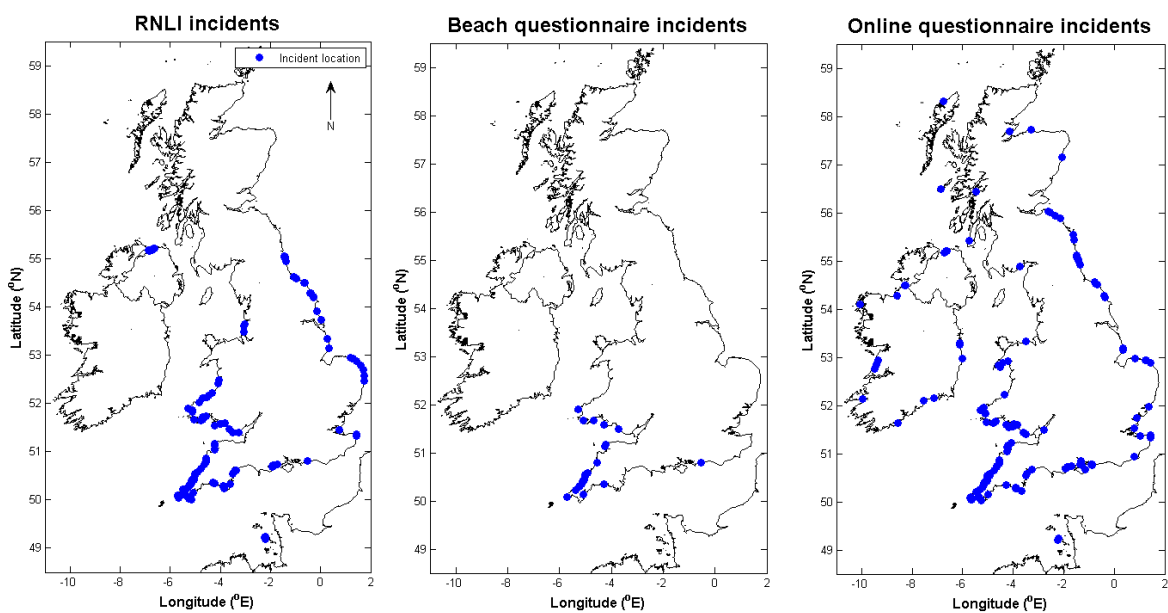


Figure 5.4 – Comparison of rip current incident locations from RNLI statistics in Chapter 3 (left), beach questionnaires from Chapter 4 (centre), and the online questionnaire in this chapter (right).

5.3.4.2 Incident location and home location comparison

Incident locations were studied to assess where respondents were caught in relation to their home address to determine whether rip current ‘victims’ are local beach users or tourists. Figure 5.5 shows where respondents in this questionnaire live, and their location is coloured by which region they were caught in a rip current. It is assumed that those living closer to the coast might enter the water more frequently and have a higher exposure to rip currents. It is, therefore, not surprising that coastal dwellers have been caught in rips on beaches close to where they live. The majority (n=209, 20%) of incidents occurred within the respondents

home region, yet 40% (n=138) of respondents travelled outside of their home region to the beach they were caught in a rip current, as indicated in Figure 5.5.

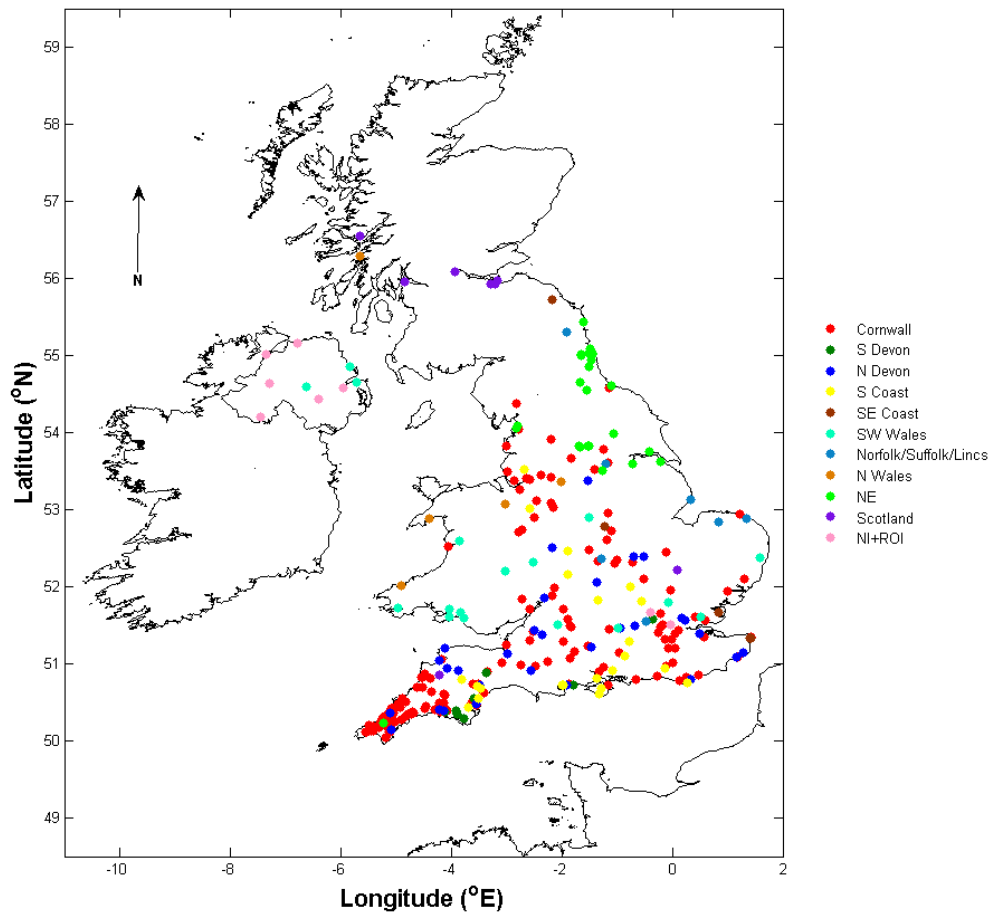


Figure 5.5 Map of the UK showing respondents' home location coloured by the region of the beach where they were caught in a rip current.

There are a large number of points indicating Cornwall (red) and north Devon (blue) in a broad countrywide spread from the tip of Cornwall to London and the Southeast, up to Lancashire and North Yorkshire (54.5°N). This indicates that these respondents have been caught whilst on holiday in the Southwest, and that there is an influx of tourists to rip current prone areas. Coastal dwellers are most likely to be caught nearer to home, such as the Northeast (light green), which is as to be expected due to proximity and frequency of water use. This is an interesting insight into home location of 'victims', reiterating nationwide education is necessary with increased emphasis on coastal dwellers who are more likely to go in the water. Additionally, popular tourist areas and visitors should be targeted.

5.3.4.3 Lifeguarded beaches and safety flags

Two questions established whether respondents were caught in a rip current at a lifeguarded beach, and whether they were between the red and yellow safety flags when caught. A Statistically significant relationship ($\chi^2(1)=108.069, p<0.0005$) was found between being caught in a rip at a lifeguarded beach and being between the flags when caught. Respondents caught in a rip at a lifeguarded beach totalled 55% (n=262) and 45% (n=212) stated they were not at a lifeguarded beach (79 did not answer). Of the 440 respondents who answered if they were between the safety flags when they were caught in a rip current, nearly three quarters were not (n=307, 70%). The proportion of respondents that were between the flags when they were caught in a rip current at a lifeguarded beach was near even, with 51% (n=128) being caught outside of the flags, and 49% (n=125) within the flags. Good waves and conditions (n=203, 43%) for their chosen activity encouraged people to be in certain areas of the beach when they were caught in the rip, and some people didn't realise it was unsafe (n=54, 11%).

These figures are consistent with those from Chapter 4, where the majority of people do go to a lifeguarded beach and understand the flag system, but don't always go between the flags. Numerous reasons have been presented for this behaviour – some people are ignorant, some over confident, some experienced, and some defiant – but what is agreed upon is that even with knowledge of the flags, there will always be people who don't act upon it and expose themselves to more risk (Ballantyne *et al.*, 2005; Moran, 2006; McCool *et al.*, 2008; Sherker *et al.*, 2010), and that this is ingrained within complex psychologies (White and Hyde, 2010; Williamson *et al.*, 2012). A possible way to combat this would be to explain *why* flags are placed where they are, as this may help people to understand the risks of entering the water outside the flags.

Whether respondents were caught in rip currents at lifeguarded beaches was compared against age to assess whether demographics were a factor in beach selection. A significant relationship ($\chi^2(14)=10.504, p=0.033$) was found between being caught at a lifeguarded beach and age group, where more 14-17 year olds (n=68, 69%) were caught at a lifeguarded beach than the other age groups (mean 51% at a lifeguarded beach). Results from Chapter 3 state teenagers (13-17) are the group most rescued from rip currents in the UK. It is perhaps because they go to lifeguarded beaches the most that there is a high proportion of teenagers in the water.

Whether respondents were between the flags when caught in a rip was also correlated against age (Table 5.6), and found a statistical significance ($\chi^2(4)=23.586, p<0.0005$). Respondents aged 18-30 were the group predominantly outside the flags (n=82, 82%), followed by those aged 31-59 (n=150, 74%). This adds to results from Chapter 3, (54% of people were rescued outside of flagged areas), and to literature that those who swim outside flagged areas are more at risk from rip currents (Sherker *et al.*, 2010). Those aged 18-30 are, therefore, a prime audience for rip current education, in particular for highlighting the risks of entering the water away from the flags.

Table 5.6 – Correlation between age of respondent and going to a lifeguarded beach (n=474) and entering the water between the flags (n=440).

		AGE					Total
		0-13	14-17	18-30	31-59	60+	
At a lifeguarded beach	Yes	[8] 50.0%	[68] 69.4%	[60] 54.5%	[112] 50.5%	[14] 50.0%	[262] 55.3%
	No	[8] 50.0%	[30] 31.6%	[50] 45.5%	[110] 49.5%	[14] 50.0%	[212] 44.7%
Between the flags	Yes	[8] 47.1%	[41] 44.1%	[18] 18.0%	[53] 26.1%	[13] 9.8%	[133] 30.2%
	No	[9] 52.9%	[52] 55.9%	[82] 82.0%	[150] 73.9%	[14] 51.9%	[307] 69.8%

Whether gender is a contributing factor into water based activity location is important to consider, especially as gender has been a frequent theme throughout this thesis. No significance was found between being caught at a lifeguarded beach and gender, where both males (n=171, 54%) and females (n=91, 58%) were mostly caught at a lifeguarded beach. A significant association ($\chi^2(1)=9.321, p=0.002$) was found, however, between being caught between the flags and gender, where more males (n=221, 75%) were outside of the flags than females (n=86, 60%). Once again, this highlights the reoccurring theme within this thesis, and the wider literature, of male dominance in rip current incidents, and further reinforces the need to target males in the delivery of education.

Gulliver and Begg (2005) found similar results in New Zealand, where females were more likely to choose low-risk places to swim (patrolled beaches) and males were more likely to choose unpatrolled beaches. Moran (2006) states that this gender difference is less about where young males choose to swim, but what level of understanding and practice of water safety they have, which may bring about certain behaviours leading to incidents.

5.3.5 Rip current experience

5.3.5.1 Rip current reaction

Respondents were asked to describe their rip current experience by recounting their initial reaction to being caught by describing how it felt physically, and what their immediate response was after realising they were caught. For some respondents, reaction was varied where a mixture of positive, negative, physical and emotional responses were recalled, and for others the experience was more basic. These questions resulted in multiple-response answers, where one answer may fall into several categories thus producing more responses than respondents. For example,

“Completely uncontrollable and terrifying. There was nothing I could do to make progress towards the shore. It was like swimming in treacle and getting dragged further away from the shore.” (#35)

This reply was then coded into three different categories; ‘Powerless/Helpless’, ‘Panic/Scared’, and ‘Hard work’. For others, the response was more clear cut such as; “*Petrified*” (#161), “*Exhausting*” (#256), and “*Alarmingly strong*” (#488). Therefore, these responses were able to be coded into one category. For some people the experience did not concern them at all, for example:

“It was very calming and I was decisive, as if there was no point in struggling.” (#21)

And their immediate response was:

“I decided not to try to swim against the current and just to drift with it.” (#21)

These responses were coded into ‘not concerned’, and ‘OK/Go with the flow’ categories for the respective questions. Table 5.7 shows a cross tabulation of these two questions and respondents’ subsequent answers, where the column on the left shows the coded categories

for how the rip physically felt to respondents’, followed by their first response after realising they were caught in the rip, in the rows.

Table 5.7 - Cross-tabulation of coded categories for respondents’ answers to how the rip current felt physically as they were caught in a rip current and their subsequent first response.

	Initial response to being caught						Total
	Fear/ Shock/ Panic	Keep calm/ Don’t panic/ Focus	OK/ Go with the flow	Swim against the rip	Get help/ Shout	Get out!	
Powerless/ Helpless	50 11.1%	22 4.9%	4 0.9%	16 3.5%	6 1.3%	3 0.7%	100 22.1%
Scary/ Terrifying	60 13.3%	30 6.6%	2 0.4%	47 10.4%	11 2.4%	0	146 32.3%
Not concerned	7 1.5%	20 4.4%	14 3.1%	2 0.4%	2 0.4%	1 0.2%	45 10.0%
Hard work	49 10.8%	23 5.1%	4 0.9%	18 4.0%	5 1.1%	3 0.7%	99 21.9%
Strong/ Forceful/ Powerful	34 7.5%	36 8.0%	6 1.3%	27 6.0%	10 2.2%	0	109 24.1%
Tiring/ Exhausting	44 9.7%	21 4.6%	3 0.9%	29 6.4%	5 1.1%	0	100 22.1%
Surreal/ Strange	10 2.2%	5 1.1%	5 1.1%	4 0.9%	3 0.7%	2 0.4%	25 5.5%
Total	172 38.1%	123 27.2%	33 7.3%	100 22.1%	28 6.2%	9 2.0%	452 100%

This shows that most people found the rip scary or terrifying (32%), and their first response was to continue panicking and/or then swim directly straight back into shore, against the rip current. Those people who were not concerned by the rip (10%) initially responded by staying calm and focussed, and going with the flow of the current. Those who thought the experience was tiring or exhausting (22%) initially panicked, then swam against the current to shore; yet some managed to stay focussed and not panic. For others the initial reaction was physical whereby they found the rip strong, powerful, and forceful (24%), and were as equally focussed as they were to shock and fear.

These results suggest that despite their ability and knowledge, the experience of being caught in a rip current overwhelmed the majority of people, and they were unable to think about their situation, suggesting that “*Adrenaline takes over!*” (#58) or because they were “*too scared [to remember]*” (#191), and an admittance of panicked behaviour: “*I was a bit deluded by panic and I don’t think I could think straight!*” (#223.)

For some people this initial panic was followed by the realisation of what was happening and were able to focus on calming down:

“Initially I panicked and swam with all of my might towards the shore. When I was exhausted and had made no progress, I realised I was in a rip current and began swimming in a horizontal direction.” (#282)

This worked both ways however, as the experience of some people changed from calm into panic when they realised the situation was beyond their control and ability, or began to panic when their strategy was unsuccessful:

“Initially I didn’t panic. Panic started to set in when I lost the bodyboard.” (#260)

Those with experience, however, were more able to remain calm and devise an escape strategy. These experiences are generally of people caught for the first time, which to them is an unknown situation with no idea what to expect, and is therefore bound to elicit some form of panic and confusion. This highlights a need for rip current education and safety messages to communicate what to expect when caught in a rip current to reduce terror, or at least go some way to preparing people.

These two questions were then combined to seek out physical and emotional responses to their rip current experience (Table 5.8). Emotions can drive physical reactions, as it can be seen that the majority of people (n=153, 62%) panicked, were fearful, anxious, or distressed and immediately swam straight to shore against the rip current. By contrast, respondents who were calm, focussed, and relaxed (n=104, 42%) mostly swam parallel to the shore.

These actions are typical primitive responses to fear, known as one of the most powerful emotions that determine action within mammalian defence systems (Cannon, 1929). This dominant emotion drives brain function and the body responds in turn, where thinking can take too long so that the physical reaction to fear results in an emergency response maximising the chance of achieving safety (LeDoux, 1996). These psychologies are well understood; a chain of reactions can be seen in humans (and animals) when subjected to a trauma starting with physiological reactions such as increased heart rate, raised blood

pressure, and hair standing on end. This then leads to emotional and physical reactions where the instinct is to freeze, stopping and assessing the surroundings by sight and sound, which leads to either flight, fleeing from the situation, or fight; ultimately trying to stop, escape from or avoid the threat (Gray, 1988).

Table 5.8 – Cross tabulation of respondents’ emotional response to being caught in a rip current and their subsequent physical response.

		Physical responses to being caught in a rip current					
		Swam against the rip	Swam parallel	Floated/Drifted	Swam hard anywhere	Shouted/ Got help	Total
Emotional responses to being caught	Panic/ Fear/ Distress	108 43.7%	31 12.6%	9 3.6%	2 0.8%	31 12.6%	153 61.9%
	Calm/ Relaxed/ Focussed	24 9.7%	59 23.9%	19 7.7%	4 1.6%	9 3.6%	104 42.1%
	Surprised	9 3.6%	5 2.0%	3 1.2%	0	1 0.4%	16 6.5%
	Total	131 53.0%	80 32.4%	27 10.9%	6 2.4%	37 15.0%	247 100.0%

This sequence of events has been related to people caught in rip currents by Brander *et al.* (2011), where this psychological ‘stressor’ has been identified as deep water and movement away from the beach. The respondents in this study certainly follow this pattern and establish why so many panic and instinctively fight to return to the safety of shore. This inherently deep-rooted evolutionary reaction is difficult to overcome, especially during an unfamiliar event such as being caught in a rip current. This is where people with rip current experience have an advantage, as they know what to expect and the fear factor is thus reduced. It has been documented that those who panic in a rip current and swim straight for shore tire more quickly and this exhaustion becomes the basis for drowning (Fenner, 1999; Brander *et al.*, 2011; Drozdewski *et al.*, 2012). This emphasises one of the most clear and well promoted rip current safety messages of ‘don’t swim against a rip current’, and provides further weight behind disseminating this key piece of information.

5.3.5.2 Reactions of different demographic, ability, and water use groups

It is important to investigate whether age, gender, swimming ability or water use, influenced reactions when caught in a rip current, especially when designing an education scheme, as an understanding of the reactions of different groups of people can aid effective targeted messaging.

Physical and emotional responses for these different groups were analysed. Statistical significance was found between physical reactions to being caught in a rip current and gender ($\chi^2(5)=22.133, p<0.0005$), where both genders swam against the rip directly back to shore, but males less so than females (n=111, 49%: n=67, 60%). Males were more confident to swim parallel to the shore (m=36%, f=23%) and float/ride out the current (m=13%, f=6%) whereas more females shouted for help (f=22%, m=11%). A statistically significant relationship was found between emotional responses to being caught in a rip current and gender ($\chi^2(3)=66.537, p<0.0005$), where males showed similar frequencies for panicking and remaining calm (n=128, 53%: n=118, 49%), females panicked more (n=107, 84%) and were less calm (n=25, 20%) in the rip current. Males, however, have a propensity to overestimate their ability, especially when in a self-reporting study (Howland *et al.*, 1996). The reactions of males, in particular, can aid our understanding of why this group account for so many fatalities and incident numbers.

Similar gender differences were observed by McCool *et al.* (2008) who studied beachgoers' perceptions of the risk of drowning. They found that females feel more vulnerable to, and are more concerned by, the risk of drowning than males, which is demonstrated here by the increase in panic among these female respondents. Females perceive scenarios, such as being caught in a rip current, with an increased severity, feeling a greater need to be rescued (McCool *et al.*, 2008). This is shown above by the higher proportion of females seeking assistance when they were caught.

Differences in age groups were not found to be statistically significant. However, the 0-12 year olds mostly panicked (n=9, 90%), whereas the mean of the other age groups (14-60+) was 63%, and a higher proportion were able to remain calm (mean= 41%). There was a statistically significant association ($\chi^2(20)=36.145, p=0.015$) between respondents' age and their physical response, outlined in Figure 5.6. The oldest and the youngest attracted attention for assistance, and drifted in the rip most; whereas people aged 31-59 mostly swam against the rip and did not seek help. This is also corroborated by McCool *et al.* (2008) where participants aged 16-29 reported a higher self-efficacy, to the extent that they felt more able

to cope with getting into difficulty in an aquatic environment and getting themselves out of the situation. Their study, however, was not specific to rip currents, and the rip current survivor survey reported by Drozdowski *et al.* (2012) compared age and escape method, but not the physical responses reported in this study.

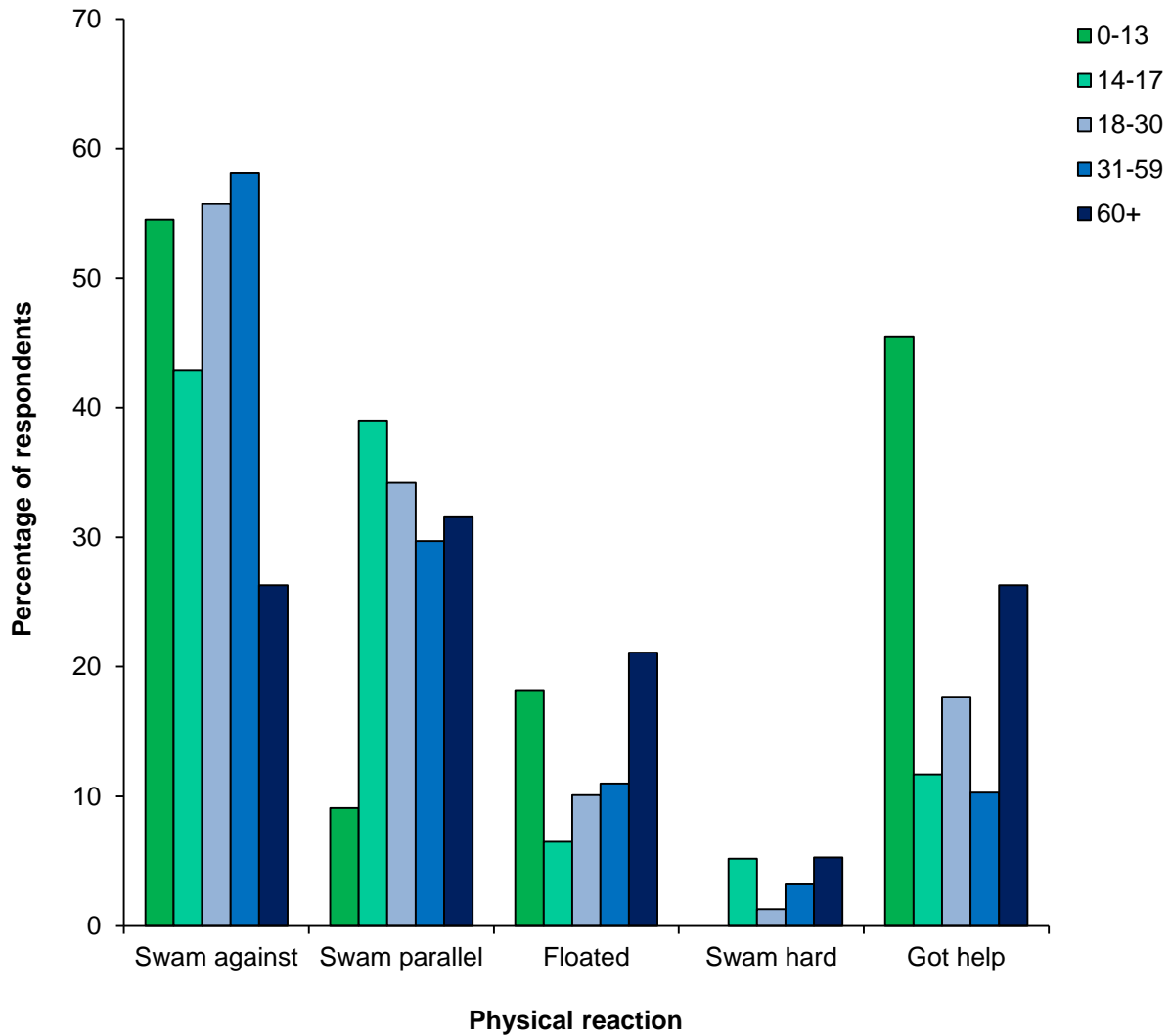


Figure 5.6 – Clustered bar showing different age groups’ physical reaction to being caught in a rip current.

Those younger (0-13 year olds) in this study may lack the skills and strength required to escape a rip current, and feel more vulnerable due to an absence of experience. Indeed those older (60+) may also have insufficient strength, but may also have a more relaxed approach to dealing with threatening situations, knowing their limits, i.e. they know they are weaker, so there is no point in fighting it, and may be wiser not to attempt futile movements. This result,

therefore, shows that weaker, more vulnerable respondents sought help more and floated in the rip current.

Swimming abilities compared to the emotional and physical responses did not yield a statistically significant relationship. Those learning to swim, however, mostly panicked (n=5, 83%), and this trend reduced as swimming ability increased. Physically, however, there was a less defined trend where those learning to swim sought help the most (n=4, 67%), able swimmers mainly swam towards the shore against the rip current (n=44, 60%), and highly competent swimmers responded in a more mixed approach. Likewise, these patterns and non-significance existed within summer activity, where increased frequency reduced the panic emotion, and increased the calm, relaxed approach. The physical reaction was less distinct, but higher frequency of activity led to more respondent's swimming parallel to the shore, and seeking help less.

Those who perceive less personal risk from the threat of rip currents tend to have a higher ability and confidence (White and Hyde, 2010), and feel more able to remove themselves from the situation (McCool *et al.*, 2008). Having a higher level of swimming ability can therefore increase confidence, which is perhaps why those able to swim thought they could remove themselves from the threat. Those learning to swim perhaps panicked more and sought help because they do not have the ability to remove themselves from an unfamiliar situation.

5.3.6 Rip current escape

Respondents were asked to describe how they escaped from the rip current. They were firstly asked if they signalled for help, to which 67% (n=370) said they did not (male n=251, 81%, female n=119, 76%), 15% (n=86) did not answer, no statistical significance was found between signalling and gender. Unfortunately this question did not expand on their answer, so there are no results as to why the majority did not signal. We can only speculate that they were either not at a patrolled beach, it was out of lifeguard hours, they were too busy swimming, they were too embarrassed, or didn't need help.

Nearly half of respondents swam parallel to the beach or across the current to escape the rip (n=228, 48%), a quarter were rescued or assisted either by lifeguards, other water users or family members (n=126, 26%), or swam hard back to the beach (n=48, 10%) and drifted with the current (n=27, 6%). A statistically significant relationship ($\chi^2(7)=60.048$, $p<0.0005$) was found between escape method and gender, where males swam parallel to the shore more than

females (m=58%, f=33%), females were rescued more than males (m=20%, f=41%), females swam hard against the rip back to shore more than males (m=9%, f=14%), and more males floated and went with the flow of the rip current (m=7%, f=4%).

Swimming parallel is a safety message that has been promoted for decades (Brander and MacMahan, 2011), known by 70% of people in this survey to be a method of rip current escape (Table 5.3), and the message remembered most by respondents when in a rip current (Table 5.2). This tactic is highlighted in the following examples:

“The current was taking us out, and then across and outwards at an angle, we swam across the flow of the rip and then used the beach waves to help bring us into shore” (#498)

“After a short while I realised what I was doing wrong and made myself stop panicking and swam across the current as I had been taught.” (#245)

These excerpts show that swimming parallel to the beach was successful; with some choosing to do so immediately, others after realising swimming against the rip was unsuccessful. The second quote also highlights that effective teaching can assist someone in a rip current. People who were rescued by other water users or family members also appeared to swim parallel, again achieving the result of returning to shore safely:

“There were no lifeguards, a man saw us and told us to swim sideways and he helped us out, thank goodness he was there!” (#56)

Floating or drifting with the current was a tactic also used by respondents, and has been suggested by physical rip current scientists as an alternative to the ‘swim parallel’ message (MacMahan *et al.*, 2010). It appears, from the results, that those who went with the flow of the current mainly did so after realising that they could not return by alternative methods:

“Once I realised that I couldn’t swim to the shore, I just stopped and let myself float out until I could swim around and back to the shore further up the beach.” (#372)

“I realised that it was pointless fighting it and so I just let it take me out of the rip and towards some rocks where I climbed out of the water.” (#9)

It is clear that a number of escape methods were utilised by respondents, highlighting that different approaches work in different rip current scenarios, varying with rip strength, wave conditions, distance from shore, and experience, confidence and ability of the victim. Variations in escape strategies may be needed depending on beach type and location as rip

current circulation varies under tide and swell conditions; where a swim parallel option may work for one beach, a float tactic may work for others (MacMahan *et al.*, 2010; Miloshis and Stephenson, 2011; McCarroll *et al.*, 2014). There are several ways of exiting a rip current available to people who become caught, depending on the individual situation. There is an argument, however, that there is no one clear escape message to promote, suggesting that promoting both swimming parallel and floating will equip people with the ability to remove themselves from danger (McCarroll *et al.*, 2014).

Despite this debate about the best way to escape from a rip current, it appears evident that respondents in this survey were able to focus on swimming parallel, going with the flow, and/or seeking assistance, which allowed them to calm down and not panic. Those who did panic were unsure of how to escape and attempted to swim directly back to shore. The key argument here is that by giving people solutions to escape a rip current, they can focus on doing *something* and may not panic or fight against the current.

An additional message to disseminate may be to use the waves as this firstly allows people to focus on action and aiming for an identifiable target when the shore may not be visible, and places them into waves which drive onshore motion. The best message to promote, however, is to swim at a lifeguarded beach between the flags as this reduces the risk of firstly being caught in a rip and secondly having the assurance that there is help close by.

Respondents were asked if, on reflection, they would react differently should they find themselves in a rip current again. Those people who stated they would not do anything differently next time totalled more (n=252, 46%) than those who would act differently (n=216, 39%), and Table 5.9 outlines the response categories. For those who said they would act differently, 45% (n=73) said they would swim parallel, 27% (n=44) would remain calm, not panic and be more relaxed, 19% (n=31) would not swim against the current, and 17% (n=28) said they would be more careful or not go in at all.

Asked if the experience had put them off entering the water again, 71% (n=393) of people stated that it had not, and for some has increased their respect and appreciation for the sea, and heightened their attention of the hazard:

“I am more aware before I enter the water, and more mindful all the time, especially at unknown breaks/beaches.” (#42)

For 21% (n=45) of people, however, the experience had left them more wary and reluctant to go back in the water:

“I have not been in the sea since unless it has been flat calm, and I have lost all confidence in venturing out of my depth.” (#92)

“Lost all confidence in my ability in the sea/ocean in the UK, terrifying experience” (#186)

With hindsight, most people realised that their attempts to swim to shore were futile and that adopting a different strategy in the future would get them back to shore more efficiently. Those who swam parallel or went with the flow successfully escaped and would do the same again. The experience has left these respondents with more knowledge about rips and how to escape, as summed up by respondent #257: *“It is now burned in my memory, once experienced never forgotten.”*

Table 5.9 - Cross tabulation of respondents’ physical reaction to being caught in a rip current and what they would do differently or the same if they were caught in a rip current again.

		Different action if caught in a rip current again									Total
		Parallel	Assistance	Calm	Float	Don't fight	Don't know	Be more careful	Do the same	Float aid	
Physical responses to being caught	Swam against rip	62 38%	21 13%	31 19%	8 5%	29 18%	5 3%	20 12%	3 2%	7 4%	122 75%
	Swam parallel	5 3%	5 3%	7 4%	2 1%	3 2%	0	6 4%	3 2%	0	26 16%
	Floated	3 2%	2 1%	1 1%	0	1 1%	0	1 1%	1 1%	1 1%	8 4.9%
	Swam hard	1 1%	0	2 1%	0	0	1 1%	2 1%	0	0	5 3.1%
	Got help	15 9%	7 4%	10 6%	1 1%	5 3%	1 1%	4 3%	0	2 1%	28 17.3%
	Total	73 45%	30 19%	44 27%	10 6%	31 19%	5 3%	28 17%	6 4%	8 5%	162 100.0%

5.3.7 Rip current safety messages and education

Where people gained their knowledge of rip currents from is an important factor in assessing which methods have been successful in promoting safety messages and what might have been lacking, in order to take these findings into consideration when devising a new education scheme. Signage (n=209, 38%), media (n=139, 25%), RNLI leaflets (n=138, 25%), and face-to-face advice from lifeguards (n=136, 25%) were the most popular selection from a list of pre-determined choices. RNLI education was the least selected with 7.8% (n=43). There were multiple sources of rip current information, where signage remains high, yet this question does not delve any deeper to establish what type of sign they saw, where it was, or what information was portrayed. This is also the case for the ‘media’ option (although 28 people did mention they saw ‘Bang goes the Theory’ and got most of their rip knowledge from that programme), and unless respondents expanded on their choices by filling in the ‘other’ box, then there is unfortunately a lack of depth to this question.

After recounting their rip current experiences, respondents were asked what messages, training, or education would best equip someone with the skills and knowledge to survive a rip current. This open-ended question allowed respondents to give as much detail as they wanted, eliciting an abundance of suggestions (n=777). An overwhelming 70% (n=304) suggested that knowing what to do when caught in a rip is paramount, followed by 28% (n=123) stating that education is needed, and advice from safety professionals such as lifeguards would be beneficial (n=100, 23%). Respondents were asked which messages they would recommend, and are detailed in Table 5.10. Knowledge of how to get out of a rip current is stated by 60% (n=120) of respondents; feeling that had they known these vital pieces of information before they were caught, their situation would have been less stressful and exhausting, and an escape may have come sooner:

“It would be helpful to know what to expect in a rip current and then what to do to get out of it” (#400)

“Knowing how one works and why it happens. This would help people to know why swimming across is the correct option. (#253)

There were 76 (38%) proponents of the ‘don’t panic, stay calm’ message, as respondents thought that by promoting this people would be able to think more clearly. Having established most respondents panicked in the rip, clearly showing that they have learned that this is not the best course of action, following their own experiences:

“Not to panic, this uses up your energy quickly and can leave you tired.”(#486)

“1. Avoid it by obeying lifeguards' advice! 2. Don't panic 3. Work your way across it and never try and swim against it.” (#378)

Table 5.10 – The best safety messages to disseminate to people to give them the knowledge to survive a rip current (*Number of respondents = 200*).

	N	% of responses	% of people
Raise arm/Seek help	37	10.2	18.5
Don't panic/Stay calm	76	21.1	38.0
Knowledge of how to get out	120	33.2	60.0
What to expect/How rips work	32	8.9	16.0
How to identify a rip	45	12.5	22.5
Float/Go with the flow	19	5.3	9.5
Don't fight the current	32	8.9	16.0
Total	361	100	180.5

After safety messages, respondents suggested education about rip currents to be discussed mainly in schools, during assemblies, geography lessons, and as part of the national curriculum, as well as at the beach with different user groups, talks and demonstrations. Signage was another popular proposal, stipulating the need for rip specific signs to include the key messages detailed in Table 5.10:

“Large clear signs at the beach where there are known strong rips and what to do. These should be customised per beach or at least at beaches where the same spots produce strong rips repeatedly.” (#477)

“Have on the beach on the signs what to do, not just "Danger! Strong Currents", maybe have more moveable signs down by the water's edge as sometimes there is more than one way onto the beach, you can sometimes miss the safety signs.” (#326)

There are some arguments as to whether signage on beaches is effective (Matthews *et al.*, 2013), yet both the respondents of this survey, Drozdowski *et al.* (2012), and the results from Chapter 4 indicate that signage is a popular education method. What is inferred from the

results above though, is that the *right* information needs to be illustrated with rip current specific safety messages.

As well as signage to present information, additional recommendations included disseminating messages via media channels (television, radio, internet, social media), other visual aids such as posters, leaflets, videos and magazines, and placing these in shops in beach locations, hire outlets and tourist information offices. In terms of the type of training that people could undertake, suggestions included attending surf schools and surf lifesaving clubs for lessons, as well as increasing swimming ability through swimming lessons at schools and clubs. An interesting proposition came from several people advocating that experience of a rip current is the best form of education:

“I think the best way to understand a rip current you need to experience it first hand, so maybe the RNLI could run courses to take people into rip currents with lifeguards.”
(#331)

“In the water with rip currents with lifeguards, just small groups for 10mins or so just showing you what to do, should be on offer at beaches for free” (#214)

Whilst difficult practically and potentially an unsafe way to promote rip current experience and confidence in the sea, there is some merit in this suggestion as it is clear from these respondents that, with experience of rips does come better knowledge, increased vigilance and confidence. Conversely, experience can lead to over confidence and lessened risk perceptions, in addition to the understanding that individual response is indefinite in such dynamic situations (Drozdowski *et al.*, 2012). An alternative compromise was highlighted by some respondents who stated that:

“It would be good to develop a special machine that could replicate the pulling factor on dry land.” (#394)

“Something which physically demonstrates the rip current in a controlled environment, as quite often, presentations about a subject do not enable people my age to learn, they are boring to listen to.” (#198)

This is a practical land-based solution to potentially utilise in future rip current education campaigns, and can be demonstrated in swimming pools with rapid capabilities or with a specially designed machine.

Common in these suggestions was the use of lifeguards to deliver the messages both on the beach and in schools. People advocated lifeguards approaching beach users with leaflets

to talk to them about rip currents, explaining why people should swim between the flags, communicating this through their loudspeakers on the beach. Using lifeguards to promote beach safety issues has been effective (Klein *et al.*, 2003) and, due to the high public regard in which the RNLI is held in the UK, may have a higher impact on people receiving education.

This final question of the survey has elicited a large amount of data, and some extremely interesting, useful and insightful suggestions to improving rip current safety messages in the UK. There is a difficulty, however, in determining a single message which promotes all the safety advice, in an easy to remember format, due to the many inconsistencies which exist within the dynamics of rip currents. This is succinctly summarised by one respondent who stated:

“Too tough to answer because so many variables - age of person, competence of swimmer, reason for being in water, presence (or absence) of lifeguards/signage, whether person lives near coast and can be shown what to look for easily etc.” (#218)

This reiterates the point that we are dealing with a physical hazard and human behaviour, both of which are difficult to predict and control, confirming the complexity of the task of educating people about rip currents.

5.3.8 Children and Teenagers

Under 18's, and more particularly teenagers, have been highlighted from Chapter 3 as being the age group that are rescued from rip currents more than any other age group, and therefore are a prime audience for rip current education. A total of 140 (25%) respondents in this survey were aged under 18; 26 (5%) aged between 0-13, and 114 (20%) aged 14-17 years old. The results from teenagers are presented below as they will be the audience for the rip current education pilot in Chapter 6.

Of those aged 14-17 years old, two thirds were male, and nearly three quarters deemed themselves competent to highly competent swimmers, having had swimming lessons in a pool (n=54, 47%), and in both a pool and the sea (n=50, 44%). Rip current knowledge, identification, and how to escape followed the trend of the other age groups. The majority of rip current information that teenagers had come across or experienced were RNLI leaflets (n=38, 33%), signs at the beach (n=34, 30%), and face-to-face advice from lifeguards (n=31,

27%). The least seen or identified sources were RNLI education (n=13, 11%) and the internet (n=19, 17%).

Teenagers were mainly at a lifeguarded beach when caught in a rip (n=68, 69%), but not between the lifeguards flags (n=52, 56%) and did not signal (n=78, 82%) for assistance during their rip current experience. They remembered the safety message of swimming parallel to the beach to escape a rip current the most (n=54, 61%), followed by not panicking and not to swim against it. Despite the majority of teenagers panicking when caught in the rip (n=41, 66%), and then swimming against the rip back to shore (n=33, 47%), this age group were the most likely to swim parallel to shore. Incidentally this method was the one adopted by most teenagers (n=48, 54%) to escape the rip current, followed by rescue (n=25, 28%).

Table 5.11 – Responses of children and teenagers to the question ‘What messages, training, or education would best equip someone with skills and knowledge to survive a rip current?’ showing the main response categories and the specific safety messages they advocated.

Education/Training/Safety message	N	Percent	Percent of cases
Beach Signage	12	8.7%	12.2%
Experience	12	8.7%	12.2%
Media	5	4.2%	6.0%
Leaflets	6	5.0%	7.2%
Practical Advice	73	53.3%	74.4%
Lifeguards	17	12.4%	17.4%
Don't know	7	5.1%	7.1%
Total	137	100.0%	139.8%
Safety message			
Raise arm/Seek help	18	5.2%	12.9%
Don't panic/Stay calm	34	9.8%	24.3%
Knowledge of how to get out	96	27.6%	68.6%
What to expect/How rips work	32	9.2%	22.9%
How to identify a rip	60	17.2%	42.9%
Float/Go with the flow	28	8.0%	20.0%
Don't fight the current	80	23.0%	57.1%
Total	343	100.0%	248.6%

Signage was most popular with older age groups, but those 17 and under rated it low on their suggestions, particularly the 0-13 year olds who rated it the lowest. Table 5.11 shows that an overwhelming number of children and teenagers recommended that practical advice should be given in safety messages. Examples of teenage respondents' suggestions are outlined below:

“A diagram with instructions on it and arrows pointing where to swim if caught in a rip, someone with experience of rip currents should also visit schools giving tips and leaflets.” (#387)

“First, the ability to recognise and avoid rip currents. People need to know not to panic, and also keep in the flags and in their depth if they aren't good at swimming.”(#148)

“A TV programme or lesson in school stating the basic principles of what rip currents are and how to get out of them. The information should not be so large that it can't all be taken in, but not too short that the information is insufficient.”(#246)

These recommendations are extremely important pieces of information to ensure the right messages and methods are utilised in the rip current pilot where teenagers are a key audience. It is clear that this age group are advocates of knowing how to escape a rip current, what to do when caught in one, and learning more about them to avoid getting caught.

5.4 Conclusions

An online questionnaire was undertaken by 553 people who had been caught in a rip current. The questionnaire sought to explore these people's rip current experience, and determine their reactions and methods of escape. Additionally, the recommendations and opinions for rip current education were investigated to further inform the rip current education pilot presented in Chapter 6. This is only the second piece of research to investigate the experiences of people caught in rip currents, presenting for the first time the UK perspective, and some new insights that may be applicable globally. The following conclusions can therefore be drawn:

- Males (n=381, 69%) were caught in rip currents more than females (n=171, 31%), and teenagers (14-17 years old) represented the age group most caught (55%). Both of these demographic groups were not found to be statistically different from the expected population, finding this survey a representative sample of rip current incidents in the UK.
- Rip current incidents mainly occurred in the UK and Republic of Ireland (n=166, 74%), where beaches in the Southwest region accounted for the most rip current incidents (n=70, 42%), and therefore remains a 'hotspot' for rip current activity and an initial target area for the future dissemination of rip current education.
- Two thirds (n=426, 77%, mean 2.84) of respondents gave a correct description of a rip current. In comparison to knowledge levels in Chapter 4 (35% correct, mean=2.14), the respondents in this chapter have a higher knowledge, indicating that the experience of being caught in a rip current increases understanding.
- When caught in a rip current, most respondents panicked and swam straight to the shore against the rip current (n=108, 34%). This reaction indicates that despite an awareness of rip currents and escape methods, instinct takes over and actions follow a method that has been established as the most prone to drowning in rip currents. This is an important implication for drowning prevention strategies, bespoke rip current education, and lifeguard training.
- Swimming out of the rip current parallel to the beach was the most remembered, advised, and promoted safety message, and a successful escape method for those who utilised it (n=277, 50%). Only 6% of respondents in this survey used the alternative strategy of floating in the rip current to escape, compared with 17% in Australia (Drozdowski *et al.*, 2012). Swimming parallel to the beach to escape a rip current should continue to be safety message promoted in the UK.
- Suggested safety messages advocated the promotion of knowing how to escape from a rip current (n= 120, 32%), staying calm and not panicking (n= 76, 21%), and identifying a rip current (n= 45, 13%). Additionally, lifeguards were the most popular source to disseminate these safety messages, specifically on beaches where rip currents are present, and in schools.

Knowing what to do when caught in a rip current could be the difference between an effective escape and a more serious outcome. Providing people with material about rip

currents *will* give them more knowledge and potentially the skills to escape from a rip or have the confidence to seek assistance. These results provide the further evidence that is needed to continue the development of the rip current education pilot. The next chapter presents the amalgamation of all the relevant data from chapters 3, 4, and 5, taking into account demographic information, rip current knowledge, rip current experience, and recommendations for rip current education from the public, and presents the first rip current education scheme in the UK.

Chapter 6

Rip current education pilot

6.1 Introduction

This final data chapter synthesises the work of Chapters 3, 4, and 5, and fulfils the final outcome of the PhD thesis: a rip current education pilot. This pilot has developed from the main findings presented in the thesis, specifically the identification of male teenagers as a target audience, focussing the pilot design and implementation around this demographic.

Findings from Chapter 4 indicated poor rip current knowledge within the UK public, and that lifeguards should be at the forefront of future education. Chapter 5 presented key educational messages to ensure people know what a rip current is, how they work, and what to do when caught. The pilot presented in this chapter therefore uses these findings to raise rip current awareness and understanding to the most at risk demographic, in areas where rip current incidents are the highest in the UK. The aims of this chapter are:

- To design, develop, and pilot a small-scale rip current education scheme to a teenage audience to increase awareness of rip currents.
- To evaluate levels of knowledge and awareness of rip currents directly before and after delivery of the pilot education programme, and over a three month period to assess individual retention of knowledge.
- To test different delivery techniques, and assess the most effective methods of dissemination for the target audience.
- To assess the feasibility of future implementation of the programme (or similar) within secondary schools, and potentially to a wider audience, to increase rip current awareness.

As previously stated in Chapters 3 and 4, rip current education schemes are needed as rip currents are responsible for the highest number of lifeguard rescues in the UK and worldwide (Scott *et al.*, 2007, 2009a; Brander and MacMahan, 2011), and make up a significant proportion of nearshore beach fatalities (Gensini and Ashley, 2010; Brighton *et al.*, 2012). In

addition, it is known from Chapter 4 that knowledge of rip currents is poor among the beach going public in the UK, and worldwide (Sherker *et al.*, 2010; Caldwell *et al.*, 2013), indicating a need to inform people of the hazard to reduce incidents and fatalities.

Results from Chapter 5 have shown that people who have been caught in a rip current have a higher level of rip current knowledge than those who have not been caught. In addition, respondents who had been taught how to escape from a rip current were much more able to stay calm, not panic, and have the confidence to remove themselves from the rip current. Rip current education can provide people with an understanding of what the experience of being caught in a rip might be like and how they can either avoid it or escape.

There has only been one evaluated rip current specific education scheme worldwide (Hatfield *et al.*, 2012). This chapter, therefore, presents the first rip current education programme to be implemented in the UK. Hatfield *et al.* (2012) developed and evaluated a rip current campaign in Australia where the primary aim was to improve rip current identification by highlighting the calm patches of water in-between breaking waves. Their passive, print-based campaign was deemed effective in that it improved intentions to swim away from calm looking rip currents, ability to identify rip currents, intention to never swim at an unpatrolled beach, and responses to being caught in a rip current. When measured six months after exposure to the campaign, the improvements were still retained.

In the USA, the NOAA Sea Grant programmes have used signage, brochures, posters, videos, and public service announcements using the ‘Break the Grip of the Rip!’ slogan to raise awareness (Carey *et al.*, 2006), but to date, there has been no measurement of how successful this scheme was. More recently in Australia, community-based multi-media rip current talks, called the ‘Science of the Surf’, give the general public information on beach safety (Brander and MacMahan, 2011), but again the effects have not been measured. Williamson *et al.* (2012) stress evidence-based education is needed, valuable, and rigorous.

Evaluation provides proof that something is either needed, has worked, or can improve a practice or project (Rogers and Smith, 2006). Additionally, evaluating a scheme or method has an aim to strengthen it (Chelimsky, 1997). Evaluation of rip current awareness programmes is therefore essential as only one has been conducted to date, and to ensure future schemes have guidelines from both effective and ineffective programmes.

The implementation of the pilot presented in this chapter will firstly assess the methods used on the target audience and its effectiveness, providing a baseline from which to apply future iterations of the scheme in the UK, and potentially to assist and compliment other practitioners worldwide.

6.2 Method

6.2.1 Study groups

Five separate convenience sample groups in Devon and Cornwall, consisting of three secondary and sixth form school groups and two Scout groups, were chosen to be part of the study (Figure 6.1). The results of Chapter 3 determined the location and demographic of these groups, where teenagers were found to be the most common age group caught in rip currents, and that beaches in Devon and Cornwall were prime sites for rip current incidents. A mixture of socio-economic areas were chosen to be representative of the wider society encompassing state controlled schools, independent schools, technological colleges and community scout groups (Table 6.1). Participants were chosen by teachers and group leaders based on who was available on that date and during an available time slot within the school timetable, incorporating a variety of ages from 13-22 both male (n=115) and female (n=70).

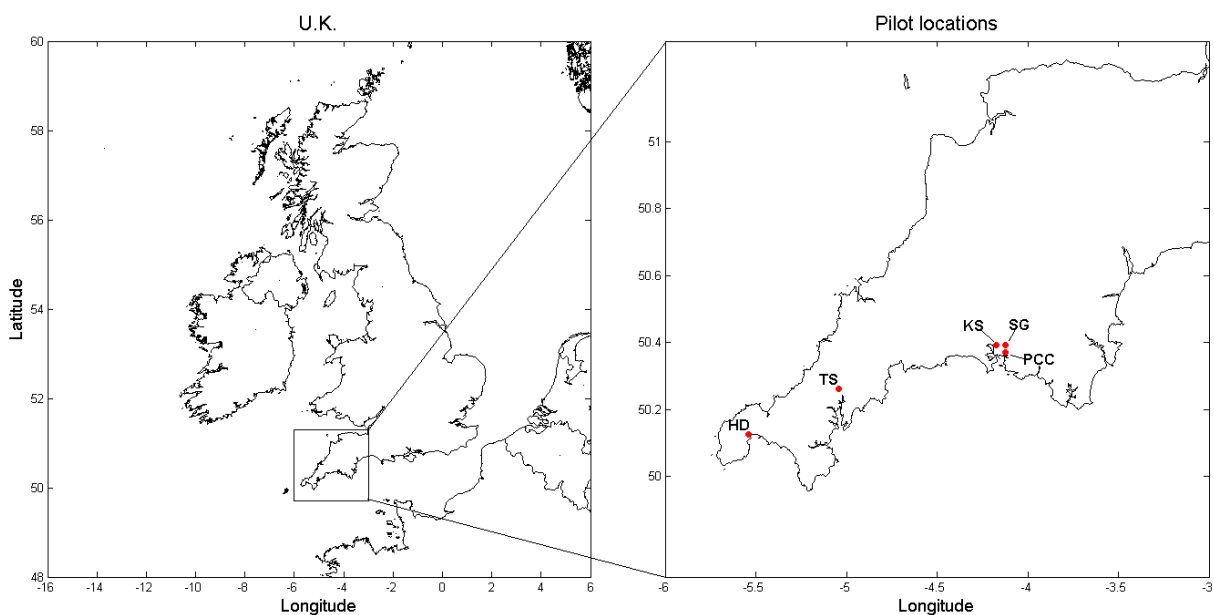


Figure 6.1 - Locations of study groups chosen for the pilot rip current education scheme.

6.2.2 Theoretical construct

6.2.2.1 Public awareness campaigns

Due to the limited number of rip current awareness campaigns and subsequent evaluation, the theories and principles associated with alternative public awareness campaigns have been

studied. Atkin and Rice (2012) state that there is no particular theory to clarify public communication campaigns, and therefore a mixture of related theories from behavioural change campaigns within the health, social and environmental fields have to be utilised alongside the similarities to commercial advertising and marketing. The reasons for applying a social marketing framework are succinctly summed up below:

It is useful to apply social marketing, which emphasises an audience-centred consumer orientation and calculated attempts to attractively package the social product and utilise the optimum combination of campaign components to attain pragmatic goals (Atkin and Rice, 2012, p3).

Elliot (1993) concluded that an ineffective campaign comes from ignoring the difference between marketing products and services and persuading people to do or not to do certain behaviours. The design of this pilot therefore, has been guided by theories applicable to communication campaigns and prior research of safety campaigns from areas such as health topics, nutrition, drugs, smoking, HIV/AIDS, and environmental issues.

Table 6.1 - Table of study group information including the type of group and distance from the nearest rip current dominated beach.

Group	Town/City	Type of school/group	Distance to coast (km)	Distance to dominant rip current beach (km)
Humphrey Davy School	Penzance, Cornwall	State comprehensive	0.76 Penzance seafront	11.34 Sennen Cove
Truro School	Truro, Cornwall	Independent	6.52 Carrick Roads	12.62 Perranporth
Keyham Scouts	Plymouth, Devon	Scout troop	3.71 Plymouth Sound	8.11 Whitsand Bay
Plymouth City College	Plymouth, Devon	City technology college	1.96 Plymouth Sound	7.29 Whitsand Bay
21 st Scout group	Plymouth, Devon	Scout troop	3.62 Plymouth Sound	11.61 Whitsand Bay

6.2.2.2 Behaviour change

As there is no specific theory for campaign work, a number of frameworks have been studied and followed throughout the implementation of the study process. Although the main aim of the study was to assess the level of knowledge change before and after delivery, theories of behaviour change were researched, as awareness and knowledge are the first stages to changing behaviours (Ajzen, 1991; Elliott, 1993; Hunt, 2003), and ultimately behaviour change is what will lead to less rip current incidents and fatalities.

In order for a behavioural change to take place, there is generally a lag time between the initiation of campaign exposure and effects (Warner, 1981; Raman *et al.*, 2010). This has been seen in areas such as seat belt use, smoking behaviour, bicycle helmet use, and recycling habits, where the time between introducing the campaign to seeing a real shift in behaviour can take years, if not decades (Hornik and Yanovitsky, 2003). This is achieved by campaigning at an individual, social, and organisational level, with substantial levels of repetitive exposure via multiple channels, over time, to target audiences. Core concepts or theories of behaviour change campaigns need to be incorporated within a small scale awareness campaign such as this pilot study, to make it easier to transfer to another level - perhaps geographically, institutionally, or on a community level.

The Integrative Theory of Behaviour Change (ITBC) first pioneered by Fishbein (2000), integrates the Health Belief Model, Social Cognitive Theory, and Theory of Reasoned Action/Theory of Planned Behaviour (Figure 6.2). In short it “specifies how external variables, individual differences, and underlying beliefs contribute to differential influence pathways for outcome behaviours, intentions, attitudes, norms, and self-efficacy” (Atkin and Rice, 2012, p.4).

The central premise, therefore, is that behaviours are driven by intentions, and the stronger these intentions are, the more likely someone is to undertake that behaviour. The principle is that beliefs need to be targeted in order to change attitudes and intentions. For example, behaviour change interventions that use the premise of the Theory of Planned Behaviour (TPB), whilst utilising cognitive methods such as information and persuasion, are said to be effective (Hardeman *et al.*, 2002). This study, therefore, intended to provide respondents with a greater understanding of what rip currents are, how they work, and how to escape, in addition to providing information on safe swimming areas. This targets what they believe about rip currents and safe swimming locations, in the hope that it would begin to alter attitudes or intentions to behaving in a safe manner.

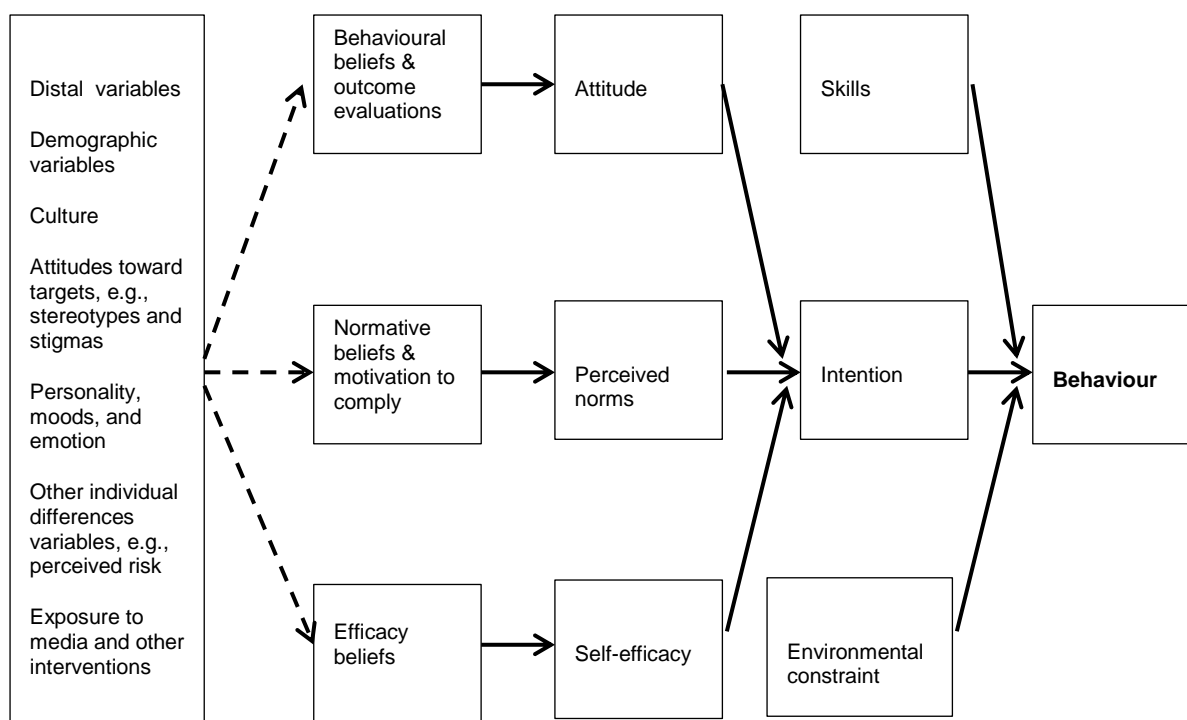


Figure 6.2 – The Integrative Theory of Behaviour Change (ITBC) model showing the pathways to intentions and behaviours that are led by external variables. The model shows the complex cognitive stages through which individuals move towards behaving in a certain way (Adapted from Fishbein (2000)).

Direct exposure to messages conveyed by campaigns is crucial for influencing behaviour, and as a result of this exposure individuals may then be armed with information that could alter their behaviour. Campaigns often present individuals with benefits and costs of conducting specific behaviours, and it is thought that learning the consequences of these actions may develop attitudes and beliefs, as well as providing the skills, self-efficacy, and social norms of performing a specific behaviour (Hornick and Yanovitsky, 2003). A print advertisement launched by the Child Health Foundation in Germany, for example, attempted to raise awareness of passive smoking around children. The image showed a child with a smoke halo around her head with the words “children of parents who smoke, get to heaven earlier”. Exposure to emotive campaign messages like this attempt to change behaviour of target audiences.

In this study, behaviour change is not the main aim (although an advantageous consequence), but by raising awareness and knowledge of rip currents, a change in attitude

towards beach safety and behaviours when at the beach might begin to take place. It is argued that true knowledge only comes from having a correct and justified belief about something, which in turn has to come from the certainty with which the belief is held, and the confidence with which decisions are made and behaviours are performed (Hunt, 2003). It is therefore important that an intervention which aims to increase knowledge has to firstly give people the correct information to believe in and make people sure of this information, through examples, experts, facts, and research. The true measure of knowledge is then for them to use this knowledge to inform their actions.

For changing attitudes, Zanna and Rempel (1988) advocate using multiple methods such as dissemination of specific information, inclusion of messages high in emotion, and messages that connect attitudes to past behaviours. Kim and Hunter (1993) argue that when changing attitudes it is essential to place a positive emphasis on performing the behaviour targeted to change, as well as the social appropriateness and the benefits it may bring. For example, highlighting that going to a lifeguarded beach and going between the flags has a positive benefit as it reduces the chances of getting caught in a rip current, and chances of rescue are extremely high. Not performing this behaviour can be seen as socially unacceptable by taking lifeguard and emergency service resources away from others complying by the suggested safety messages.

6.2.2.4 Teaching teenagers

In addition, techniques for teaching teenagers were researched as the challenges are well known for engaging this audience (Feinstein, 2009; Kidd and Czerniawski, 2011). The different learning styles appropriate for teenagers (Felder and Silverman, 1988) were taken into account during the development of this study. Research suggests that short activities should be used at a quick pace, with a variety of activities combining humour and participation to engage a teenage audience (Hurwitz *et al.*, 2014). Additionally, gaining attention is crucial for engaging the brain and for creating an environment in which the brain maintains pleasurable feelings such as amusing or horrific stories (Feinstein, 2009). It is also essential that working memory is not overloaded, as processing more than seven pieces of information concurrently results in cognitive fatigue and ineffective learning (Raman *et al.*, 2010). With this in mind, behaviour change, attitude change, and educational learning techniques were taken into account when designing and implementing the pilot.

6.2.3 Study components

The education pilot study consisted of an interactive talk delivered by an RNLI beach lifeguard using a computer based presentation (PowerPoint) that utilised a variety of media (video, news reports, images), accompanied by a Vasa ergometer swimming/paddle machine. A lifeguard was used for two main reasons: firstly, the outcome of Chapters 4 and 5 concluded that lifeguards are a source of delivery that most people favoured, and secondly, the RNLI lifeguards represent an authority on beach safety and are widely respected. In addition, results from Chapter 5 highlighted people wanted to know what rip currents were, how they worked, what to expect, and what to do if caught in one. The pilot was designed around these pieces of information, taking into account frameworks used in awareness campaigns and education methods.

A key concept in designing the talk was the engagement of participants through active learning. This method has been proven to be effective in classroom environments, where providing physical and mental engagement, as opposed to sitting, listening and watching, stimulates people more, providing them with a richer learning experience (Feinstein 2009; Kidd and Czerniawski 2011). Presentation of a diverse set of short activities, whilst merging various delivery techniques, addressed the short attention span of teenagers, and by moving at a fast pace, held their attention throughout the study.

In a review of 87 road safety campaigns, Elliott (1993) concluded that campaigns with a deliberate persuasive intent, using emotional appeal, requesting or instructing a specific behaviour are more effective. Utilising this, the pilot included emotional, informative, participatory, active, and instructional content to introduce key rip current information and messages to the teenage audience.

Emotional – A news clip reporting a rip current drowning was shown (footage of the drowning incident was not shown). It described how a mother drowned in a rip current on a north Cornwall beach whilst going to the aid of her two teenage sons who survived. This was relevant to the audience as it involved people of the same age, and the significant emotional impact of losing a mother.

Informative – A time lapse video was shown of rip current formation on a beach in north Cornwall, with arrows and text entering the screen. The lifeguard talked through the physical processes of how a rip current worked.

Participatory – A section called ‘spot the rip’ included several pictures of rip currents from around the world. Participants were invited to hold the laser pointer and shine the laser

6.2.4 Questionnaire design

The pre-talk and post-talk questionnaires (Appendix 3 and 4 respectively) were designed to be as short and simple as possible giving consideration to teenage attention span, variation in academic ability, and time constraints within the school/club. Closed questions were chosen because they are quick to answer, factual, require no writing from the participants, make group comparisons easy, as well as being a measure of attitudes (Oppenheim, 1992). The downside to excluding open-ended questions meant that there were no expressive, richly detailed answers from participants, and limited the answers to predefined categories. In this instance however, it was decided that the increased demand on the students for writing an open ended answer would not have provided any further insight into the purpose of the before and after design.

The pre-talk survey consisted of 12 closed and mainly multiple choice questions, establishing frequency of water use, swimming and watersports ability, rip current knowledge, ability to locate a rip current on a picture, rip current experience, and demographic information. The post talk survey consisted again of 12 closed questions asking for rip current knowledge and identification, and evaluative questions about the talk. The strengths and weaknesses of the study were sought from these evaluative questions, as well as seeking to establish whether the delivery methods were correct, what the overall impact was and had it changed or increased rip current understanding.

Participants were asked to give their age, gender, date of birth and initials so they could be given an identification number for the purpose of analysis. This enabled each individual to be tracked over time before, after, one, and three months after the talk. Certain questions were also duplicated in the post-talk questionnaires to track knowledge retention over time.

6.2.5 Rip current identification

As part of the questionnaire, each participant was asked to identify and mark on a photograph where they thought there was a rip current with a cross, and where they thought it was safe to swim with a tick. Figure 6.4 shows the picture with a 1x1cm grid superimposed during analysis to aid manual measurement of each individual point. These points were then electronically entered onto the image for the before and after surveys.

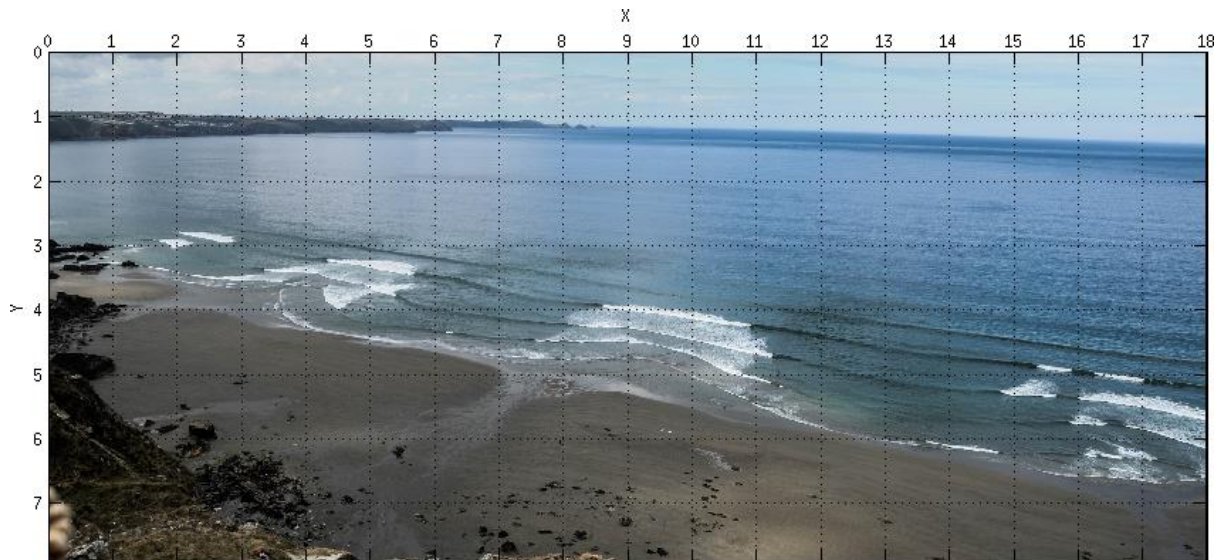


Figure 6.4 – Rip current identification photograph used to measure where participants think rip currents and safe areas are. (T. Scott, personal photograph, September, 2013).

6.2.6 Data analysis

Data from the questionnaires was analysed to establish the effectiveness of the pilot, whether knowledge had increased, and to evaluate each component of the talk. Descriptive statistics were used to establish whether an overall positive or negative change had been experienced for the categories within the rip current knowledge questions before and after.

The Chi-square test for association (χ^2) was used to determine whether nominal (or categorical) variables were statistically independent or if they were associated, confidence levels were set at 0.05. A Fisher's Exact test was used where cell frequencies are less than 5 in a Chi-Square test.

A Wilcoxon Signed Rank test (Z) was performed on the respondents' pre-talk and post-talk knowledge to assess significance of the mean. This test was used because the data deviated from a normal distribution, where a t-test would be used for normally distributed data. This test is used to determine whether the mean of a dependent interval (or ratio) variable is the same in two samples. The analysis was done on an overall level and demographic level (gender). Confidence levels were set at 0.05.

Because the interval data was not normally distributed, a Kruskal-Wallis 1-way ANOVA test to compare means was used when there were more than two samples, such as age or group.

6.3 Results

6.3.1 Pilot profile

The pilot engaged with 185 participants, with a gender split of 115 male and 70 female, and an age range from 13 to 22 years old (mean=15). Most participants were recruited from Humphrey Davy School in Penzance (n=74), and the least from the two scout groups in Plymouth (n=16). The profile of participants can be seen in Table 6.2.

Sea based activity is mostly undertaken during the summer months only, but nearly a quarter go in the water all year round. Chi-Square analysis found a statistically significant relationship ($\chi^2(20)=54.954, p<0.0005$) between groups and water use. The majority in all groups frequented the sea in the summer months, yet Truro School respondents (n=19, 36%) entered the sea all year round most frequently.

A Significant association was also found between gender and water use using a Fisher's Exact test ($p=0.007$), which found the majority of both males and females go in the sea during summer months only, but that males are more likely to go in all year round, and females in the warmer spring and summer months. More males than females, however, stated that they never go in the water. No significant differences were found between being caught in a rip current and gender, age, group, or swimming ability. This contradicts earlier observations from the incident data in Chapter 3 and rip current 'victims' in Chapter 5, which may be an indication of reduced sample size. There was, however, a significant association ($\chi^2(10)=20.037, p=0.011$) between water use and caught in a rip current, where 39% (n=10) of those caught in a rip are year round water users, which is more than those who have not been caught (n=22, 22%). Only 14% of participants were certain that they had been caught in a rip current.

Participants were asked to self-rate their ability in swimming, bodyboarding, and surfing. Participants rated their swimming ability highly, with 125 participants (68%) stating they were 'good' or 'very good'. Bodyboarding aptitude was ranked below swimming with the majority of participants stating their ability was 'average' (n=65, 35%), and surfing ranked the lowest, with the majority admitting 'very poor' ability (n=71, 38%).

Significant values were found between self-rated activities and school group where Chi-square values for swimming $\chi^2(16)=28.203, p=0.030$, bodyboarding $\chi^2(16)=30.686, p=0.015$, and surfing $\chi^2(16)=28.855, p=0.025$ determine that there is a statistically significant

association between self-rated activity ability and school groups. There were no significant associations between self-rated activity and gender, age, or frequency of water use.

Table 6.2 – Profile of pilot participants.

	Freq.	%		Freq.	%
Gender			Group		
Male	115	62.2	Humphrey Davy School	74	40.0
Female	70	37.8	Truro School	53	28.6
			Keyham Scouts	16	8.6
			Plymouth City College	26	14.1
			21 st Plymouth Scouts	16	8.6
Age			Water use		
13	19	12.3	All year round	9	4.9
14	57	30.8	Spring – Autumn (March-December)	17	9.2
15	59	31.9	Spring to Summer (March-September)	79	42.7
16	16	8.6	Summer (June-September)	30	16.2
17	20	10.8	Never	8	4.3
18	6	3.2			
19+	8	4.3			
Have you ever been caught in a rip current?					
Yes	26	14.1			
No	111	60.5			
Maybe	47	25.4			

6.3.2 Rip current knowledge

Participants were asked to rate their knowledge of rip currents on a scale of 1 (nothing) to 5 (everything) before and directly after the pilot to assess whether there had been a change. Table 6.3 shows most participants mainly self-ranked knowledge as 2 (n=71, 38%) before the talk, with a significant positive shift to a 4 (n=130, 71%) directly after the talk. This is an encouraging result for the pilot study showing that there is a direct change in rip current knowledge after the delivery of simple rip current information to small groups.

A Shapiro-Wilks test established the data deviates from a normal distribution, so a series of non-parametric tests were used on the data in this chapter. A Wilcoxon Signed Rank test was undertaken to assess whether there was a difference in participants' mean rip current knowledge before and after the pilot. Table 6.4 shows $Z=-11.322$, $p<0.0005$, indicating that there is a statistically significant improvement of rip current knowledge (average rank of 0 vs. 83.00) following the delivery of the education pilot from a mean of 2.35 to 4.05; an improvement of 1.70.

Table 6.3 – Participants understanding of rip currents pre-talk and post-talk. The end column shows the degree of change from before to after (red negative, green positive), and correct answers are indicated in black, incorrect in grey.

	Pre	Post	Pre %	Post %	% change
Q1. How much do you know about currents?					
Nothing (1)	39	0	21.08	0.0	-21.08
Not much (2)	71	0	38.38	0.0	-38.38
Some (3)	49	22	26.49	11.96	-14.53
A fair bit (4)	24	130	12.97	70.65	57.68
Everything (5)	2	32	1.08	17.39	16.31
	185	184	100	100	0
Q2. What is a rip current?					
A whirlpool	11	2	5.95	1.09	-4.85
A body of water flowing out to sea	62	164	33.51	89.61	56.10
A sideways sweeping current	42	11	22.70	6.01	-16.69
A big breaking wave	3	2	1.62	1.09	-0.53
An undertow	26	3	14.05	1.64	-12.41
I don't know	41	1	22.16	0.55	-21.62
	185	183	100	100	0
Q3. What does a rip current do?					
Pulls you under the water	31	5	16.76	2.72	-14.04
Drags you out to sea	116	168	62.70	91.80	28.60
Goes in and out like the tide	1	10	0.54	5.43	4.89
Sweeps sideways across the beach	10	1	5.41	0.54	-4.86
I don't know	27	0	14.59	0.0	-14.59
	185	184			
Q4. What does a rip current look like? (% of participants)					
There is churned up sand and sediment	19	89	10.30	48.11	37.84
A patch of shallow water	7	6	3.80	3.24	-0.54
An area with no breaking waves	54	142	29.20	76.76	47.57
There is floating debris in it	5	76	2.70	14.08	38.38
Invisible	22	4	11.90	2.16	-9.73
There is foam or froth on the surface	8	66	4.30	35.68	31.35
A darker patch of water	35	161	18.90	87.03	68.11
There is a choppy/rippled surface	47	117	25.40	63.24	37.84
A vortex	5	1	2.70	0.54	-2.16
I don't know	48	1	25.90	0.54	-25.41
	250	663	159.4	331.38	+223.25

N.B. Q4 is multiple choice, therefore responses are more than respondents, and percentages add up to more than 100%. Percentages reflect what percentage of participants chose each choice.

Table 6.4 – Results of a Wilcoxon Signed-Rank test to assess the level of rip current knowledge between the before-talk and after-talk surveys.

Descriptive Statistics								
	N	Mean	Std. Dev.	Min.	Max.	Percentiles		
						25th	50th (Median)	75th
Rip knowledge (pre)	185	2.35	.989	1	5	2.00	2.00	3.00
Rip knowledge (post)	184	4.05	.540	3	5	4.00	4.00	4.00

Ranks			
	N	Mean Rank	Sum of Ranks
Rip knowledge (post) - Rip knowledge (pre)	Negative Ranks	0 ^a	.00
	Positive Ranks	165 ^b	83.00
	Ties	19 ^c	
	Total	184	

- a. Rip knowledge (post) < Rip knowledge (pre)
- b. Rip knowledge (post) > Rip knowledge (pre)
- c. Rip knowledge (post) = Rip knowledge (pre)

Test Statistics ^a	
	Rip knowledge (post) - Rip knowledge (pre)
Z	-11.322 ^b
Asymp. Sig. (2-tailed)	.000

- a. Wilcoxon Signed Ranks Test
- b. Based on negative ranks.

Significant values ($\chi^2(2)=13.234, p=0.001$) were also found between self-rated rip current knowledge pre-talk and those that had been caught in a rip current, as those that had been caught had a mean rank of 126.25, compared to those who have not been caught with a mean rank of 85.77. Similarly, a significant association was found between those who had been caught in a rip current and their answer to ‘what does a rip current do?’ (Fisher’s Exact test $p=0.027$) where those who have been caught were able to give the correct answer (n=20, 77%) more than those who have not been caught (n=75, 67%). More of those not caught in a rip were unable to give an answer (n=17, 15%) compared with those who have been caught (n=1, 4%). Significant differences were not found between those who had been caught and the answer to ‘what is a rip current?’

6.3.3 Rip current identification

Participants were asked if they knew what a rip current looked like, and to choose answers from a prescribed list with a selection of correct and incorrect answers. Table 6.4 shows that before the pilot, participants ticked 250 responses from the 10 options (6 correct, 3 incorrect, 1 don't know), and after the pilot ticked 663 responses, an increase of 413 more responses.

Before the talk there was a mix of correct and incorrect answers for rip current identification, with the majority of responses being correct (Table 6.5). These included 'An area of no breaking waves', 'I don't know', and 'There is a choppy/rippled surface'. Two of these answers were correct, indicating that the participants already had reasonably good baseline knowledge of what a rip current looks like. After the talk, there was an increased change in correct and incorrect answers to correct answers, with only one person stating they did not know. The most selected responses were 'A darker patch of water', 'An area of no breaking waves', and 'There is a choppy/rippled surface'. There was a positive increase in all the correct answers and a negative decrease in the incorrect answers, indicating a success in enhancing the participants' knowledge and that the methods utilised effectively communicated what a rip current looks like.

Table 6.5 – Participants responses pre-talk and post-talk for rip current identification showing the number of correct and incorrect responses and subsequent change.

	Pre	Post	Pre %	Post %	Change in responses	% change
Correct	168	654	67.20	98.60	+486	+31.40
Incorrect	34	8	13.60	1.20	-26	-12.40
Don't know	48	1	19.20	0.20	-47	-19.00
	250	663	100	100	+413	0

N.B. Multiple choice question, therefore total responses can be more than respondents.

The second part of the rip current identification process to mark on a picture (Figure 6.5) where they thought rip currents were present and which areas were safe. Figure 6.6 shows the before and after results, indicating a wider spread of marks before and more concentrated clusters of marks after, showing an improvement in identifying rip channels and safe areas

after participating in the pilot. Encouragingly, there were a number of correct answers before the talk which was greatly increased afterwards, and although there were still a number of incorrect answers on the plot after the talk, the numbers have largely reduced (Table 6.6).

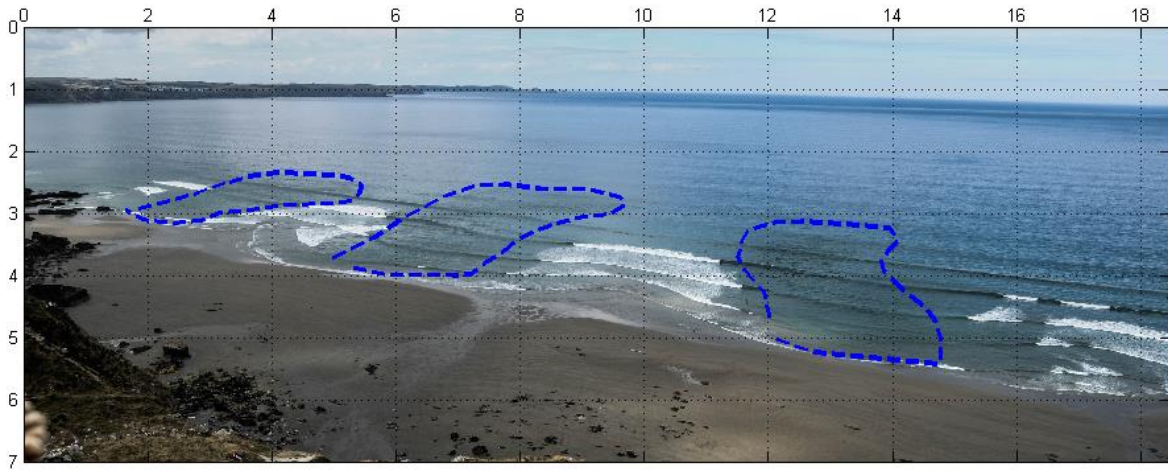


Figure 6.5 – The areas identified as rip current channels. Crosses located within the area are deemed correct, outside incorrect, with any ticks located inside incorrect, outside correct.

The ticks and crosses marked by participants on the photograph were evaluated in terms of their correct or incorrect rip current location, by calculating all the ticks and crosses within certain areas outlined in blue on Figure 6.5. Participants marked 269 crosses, and 275 ticks before the pilot, and 422 crosses and 450 ticks after; additionally they were asked not to mark the photograph if they did not know where to place their answer. Blank responses totalled 54 people for crosses and 41 for ticks pre-talk, and 14 people for crosses and ticks post-talk.

Table 6.6 shows the number and percentages of marks and whether they were placed in or out of the rip currents. The pre-talk data shows 69% (n=186) placed their rip current identifying crosses in the wrong place (outside rip channels), and post pilot this was reduced to 19% (n=81). Safe area indicating ticks were much more positive, as 77% (n=212) were placed in the correct area pre-talk, and post-talk this increased to 94% (421). Pre-talk baseline levels for safe areas were much higher and saw only a 17% positive change, compared with rip current locations confirming a 50% positive change between pre and post talks. These results are encouraging as they show a positive change in participants' ability to identify the rip currents, and in particular where they deem the safe places to enter the water.

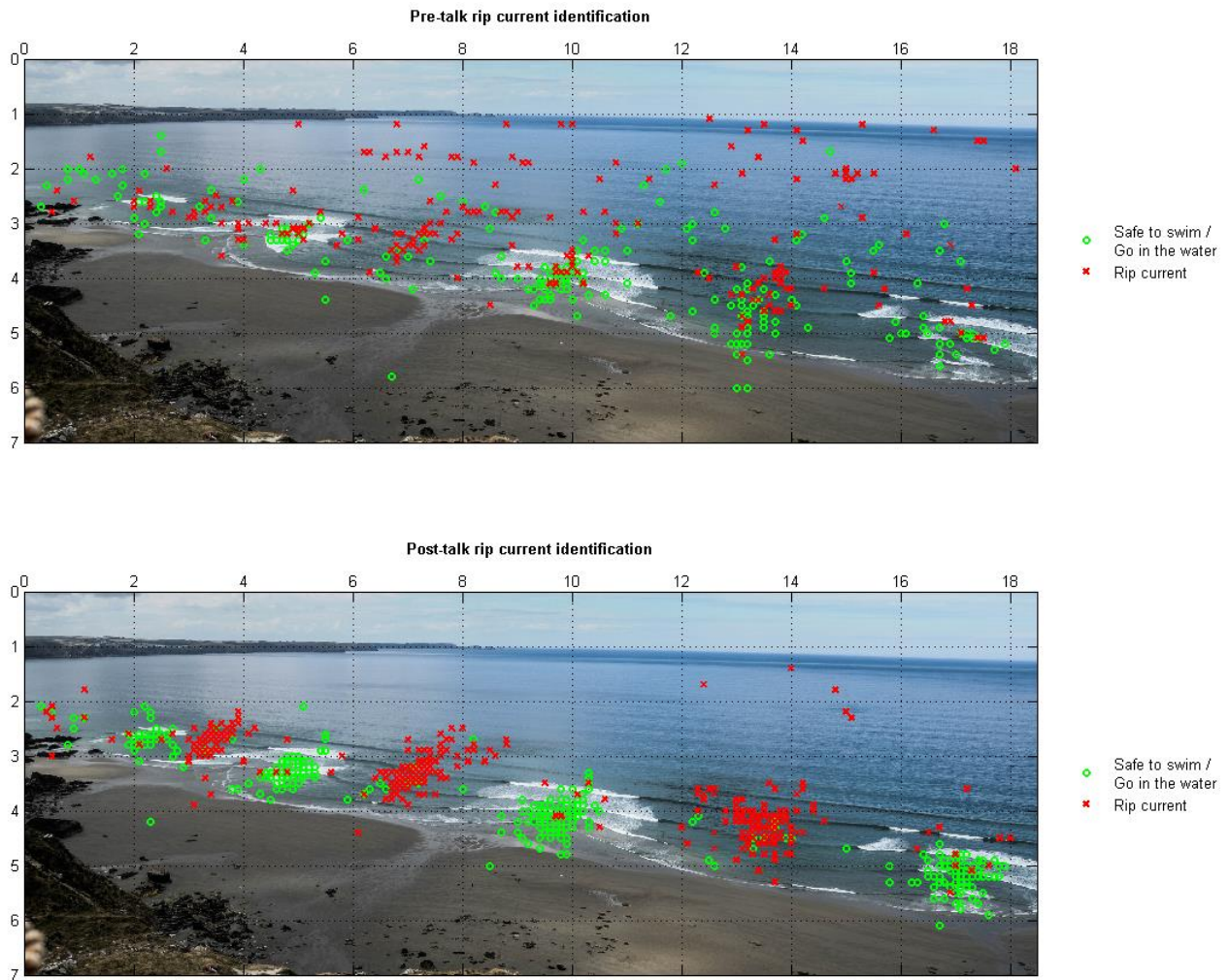


Figure 6.6 – Rip current identification before (top) and after (bottom) the rip current pilot. Participants marked red crosses for where they thought rip currents were, and green circles for where they thought it would be safe to swim.

Table 6.6 – The number of correctly and incorrectly placed ticks (safe area) and crosses (rip current) marked by respondents on the rip current identification picture (Figure 6.6).

	RIP CURRENT (x)				SAFE (✓)			
	Correct	Incorrect	Total	Change	Correct	Incorrect	Total	Change
Pre-talk	83 30.9%	186 69.1%	269		212 77.1%	63 22.9%	275	
Post-talk	341 80.8%	81 19.2%	422	+50.0%	421 93.6%	29 6.4%	464	+16.5%

NB: Only includes number of participatory marks, not overall participants, where participants could tick or cross multiple times.

Several participants were confused by the instruction for marking ticks and crosses, and needed clarification as they were unsure if a tick meant ‘yes there is a rip current’ or whether the cross meant ‘no, don’t swim there it’s a dangerous rip current’. There was ample indication on the questionnaire response sheet for participants to notice, and it was reiterated by the lifeguard when discussing the questionnaire. Another area of ambiguity was that if the mark was not within the area marked in blue, it was counted as incorrect, even if it was close. This can be seen by comparing Figure 6.5 with Figure 6.6, where several marks come close to being in the correct area, indicating that the participant may not have been able to see the rippled surface in the photograph, or that they were acting on identifying the rip by looking where ‘no waves are breaking’ and marking the photograph.

6.3.4 Evaluation of pilot

Participants were asked how much they felt they had learned from the rip current talk (Table 6.7), with the most stating they had learned a ‘fair bit’ (n=87, 47%), and encouragingly, none felt they had not learned anything. Differences in gender and what respondents felt they had learned returned no significance using a Mann-Whitney U test. Kruskal-Wallis tests found significant differences between group ($\chi^2(4)=27.335, p<0.0005$) and frequency of water use ($\chi^2(5)=11.853, p=0.037$), but no differences were found across categories of age or swimming ability.

Table 6.7 – Frequency table showing the amount respondents had felt they had learned after the rip current talk.

	Frequency	Percentage	Valid percentage
Nothing	0	0%	0%
A tiny bit	5	2.7%	2.9%
Some stuff	26	14.1%	14.9%
A fair bit	87	47.0%	49.7%
Everything	57	30.8%	32.6%
Total	175	94.6%	100.0%
No answer	10	5.4%	
Total	185	100.0%	

Throughout the talk, key messages were introduced and reinforced with a summary at the end, with the participants then asked to state which messages they remembered at the end. The pre-defined list included two incorrect answers, four correct, and a ‘don’t know’ option.

Table 6.8 shows the message respondents most remembered was ‘don’t panic, stay calm’ (n=170, 92%), the other correct answers were also well remembered, and the two decoy answers had only two responses. Although a pre-defined response, it is encouraging these key messages were recalled as they are crucial pieces of advice for beach users to stay safe in the sea.

Table 6.8 – Participants responses for which key rip current safety messages were remembered after the talk.

	N	Percentage of responses (%)	Percentage of people (%)
Correct messages			
Don’t swim against the current	163	25.8	88.6
Stay calm, don’t panic	170	26.9	92.4
Swim towards waves if caught	139	22.0	75.5
White water is good, dark water is bad	156	24.7	84.8
Total	628	99.4	341.3
Incorrect messages			
Rips only happen at the weekend	0	0	1.1
Rips are gentle and calm	2	0.3	0
They are safe to swim in	2	0.3	1.1
Total	4	0.6	2.2
Unsure			
I don’t know	0	0	0

N.B. Multiple choice question, therefore total responses can be more than respondents.

Participants were asked to evaluate each aspect of the talk by ranking their level of enjoyment. Figure 6.7 shows that over half of all participants enjoyed every aspect, stating they either ‘liked it’ or ‘loved it’, with the lowest enthusiasm ranks all $\leq 7\%$. The paddle machine produced the highest enjoyment factor among participants with 44% (n=81) stating

they ‘loved it’ and 35% (n=64) stating they ‘liked it’. The spot the rip section of the talk was also highly enjoyed, and the word cloud least enjoyed as participants felt least enthused by this method; 3% (n=5) stated they were ‘totally asleep’ and 7% (n=12) were ‘a bit bored’. The only method where ‘totally asleep’ totalled none was the rip current basics video. These results indicate that the delivery methods positively stimulated this teenage audience.

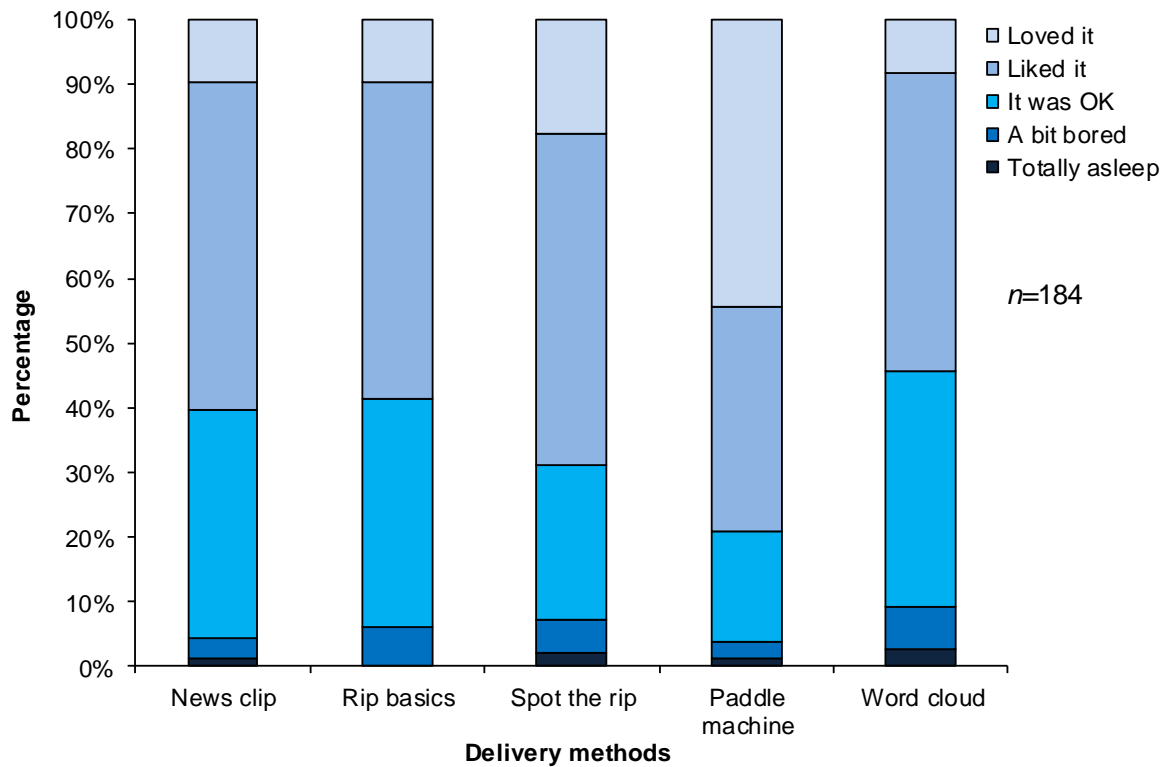


Figure 6.7 – Participant enjoyment of the different methods of delivery throughout the rip current education pilot study

Mann-Whitney tests were calculated to assess differences in the mean between enjoyment of each aspect of the talk and gender finding no significance. Kruskal-Wallis tests established no statistical significance between age, but found significance between the participatory groups for four different delivery methods; news clip $\chi^2(4)=18.253$, $p=0.001$, spot the rip $\chi^2(4)=14.738$, $p=0.005$, paddle machine $\chi^2(4)=16.661$, $p=0.002$, and word cloud $\chi^2(4)=29.575$, $p<0.0005$, with no difference for the rip current basics video. This illustrates how the groups respond differently to various types of delivery method, and therefore must be taken into account when educating groups in different locations and with diverse socio-economic backgrounds.

6.3.5 One month and three month testing

One month and again at three months after the initial pilot, the same individual groups were visited to assess knowledge retention of the rip current information. The number of participants was unavoidably reduced after the initial pilot from 185 to 113 at one month, and then to 80 at three months. This was due to participant absences and school timetabling. In addition, some participants were absent for the one month follow-up survey but were present at the three month survey. Results have been calculated on the total number of individuals for the one month and three month survey, and additionally for those who were present throughout the whole process; pre, post, one month and three months (n=52).

Table 6.9 gives an overview of the three repeated questions over the three month period and the change in knowledge over time. Table 6.10 shows the 52 participants who were present for all the surveys, where it can be seen that changes begin to become apparent at the three month stage. For the first question tested over time – ‘what is a rip current?’ – there is a -4% negative change after one month, reducing further to -12% after three months. The second question – ‘what does a rip current do?’ sees a positive change in the correct answer after one month with +6%, followed by a drop at three months to +4%, but still higher than the post survey. For the third question, the net change in the correct answers is negative (-1.56%). Some of the answers are being more easily recalled by participants, whilst others are reducing, with the trend favouring positive changes in two key correct answers of ‘An area with no breaking waves’ (+3.84%) and ‘A darker patch of water’ (+2.16%). Based on the results from the 52 participants that had 100% attendance, the results show knowledge retention for correct answers to all three questions is reduced after three months by -9.25%. In all cases rip current knowledge after 3 months is always considerably more than recorded during the pre-talk survey.

Table 6.9 – Comparisons of knowledge retention over time. The percentage change column for each survey takes into account the amount of change between the post-talk and one to three month surveys to indicate a positive or negative changes since the post-talk.

	PRE	%	POST	%	% Change	1 MONTH	%	% Change	3 MONTHS	%	% Change
What is a rip current?											
A whirlpool	11	5.95	2	1.09	-4.85	3	2.65	1.56	2	2.50	1.41
<i>A body of water flowing out to sea</i>	62	33.51	164	89.62	56.10	100	88.50	-1.12	62	77.50	-12.12
A sideways sweeping current	42	22.70	11	6.01	-16.69	6	5.31	-0.70	5	6.25	0.24
A big breaking wave	3	4.62	2	1.09	-0.53	2	1.77	0.68	3	3.75	2.66
An undertow	26	14.05	3	1.64	-12.41	1	0.88	-0.75	6	7.50	5.86
I don't know	41	22.16	1	0.55	-21.62	1	0.88	0.34	2	2.50	1.95
What does a rip current do?											
Pulls you under the water	31	16.76	5	2.72	-14.04	6	5.31	2.59	2	2.50	-0.22
<i>Drags you out to sea</i>	116	62.70	168	91.30	28.60	103	91.15	-0.15	71	88.75	-2.55
Goes in and out like the tide	1	0.54	10	5.43	4.89	3	2.65	-2.78	1	1.25	-4.18
Sweeps sideways across the beach	10	5.41	1	0.54	-4.86	1	0.88	0.34	4	5.00	4.46
I don't know	27	14.59	0	0.00	-14.59	0	0.00	0.00	2	2.50	2.50
What does a rip current look like?											
<i>There is churned up sand and sediment</i>	19	7.60	89	13.42	37.84	42	12.21	-1.21	25	10.68	-2.74
A patch of shallow water	7	2.80	6	0.90	-0.54	6	1.74	0.84	3	1.28	0.38
<i>An area with no breaking waves</i>	54	21.60	142	21.42	47.57	89	25.87	4.45	56	23.93	2.51
<i>There is floating debris in it</i>	5	2.0	76	11.46	38.38	28	8.14	-3.32	20	8.55	-2.92
Invisible	22	8.80	4	0.60	-9.73	4	1.16	0.56	5	2.14	1.53
<i>There is foam or froth on the surface</i>	8	3.20	66	9.95	31.35	21	6.10	-3.85	20	8.55	-1.41
<i>A darker patch of water</i>	35	14.0	161	24.28	68.11	90	26.16	1.88	64	27.35	3.07
<i>There is a choppy/rippled surface</i>	47	18.80	117	17.65	37.84	62	18.02	0.38	39	16.67	-0.98
A vortex	5	2.00	1	0.15	-2.16	1	0.29	0.14	0	0.00	-0.15
I don't know	48	19.20	1	0.15	-25.41	1	0.29	0.14	2	0.85	0.70
	185		183			113			80		

N.B. Bold indicates a positive change between the post talk and subsequent 1 and 3 month testing.

Table 6.10 – An overview of the 52 participants that were present for the pre-, post-, one month, and three month surveys and their change in knowledge over time.

	PRE	%	POST	%	% Change	1 MONTH	%	% Change	3 MONTHS	%	% Change
What is a rip current?											
A whirlpool	4	7.69	1	1.92	-5.77	1	1.92	0.00	2	3.85	1.92
<i>A body of water flowing out to sea</i>	23	44.23	51	98.09	53.85	49	94.23	-3.85	45	86.54	-11.54
A sideways sweeping current	9	17.31	0	0	-17.31	2	3.85	3.85	3	5.77	5.77
A big breaking wave	0	0.00	0	0	0.00	0	0.00	0.00	1	1.92	1.92
An undertow	12	23.08	0	0	-23.08	0	0.00	0.00	1	1.92	1.92
I don't know	4	7.69	0	0	-7.69	0	0.00	0.00	0	0.00	0.00
What does a rip current do?											
Pulls you under the water	5	9.62	1	1.92	-7.69	0	0.00	-1.92	1	1.92	0.00
<i>Drags you out to sea</i>	42	80.77	48	92.31	11.54	51	98.08	5.77	50	96.15	3.85
Goes in and out like the tide	1	1.92	3	5.77	3.85	1	1.92	-3.85	0	0.00	-5.77
Sweeps sideways across the beach	1	1.92	0	0	-1.92	0	0.00	0.00	1	1.92	1.92
I don't know	3	5.77	0	0	-5.77	0	0.00	0.00	0	0.00	0.00
What does a rip current look like?											
<i>There is churned up sand and sediment</i>	8	10.39	35	15.70	5.31	22	12.22	-3.47	22	12.29	-3.40
A patch of shallow water	2	2.60	3	1.35	-1.25	2	1.11	-0.23	1	0.56	-0.79
<i>An area with no breaking waves</i>	17	22.08	45	20.18	-1.90	48	26.67	6.49	43	24.02	3.84
<i>There is floating debris in it</i>	1	1.30	28	12.56	11.26	16	8.89	-3.67	18	10.06	-2.50
Invisible	8	10.39	1	0.45	-9.94	3	1.67	1.22	5	2.79	2.34
<i>There is foam or froth on the surface</i>	2	2.60	24	10.76	8.16	15	8.33	-2.43	16	8.94	-1.82
<i>A darker patch of water</i>	14	18.18	50	22.42	4.24	44	24.44	2.02	44	24.58	2.16
<i>There is a choppy/rippled surface</i>	14	18.18	37	16.59	-1.59	29	16.11	-0.48	30	16.76	0.17
A vortex	1	1.30	0	0	-1.30	1	0.56	0.56	0	0.00	0.00
I don't know	10	12.99	0	0	-12.99	0	0.00	0.00	0	0.00	0.00
	52		52			52			52		

N.B. Bold indicates a positive change between the post talk and subsequent 1 and 3 month testing.

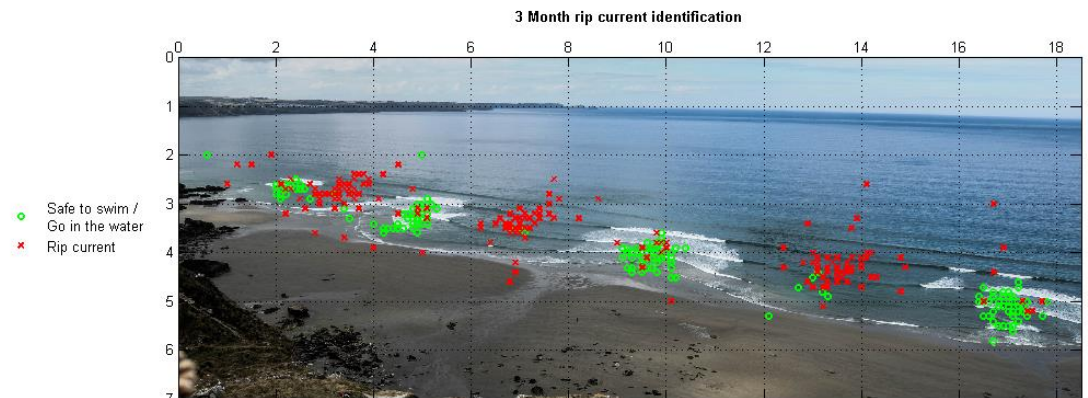
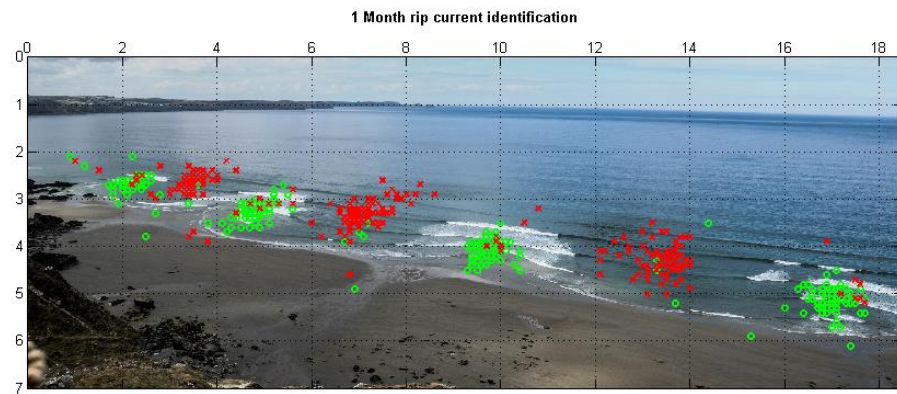
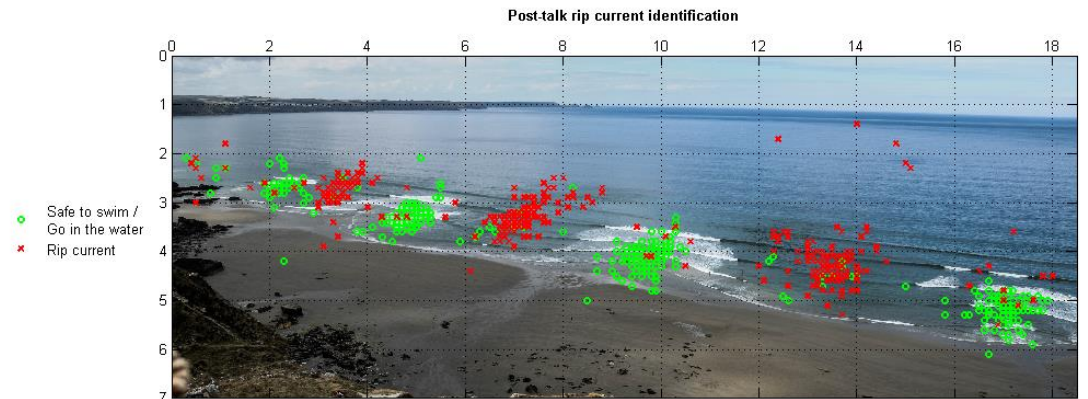
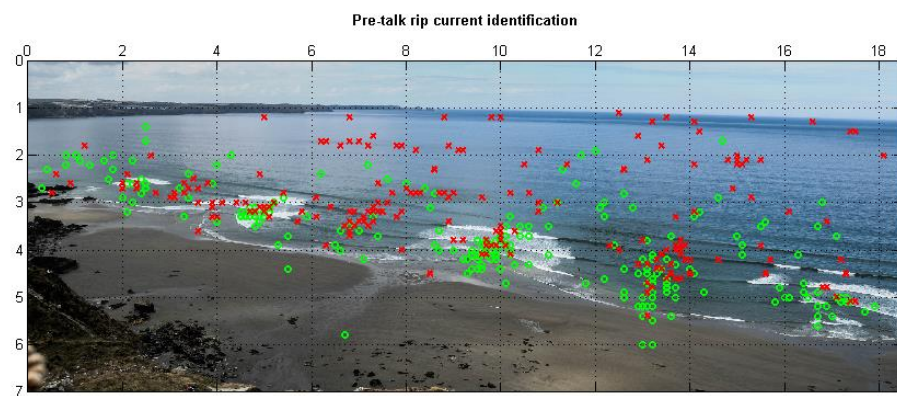


Figure 6.8 – Comparisons of rip current identification over time showing the marks participants made on the photograph pre, post, one month, and three months after the talk.

Table 6.11 - Comparisons between the correct and incorrect marks on the rip current identification photograph and the percentage change over time.

	RIP CURRENT (x)				SAFE (✓)			
	Correct	Incorrect	Total	Change	Correct	Incorrect	Total	Change
Pre	83	186	269		212	63	275	
	30.9%	69.1%			77.1%	22.9%		
Post	341	81	422	+50.0%	421	29	464	+16.5%
	80.8%	19.2%			93.6%	6.4%		
1m	254	55	309	+1.4%	309	12	321	+2.7%
	82.2%	17.8%			96.3%	3.7%		
3m	158	88	246	-16.6%	231	11	242	-3.3%
	64.2%	35.8%			90.2%	4.3%		

Table 6.11 shows the initial change between the pre- and post-talk to be high, and a slight increase during the one month survey. The three month survey shows a 17% negative change in rip current identification, and a 3% negative change in the safe area identification relative to the post-talk survey. These differences can be seen in Figure 6.8, and although there were fewer participants for the one and three month surveys, the cluster of both ticks and crosses are still compact after one month, and begin to increase in dispersal in the three month survey. Identification marks are still far from the baseline levels in the pre-talk survey, so these results show a definite positive change for up to one month, reiterating the results shown in other questions within the survey. The increase in correct one month ticks and crosses might be due to participants having this period of time to assimilate the information, and shows that there is still a strong retention.

6.4 Discussion

6.4.1 Evaluation of the rip current education pilot components

The study evaluation confirmed that the participants enjoyed the talk overall and that the paddle machine was the aspect most enjoyed. There is a link therefore, between the method of delivery and enjoyment rate, which can be related to the learning outcomes. Unfortunately there is no direct measure here between method and learning outcome, so we can speculatively link the results of Table 6.8 and Figure 6.7, where key messages learned by the participants can relate to their enjoyment.

Each aspect of the talk emphasised key messages, simultaneously elaborating particular details. For example, the 'spot the rip' aspect of the talk encouraged participants to think about ways to identify a rip current such as 'white water is good, dark water is bad'. The paddle machine highlighted the need to stay calm, and not to panic, and also that swimming against the rip current is futile. The paddle machine proved to be the most popular section of the talk, and can be related to the 'don't swim against a rip current' key message, which was successfully remembered by 98% (n=163) people. The machine allowed participation within the group, energised students, engaged the whole class, and was fun.

6.4.2 Rip current knowledge and delivery method

The main result of the study is the consistent positive increase in participants selecting the correct answers on the survey, suggesting knowledge has increased as a direct impact of the intervention. This positive change in knowledge has implications for the future of rip current education in the UK if the impact made by this small scale study is scaled up to a national campaign.

Results from the 52 participants present for all of the surveys, show that knowledge retention begins to reduce at three months after the talk. Retention levels were still high one month after the pilot was delivered, and began to drop off after three months. For some questions in the survey percentage change was minimal (<5%), but for the 'what is a rip current' question, a negative change of 12% was seen by the third month.

Knowledge retention is crucial in awareness campaigns because if the acquired knowledge can be remembered when it is needed to be used, the campaign has been successful (Hunt, 2003). The initial objective of this pilot, however, was to produce a small, short, school based

intervention that could be delivered by lifeguards to increase knowledge of rip currents before the peak beach season. The short term effects of this pilot have been successful, but to improve retention rates other methods could be used.

The spacing effect principle (Raman *et al.*, 2010) was overlooked in the education pilot development stage, and could have been a successful theory to implement. The premise of the spacing effect principle is that education spaced over time increases knowledge retention, because a greater context can be delivered and benefits from increased repetition. Known as dispersed delivery, this technique also allows greater time for individual reflection, overlapping concepts between topics and self-study, showing that increased repetition and revision of a topic improves retention over time.

Raman *et al.* (2010) states that both dispersed delivery and massed delivery (one-off information delivery) are effective in short term knowledge acquisition. Therefore, if this scheme were to be further developed, it could either adopt a dispersed delivery method where rip current information is delivered over time, for example a subject syllabus approach, thus retention levels would remain higher for longer. Alternatively, the massed delivery could continue with more effective teaching methods, at times when it was needed the most, i.e. before school holidays, which is probably more beneficial to safety organisations and could feasibly fit in with school timetables.

6.4.3 Rip current identification

There was a positive change in ability of participants to identify rip currents, particularly the safest places to enter the water. An increase of 50% in marking the correct locations of rip currents was seen, and nearly all participants (94%) marked correct safe areas, indicating confidence in placing the mark. Research suggests that confidence can be related to knowledge (Hunt, 2003), and in this instance, shows that participants have gained sufficient knowledge to understand which areas of the sea are rip currents and which are safe. However, there is also evidence to suggest that confidence is related to gender, particularly male overconfidence in aquatic environments, and that knowledge cannot overcome how males construct risk and water safety (Moran, 2011).

More people ticked the safe areas than rip currents in both pre- and post-tests. There are a few reasons for this: firstly, the talk reinforced safe swimming practices and areas; secondly more people may have felt confident in ticking the safe areas; and thirdly, participants may

have felt there were more safe areas to swim on the photograph as there were three distinct rip channels.

People may instinctively choose an area of safety when entering the water or it may be merely coincidental. People may tick where they remember having been in the water in the past, or tick where they *want* to go in the water. Wave dominated areas on the photograph are the predominant areas where ticks have been marked, which is also where people will bodyboard, surf, or jump waves. The safe areas (i.e. away from rip currents and on sandbanks) have been highly emphasised in this pilot, encouraging people to make safe decisions about where to enter the water, which are key to avoiding being caught in a rip current.

Another issue comes from the definitions of the rip current channels, where placing inside the blue areas indicates correct rip current and incorrect safe area (Figure 6.5). This right/wrong, definition gives no weighting to those who were close, or those who are not confident in expertly identifying a rip channel. Some participants may not have sufficient confidence in identifying a rip current properly as a result of the talk. This can be addressed through a more effective teaching method for identifying rip currents, and can be rectified.

6.4.4 At risk water users

Year round water use is more dominant in those who had been caught in a rip current compared to those who have not been caught. This reiterates findings from Chapters 4 and 5 that those who go in the water all year round, because of their frequency of activity and exposure to the rip current hazard, are more likely to be caught in a rip current. These people are also most at risk due to no lifeguard cover on UK beaches in the winter months, reducing the chances of rescue, and risk can be exacerbated by colder water and air temperatures.

Significant differences were found between the different school groups, water use, and ability of activities. Despite groups being located in coastal areas, where the distance to the nearest rip current dominant beach is less than 13km, most participants mainly use the water in the summer months. It was found, however, that participants from Truro School in Cornwall, furthest from a rip dominated beach (Table 6.1), mainly go in the water throughout the entire year. This is a fee-paying independent school which has weekly surf and swimming clubs available to its students. The school has a responsibility to provide pupils with safety cover at the beach, and also advice if they are to use the water outside of supervised hours, thus increasing their experience and knowledge.

This highlights two things: firstly, education of year round water users is a priority in the absence of lifeguard services. Secondly, access to the coast, equipment, and lessons can be more available to people with access to transportation, money, and support from parents and organisations that they belong to such as their school. For some participants who may come from a lower socio-economic background or area, going to the beach may not be a frequent trip, even for those who live close to the coast.

Education of beach safety, therefore, should be available in areas where year-round water use is dominant. Additionally, at risk teenagers within their schools and community groups, specifically those with greater access to watersports, should also be targeted. Both Moran (2009) and Wakefield *et al.* (2010) argue that the strong social interactions and developing personalities of adolescent audiences can influence peers at both personal and community levels. It is important, therefore, that despite the irregularity of water use, groups within this at risk demographic still need to have the same information.

6.5 Conclusions

A rip current education scheme was piloted among 185 teenagers in five secondary schools and community groups in a coastal environment. Understanding of what rip currents are, how they work, how to identify them, and the best methods of escape were presented, as well as key messages to equip participants with the safest way to enjoy the beach. The intervention showed success by increasing baseline levels of rip current awareness and knowledge. Retention was held for one month after the programme, and after three months a reduction of knowledge from the post-talk levels began to emerge, emphasising a positive change for a short-term awareness campaign.

The main findings from this chapter are:

- There was a significant improvement ($Z=-11.322$, $p<0.0005$) in levels of rip current knowledge following the delivery of the education pilot. Mean ratings were measured from 1-5, where a 1.70 change in the mean from 2.35 pre-talk to 4.05 post-talk was recorded. Participants self-rated their knowledge, where most rated themselves as 'poor' (n=71, 38%) before the pilot increasing to 'good' (n=130, 71%) after, a positive change of 58%.

- Correct answers on the post pilot questionnaire increased as participants were able to state that a rip current was a ‘body of water flowing out to sea’ (n=164, 90%), a positive increase of 56%, and that a rip current ‘dragged you out to sea’ (n=168, 92%), a positive increase of 29%.
- Participants were more capable of identifying a rip current after the pilot. Identifying features of a rip current were presented where correct answers increased from 168 (67%) responses before to 651 (98%) after, an increase of 483 (+31%). Most participants identified a rip by a darker patch of water (n=161, 87%) and an area of no breaking waves (n=142, 77%).
- When identifying rip currents manually on a photograph, the majority were able to mark safe areas more than rip currents both before and after the talk. Correct answers for safe areas improved from 77% (n=212) to 94% (n=421), a change of +17%, and correct answers for rip currents from 31% (n=83) to 81% (n=341), a change of +50%.
- The retention of information remained after one month, where 98% of respondents correctly stated that a rip current ‘flows out to sea’, with a 2% negative decrease to 96% of respondents after three months. This highlights that retention was still high after one month, but at the three month stage knowledge began to reduce among the participants. This pilot can provide a short term awareness of rip currents, and it is recommended that it be implemented to teenagers 1-2 months before peak holiday periods to ensure this information is still memorable.

Some improvements might make the study a more robust intervention, such as alternative delivery methods and educational theories that might further retain rip current knowledge and awareness over a longer period of time. As a trial for this particular audience and as a small-scale, short-term awareness scheme, however, it can be concluded that the effects were successful. The scheme can be quickly implemented by beach safety practitioners in target areas, and even adopted by teachers in schools. The format is simple, easy to learn, and easily implemented, and can be distributed to make an impressionable contribution.

This thesis has found rip current knowledge in the UK to be poor and education is needed. This study has shown that this novel form of rip current education is successful, and added further research to a field where rip current education is decidedly limited. This chapter has fulfilled its aims of evaluating the rip current education pilot study, measuring knowledge over time, and assessing the feasibility for the future implementation of this scheme. Drawing

on findings from the previous chapters, this final data chapter has completed the final aim of the thesis. A closing discussion is given in the next chapter to synthesis these results.

Chapter 7

Synthesis and Conclusions

7.1 Introduction

The aim of this chapter is to synthesise how the main findings have related to the research questions of the thesis. It will also highlight some of the implications and applications of this research. The progression of the thesis can be seen in Figure 7.1.

This thesis seeks to investigate the societal aspects relating to rip currents in the UK resulting in the identification and profiling of beach users and rip current ‘victims’ to whom an education scheme may be targeted. Through the analysis of lifeguard incident data and public questionnaires, this thesis has explored the relationships between the physical rip current process, hazard, and people. A number of important new findings have been identified through a logical and incremental progression of research that represents insights into human interaction with rip currents within the UK. There has been no prior understanding of who is effected by rips in the UK, how much the public know, what people have experienced, and how best to educate. These interrelated themes may be best connected through discussion of why people become caught in rip currents.

7.2 Why are people caught in rip currents in the UK?

A fundamental step in incident prevention (and therefore the delivery of an appropriate education scheme) is an understanding of *why* people are caught in rip currents in the UK. This understanding has been enhanced by the analysis undertaken in this thesis as we now know who is caught, where, when, and how. How beach users interpret the environment, and the risks within it has been an additional element into resolving this crucial question. There are several interconnecting factors why people are caught in rip currents, indicated in Figure 7.2 and discussed within sections 7.2.1 to 7.2.4.

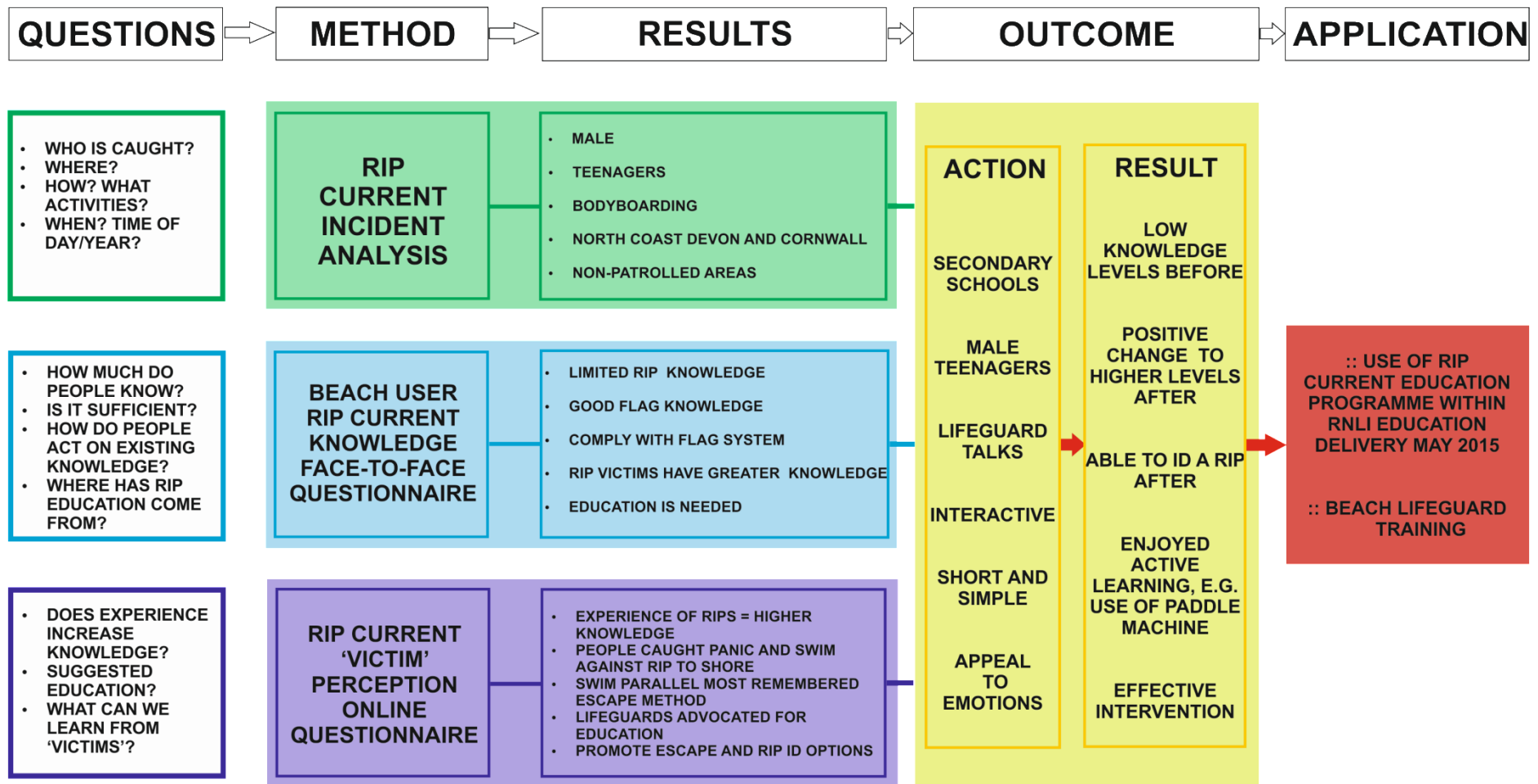


Figure 7.1 – Flow diagram showing each major topic of inquiry throughout the thesis. The green represents Chapter 3, the blue Chapter 4, and the purple Chapter 5. These three chapters guided the procedure for Chapter 6 depicted in yellow. The last column in red outlines the implications of the thesis.

7.2.1 Physical Environment

Environmental conditions and beach types provide the physical reason why people are caught (Figure 7.2), and, as highlighted in Chapter 3, the UK possesses a dynamic coastal setting for the formation of rip currents (Scott *et al.*, 2011a). Comparisons with extensive physical research studies in the US and Australia have identified that morphodynamics in these countries also play a large roll in rip current incidents (Short and Hogan, 1994; Brander, 1999; MacMahan *et al.*, 2009).

The rip current hazard is especially prevalent in the UK due to its macrotidal and geological setting. As the tide rapidly moves the surf zone over the beach, depths change quickly, especially during spring tides where the rising tide can rise by approximately 1m per hour. Water users, therefore, can rapidly become out of their depths and are susceptible to current flows. Additionally, the beaches on the north coast of Devon and Cornwall develop low-tide bar-rip classifications (Masselink and Short, 2003) during the small summer wave conditions. These beaches are popular tourist locations, and when the population is combined with this morphology, people are exposed to strong rip currents especially around low tide. The spring tides in Southwest England occur around the middle of the day, when beach and water populations are at their highest. This makes the early afternoons as the tide starts to flood, particularly hazardous.

The headlands, rocky outcrops, and coastal structures around the UK coastline, combined with swell and wind waves, create topographic rip currents. These rip currents have different characteristics to beach rips, such as becoming active during periods of high angle wave approach and larger swells, and can be just as dangerous as they can often reach faster speeds. The coastal environment of the UK, therefore, provides a variety of rip current types providing further evidence as to why people are caught.

The physical environment also provides a place of recreation for a variety of watersports. These activities such as surfing or bodyboarding rely on waves to enhance the experience. These wave dominated environments are mainly found in the Southwest of the UK, where rip currents are prevalent. The type of activity undertaken also influences the frequency of water use. Surfers tend to enter the water all year round, whereas those swimming or bodyboarding will do so in the warmer months, or when on holiday. Surfing year round in the UK exposes people more frequently to topographic rip currents, and this is a direct influence on why people are caught in rips.

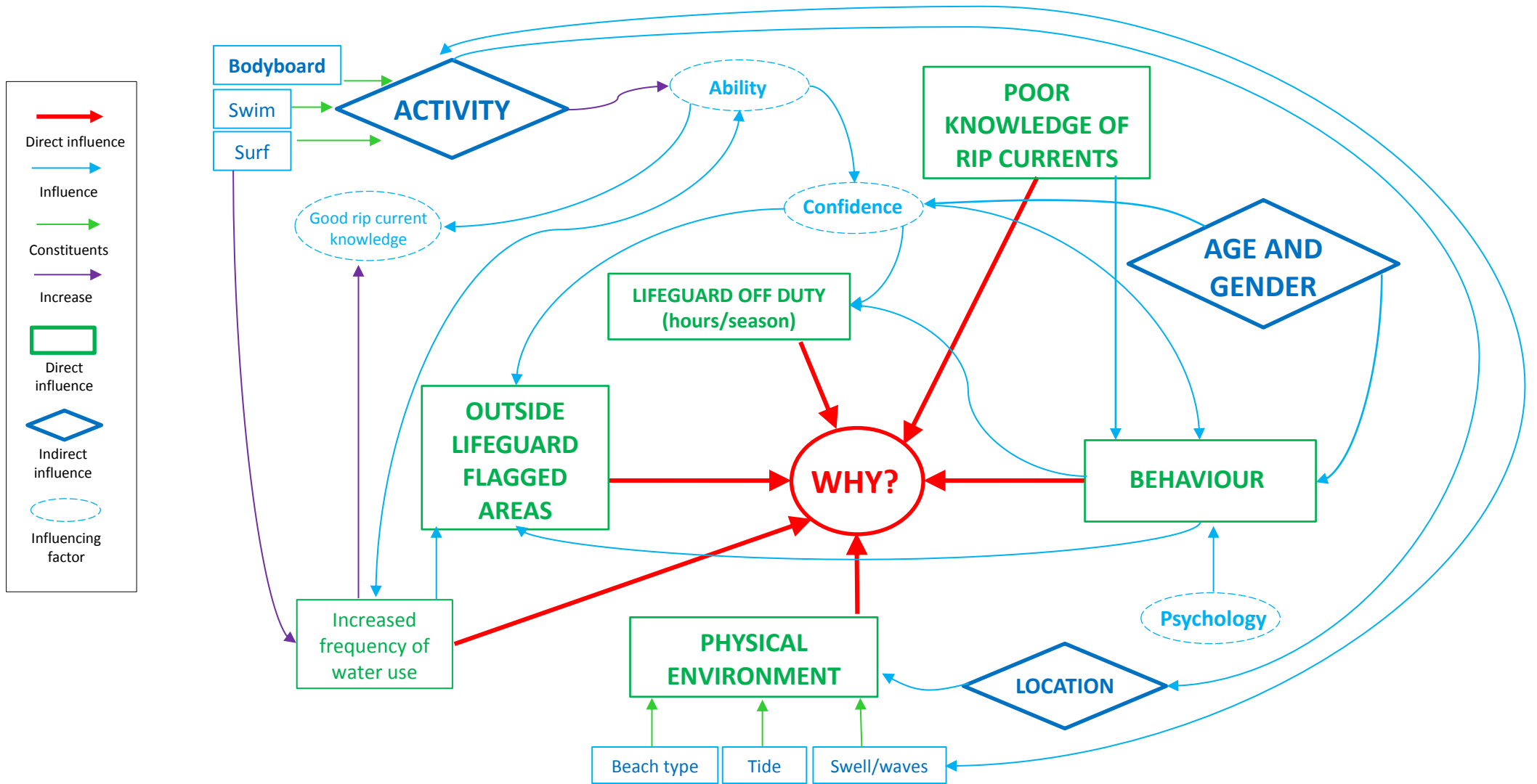


Figure 7.2 – Diagram showing the relationships between the central question of ‘why’ people are caught in rip currents in the UK and the main findings of this thesis. The green boxes show the direct influences of why people are caught in rips, and consistent themes throughout the thesis. Blue diamond’s show indirect influences and main themes of the thesis. Blue arrows show the influence between boxes – e.g. behaviour influences where people enter the water.

7.2.2 Rip current understanding and knowledge

Another argument in answer to ‘why’ people are caught is, perhaps, because the UK public knowledge of rip currents is poor (Figure 7.2). Through the use of face-to-face questionnaires, Chapter 4 identified people visiting popular surf beaches in the UK as either unaware of the rip current hazard, or lack satisfactory knowledge on the topic. This highlights a real need to raise awareness and educate people about rip currents in the UK. Together with further insights from people caught in a rip current in Chapter 5, we are able to provide an holistic view of the nations’ rip current understanding. Those who have been caught in a rip current and are more frequently exposed to rips, i.e. year round water users, have a greater knowledge of rip currents. It has been suggested that experience of a rip current provides people with the greatest knowledge of the hazard (Drozdowski *et al.*, 2012) and that being able to spot a rip current enables people to avoid entering one (Sherker *et al.*, 2010). The next best thing to experience, however, is to educate people on how to spot one, what to expect when caught and what the encounter would feel like. The work in this thesis provides a baseline from which to raise awareness and work on further relevant education efforts in the future.

It is said that awareness and knowledge of a topic is the first step to behaviour change (Ajzen, 1991). This will not always specifically change the behaviour, however, as people can be aware of, or have knowledge of something, they still may not take the steps to avoid the risk. This thesis hasn’t tried to change behaviours; the education pilot aimed to raise awareness and increase knowledge, with the expectation that *if* people are caught in a rip current, they might remember something that will help them to escape or be rescued.

7.2.3 Behaviour

Behaviour is another possibility why people are caught in rip currents, and closely related to this is psychology (Figure 7.2). Understanding the psychological processes leading to being caught is important because it can help us to understand how people relate to rips, and how they react when in a rip current. Psychology dictates human action, and when faced with a threatening, unfamiliar, or uncomfortable situation, can reduce a person’s consciousness to basic primal instinct (Gray, 1998). Chapter 5 revealed that despite having some indication of what to do if they were caught in a rip current, people panicked and swam directly to shore. Unfortunately, this underlying reality cannot always be overcome, and often worsens the

situation. With more experience and exposure to the hazard, in addition to access of further educational resources, people will potentially be able to trigger the correct response when confronted with a rip current situation.

Gender has been a major reoccurring theme throughout this thesis, and has an indirect influence on why people are caught in rip currents. Males have been overrepresented in Chapters 3, 4, and 5, and are continually quoted as being most at risk in aquatic recreation, due to their overestimation of abilities and underestimation of the risks (Moran, 2006; Morgan *et al.*, 2009). The findings of this thesis have shown that behaviour is influenced by gender, and if behaviour is ever to be changed, raising awareness and understanding of rip currents within this demographic is important. Male teenagers were therefore targeted for the education pilot in Chapter 6, to give them knowledge to alter their behaviour, e.g. go between the flags, or to know what to do if caught in a rip current.

7.2.4 Safety flags and lifeguard supervision

Chapters 3, 4, and 5 discovered that people caught in rip currents are mainly outside of lifeguard patrolled areas, or at unpatrolled beaches. This emphasises how effective and necessary lifeguard patrols are on UK beaches, and also highlights the risk of entering the sea without lifeguard supervision. Why people choose to enter the water away from the flags or on non-patrolled beaches is a matter of behaviour (Figure 7.2). Several studies have addressed the risks of entering the water outside patrolled areas (Sherker *et al.*, 2006; McCool *et al.*, 2008), and the findings from Chapters 3 (4302 people) and 5 (308 people) can confirm that entering the water outside the flags or on a non-lifeguarded beach is a major factor in why people are caught in rip currents. This again reiterates the importance of not only rip education, but also the need to continually promote the meaning of and reason for beach safety flags to the public.

Of course people cannot be forced to remain between the flags, but understanding can be increased in order that informed decisions can be made about where they enter the sea. Some people will enter the water regardless of warning signs or lifeguard patrols, so it is therefore important to give them the skills and knowledge to make safe decisions, know what to expect if caught in a rip current, and remove themselves from difficulty and safely back to shore if necessary.

Results from Chapter 3 showed that 7909 people were rescued from rips over an eight year period (2006-2013), acknowledging the work of the lifeguards around the UK coastline.

There were no fatalities from rip currents within lifeguard hours during this period. There is an argument therefore, that the lifeguards are successful in rescuing people and appear to be in control of the risk of rip currents. As previously stated, risks are difficult to wholly eradicate, despite a highly effective lifeguard service.

The point at issue is about those who use the water out of hours and throughout the year when lifeguards are not operational. In 2013, 22 people drowned (not all in rip currents) while swimming or surfing around the UK coastline outside of lifeguarded hours. Towards the end of this study in October 2014, three people tragically drowned in a rip current on a non-lifeguarded beach, and in 2013 a mother drowned in a rip current going to the rescue of her sons the day after lifeguard cover had finished for the season. This study has shown in Chapters 4, 5, and 6, that people participate in several water based activities year round, particularly surfing, and do not have the backup of lifeguard cover during winter months. No matter how frequently people enter the water at beaches, their level of rip current knowledge, and how experienced they are in the sea, the rip current hazard is always present and should never be underestimated.

7.3 How effective is rip current education?

To date there has been one rip current specific educational intervention scheme in Australia, where a passive print based campaign using posters, postcards and brochures, aimed to improve generic beach users ability to recognise the calm looking areas of a rip current (Hatfield *et al.*, 2012). It was concluded that the scheme was effective and that rip current education can improve awareness and identification of rips. The education scheme developed in Chapter 6 as part of this thesis, therefore, provides an entirely new concept to rip current research in the UK, and provides an additional method for rip current education worldwide.

This new education scheme specifically focussed on targeting teenagers, an audience identified from Chapter 3 as being the most at risk from rip currents, in three schools and two community groups. The programme used a lifeguard to deliver a variety of interactive methods: videos, photographs, news reports, and a swimming machine. The programme explained what rip currents are, what they do and why they can be hazardous, how to identify a rip, what to expect if caught, and how to survive. The short term effects were positive, showing statistically significant ($p=0.0005$) improvements in mean knowledge levels from

2.34 to 4.05. The scheme proved to be a successful intervention for raising awareness and understanding of rip currents, and extends the study of Hatfield *et al.* (2012) adding another effective rip current education method that can be applied globally.

Since the completion of the pilot, the RNLI has adopted the programme to be implemented before the main beach season begins. As a trial within their new community drowning prevention strategy, the scheme will be delivered by lifeguards to schools and community groups, simultaneously with beach safety messages in surf schools and holiday parks. The trial is being run from April/May 2015 in North Devon, which has two beaches (Croyde and Woolacombe) with the highest rip current incidents in the country.

It was clear from the work undertaken in Chapter 6, that the attention of teenagers is difficult to capture and that passive methods of delivery to this group are not ideal. Further enhancements can be made to the programme to ensure effective dissemination of rip current safety. The programme could involve more interaction between students with small group work or games to further their understanding. In this respect, the identification of rip currents presented in pictures may need to be more challenging, especially with older students. There is also scope for this programme to be delivered to adult audiences with little adjustment.

7.4 What more needs to be done?

Bodyboarding was highlighted in Chapter 3 to account for half of all RNLI rip current rescues. It might therefore be beneficial to focus additional investigations on increasing the understanding of why bodyboarders are most involved, and to develop specific educational resources in order to address this statistic. As a popular coastal activity where equipment is cheap, readily available and needing no prior experience, the susceptibility to currents and chance of incident is high. Whether bodyboarders are caught more due to inexperience, or because the buoyancy of boards allows water users to float within a rip system, or whether there is a behavioural or psychological factor could be explored in more detail in a further study.

Future rip current campaigns could be run by the RNLI and beach safety organisations working closely with manufacturers and suppliers to provide rip current information and useful instruction regarding proper use of equipment. Messages promoting best practice such as wearing the leash, staying with the board, floating and signalling for help, should be distributed, together with advice relating to remaining in contact with the seabed as much as

possible to prevent becoming swept into a rip system. Advice on how to escape the rip current in addition to promoting entering the water between the flags should be paramount. This information and advice should be encouraged at point of sale or rental, and appropriately packaged leaflets, stickers, or pre-printed safety stamps on the bodyboards should be introduced. In addition, surf schools, holiday companies, and local media should also be encouraged to promote safety messages to all beach users.

The work in Chapter 3 provided a breakdown of rip current incidents which is important and useful to lifeguards because it can aid surveillance of target risk groups such as males, teenagers and bodyboarders. Anecdotally, experienced lifeguards may already have some awareness of these groups, but increasing knowledge could still provide a useful training tool for new or less experienced lifeguards.

In addition, lifeguards have been identified in Chapters 4 and 5 as providing the best source of rip current information and education. Questionnaire respondents fully advocate the use of lifeguards for rip current education. Future education should incorporate operational lifeguards both in pre-season preparation and on the beach during heightened periods of rip current risk. It has been proven by Klein *et al.* (2003) that incidents may be reduced significantly by lifeguards adopting increased pro-active and preventative measures. In addition, lifeguards may require further training with regard to educating and presenting information in order to effectively engage with the public.

7.5 Is there a solution to reducing rip current incidents?

This thesis has not answered all the questions relating to rip current incidents, nor provided a definite solution to reducing incidents. By undertaking a detailed investigation, however, it has advanced our understanding of the rip current hazard in the UK. Through the analysis of rip current incidents, interaction with beach users to discover their rip current understanding, and examination of people's rip current experiences, a new rip current education scheme has been created. This successful evidence-based intervention provides the UK with a new approach to reducing rip current incidents through education, and can potentially be applied globally to combat the high number of rip current incidents worldwide.

7.6 Evaluation of research design and methods

The methodological approach taken was effective, as the mixed methods approach enabled the collection and analysis of a number of datasets, producing comprehensive results from which detailed conclusions were able to be drawn. Additionally, the mixed methods provided a detailed understanding of the topic in question, where the qualitative data provided richness to the quantitative results, particularly when investigating rip current ‘victims’ in Chapter 5.

The comprehensive incident dataset from the RNLI provided a valuable insight into rip current incidents, and aided the direction of subsequent methods by highlighting at risk areas and target audiences for education. Scott *et al.* (2009a) analysed the water population in relation to rip current hazard, but a shortcoming of the dataset is that the water population does not measure the demographics of recorded water users. A similar study to Morgan *et al.* (2009) would be valuable in the UK to irrevocably measure the age, gender, and activity duration of water users, as we can currently only rely on anecdotal evidence.

The face-to-face questionnaires enabled direct contact with participants, allowing a deeper understanding of their attitudes. These surveys were undertaken in areas of highest rip current incidents, but it would be of value to conduct the questionnaires in other areas of the country where rip currents occur and water use is high (areas outlined from the findings of this thesis in Chapters 3 and 5). Similar results would indicate the same educational methods and safety messages could be deployed nationwide, and conversely, different results might indicate the need for education to be tailored regionally. The aim of assessing beach users rip current knowledge used descriptions ranked on a scale. The survey did not include pictures for identification, a method used by others (Sherker *et al.*, 2010; Caldwell *et al.*, 2013), which may have provided further insight into beach users rip awareness. The detail gained from the rip current description was valuable, however, and the survey allowed a broad examination of behaviour, attitudes and awareness of beach safety issues.

The online questionnaires expanded on the incident analysis from Chapter 3 as incidents on non-lifeguarded beaches or out of hours were unable to be recorded. Although the open ended responses from the online survey were individually detailed and valuable, the use of follow-up interviews could have provided even further depth to their experiences. Interviews in general can provide a profound interpretation of people within certain environments. Had the online questionnaire not been successful at achieving the aim of understanding of experiences to inform the education pilot, the follow up interview would have been employed.

The education pilot allowed a new method to be tested, and although successful, there are several ways to improve it such as dispersed delivery, evaluation through focus groups, and specific educational learning methods. The pilot aimed to be a short-term technique to be used by the RNLI in the immediate run-up to the summer season, so needed to be informative, concise, and with minimal disruption to the schools where time is valuable. The research in this thesis informed this programme, and due to the depth of research, there is potential for the scheme to go into more detail over a longer period of time.

This thesis was an exploration of the social aspects of rip currents in the UK, and touched on behavioural concepts. The field of behavioural psychology is well developed, and has been employed in studies related to the aquatic environment. For example, Ajzen's (1991) Theory of Planned Behaviour (TPB) has been applied to studies into swimming intentions at beaches (White and Hyde, 2010), and Rogers' (1975) Protection Motivation Theory (PMT) has been utilised to understand the cognitive drivers of safe swimming behaviour (McCool *et al.*, 2009). TPB was discussed on occasion within this thesis because it was deemed important to grasp why people behave in certain ways at the beach, and through influences on attitudes can lead to behaviour change. Additionally PMT was discussed in relation to 'fear arousing communication', and alongside an appreciation of TPB, assisted in the development of the education pilot. The questionnaires in this thesis specifically aimed to investigate rip current knowledge and experience, but outlined beach selection and activity location. There is an opportunity for future studies to advance these findings to specifically look at the intentions of beach users in relation to entering the water between the flags, going to an unpatrolled beach or entering the water year round, using the TPB or PMT. This would allow a greater understanding of behaviours at the beach, and provide further research to improve beach safety education.

The new scientific knowledge generated from this thesis can be transferred to the RNLI and other beach safety practitioners in areas such as education, lifeguard training and general understanding of at risk water users. Additionally, social researchers of rip currents may find this novel UK research supplements this expanding field, and broadens our worldwide understanding to be used within other cultural contexts. Within this thesis, comparisons and contrasts have been made to similar studies set within different environments, and equally this study can encourage and inform others. It was highlighted in Chapter 5 that there may be scope for a separate psychological study into the reactions of people when they are caught in rip currents. Understanding the reactions of rip current victims would assist lifeguard surveillance, where the signs of panic can prompt faster rescue. In addition, the knowledge of

deeper psychological factors could assist in educational messages and advice. Additionally, the development of an awareness campaign for bodyboard users has been highlighted as further development from this work.

7.7 Conclusions

Rip currents represent the greatest cause of lifeguard incidents in the UK. Studies of public awareness of rip currents and human behaviour surrounding the hazard have, in recent years, slowly increased, broadening our understanding of the issue. Rip current education, however, remains limited, and this thesis has presented a new method to educate target audiences on rip currents. This work has furthered our knowledge of the social and behavioural issues surrounding rip currents in the UK, adding to the worldwide understanding.

The following aims were identified in Section 1.2, and restated here for ease of reference:

1. Analyse the demographics of people caught in and rescued from rip currents on UK beaches through examination of RNLI lifeguard incidents. Determine where these incidents occur, and what activities people were undertaking at the time of rescue.
2. Evaluate the current level of awareness and understanding UK beach users have of rip currents and beach safety, through the design and implementation of face-to-face questionnaires.
3. Investigate the experiences of rip current ‘victims’ through the interpretation of their knowledge, attitudes, and physical reactions, determined using an online questionnaire.
4. Develop a pilot rip current education scheme through the synthesis of aims 1-3, and evaluate its design, delivery, and effectiveness.

These aims have been achieved through the data collected, processed, and analysed in Chapters 3-6. The following summarises the key findings in relation to the initial aims of the PhD:

7.7.1 Rip current incidents

Rip current incident data was analysed for the 2006-2013 operational lifeguard seasons. A total of 7909 rip current incidents were recorded, involving 16,777 individuals, which indicates an average of 63.5% of all individuals rescued by RNLI lifeguards over this period were attributable to rip currents. These incidents are significantly concentrated geographically; Southwest England, particularly Devon and Cornwall pose a substantial rip current risk (n=6911, 87%) to beach users, particularly the north coast of these counties (n=5991, 76%). Beach type, environmental conditions and visitor numbers all influence rip current incidents; intermediate Low-Tide Bar-Rip beach types, combined with busy summer populations pose the greatest rip current risk, and are coincidentally located within the southwest region of the UK.

The main demographic of people caught in rip currents are teenagers aged 13-17 years old (n=2906, 63%), with a higher ratio of males to females. The incident dataset is dominated by males; 67% (n=11,225) of all rip current incidents involved men of all ages. Over half (n=4302, 54%) of rip current rescues were undertaken in non-lifeguarded areas of the beach, away from the patrolled swimming or craft areas. This emphasises the importance of going in the water between the flags, and highlights that rip current risk is increased outside of the patrolled areas, thus providing a key result to inform education strategy.

The activity most associated with rip current incidents is bodyboarding (n= 4217, 50%). No prior studies have been carried out that considered the type of craft (if any) that rip incident victims were using at the time. This important finding provides the UK with a prime target audience for public education. Analysis of rip current incidents in the UK has identified who, where, when, and how people are caught in rip currents, and key target audiences and locations for rip current education measures. Additionally, this investigation is advantageous to the deployment of beach safety resources and lifeguard provisions.

7.7.2 Rip current awareness and knowledge

In order to assess the levels of rip current awareness of UK beach users, a questionnaire was undertaken by 407 (5% margin of error at 95% confidence) people during the summer of 2012 (male=198, female=208). The level of rip current knowledge of beach users is poor (n=263, 65%), with only one third (n=144, 35%) able to give a correct description of a rip

current. This poor level of rip current knowledge indicates the need to increase education on the topic.

Conversely, those surveyed have a greater knowledge of the beach safety flags with 96% (n=389) able to give a correct description of what the red and yellow flags indicate. Good knowledge of this topic accounted for 77% (n=314) of respondents. With a good understanding of the beach safety flags, the majority of beach users enter the water between the flags (n=339, 86%) and three quarters (n=309, 75%) have not been caught in a rip current. This demonstrates that entering the water between the flags reduces the risk of being caught in a rip current. Additionally, this emphasises the value of general beach safety and the importance of attending a lifeguard patrolled beach during operational months and hours.

Males (n= 69, 70%) were caught in rip currents more than females (n= 29, 30%). The high proportion of male ‘victims’ in this sample is representative of the UK rip current incidents analysed in Chapter 3 (males= 67%). This finding highlights gender differences in susceptibility to rip currents, that have been attributed to risk perception and ability, but requires further study to examine water user demographics, as males are known to venture further out to sea and spend more time in the water (Morgan *et al.*, 2009), as well as constructing risk differently from females (Moran, 2011).

Those who have been caught in a rip current (n=98, 24%) have a greater knowledge of rip currents (n=50, 51%) than those who have not been caught (n=93, 31%). This provides further evidence that experience of being caught in a rip current is the best way to demonstrate the hazard. Lifeguards have proven to be the most effective form of rip current education and a popular source for disseminating future education. Lifeguards should therefore be included in any rip current education schemes that are developed.

7.7.3 Rip current experience

An online questionnaire was undertaken by 553 people (5% margin of error at 95% confidence) who had been caught in a rip current to explore their experiences. Males (n=382, 69%) were caught in rip currents more than females (n=171, 31%), and teenagers represented the age group most caught. This demographic is again representative of the UK incident statistics presented in Chapter 3 (males= 67%), and presents a representative sample of the wider population. Respondents were mainly caught on beaches within the Southwest region of the UK (n= 70, 42%). Rip current activity has been dominant in the Southwest throughout

this thesis and these findings further verify this region as a target area for the future dissemination of rip current education.

Two thirds (n= 426, 77%) of respondents gave a correct description of a rip current. In comparison to knowledge levels of summer beach users in Chapter 4 (35% correct), the people who have been caught have a much higher knowledge, indicating that the experience of being caught in a rip current increases understanding. When caught in a rip current, most respondents panicked and swam straight to the shore against the rip current (n=108, 34%). This reaction indicates that despite an awareness of rip currents and escape methods, instinct takes over and actions follow a method that has been established as the most prone to drowning in rip currents. This is an important implication for drowning prevention strategies, specific rip current education, and lifeguard training.

Swimming out of the rip current parallel to the beach was the most remembered, advised, and promoted safety message, and a successful escape method for those who utilised it (n=277, 50%). Swimming parallel to the beach to escape a rip current should continue to be safety message promoted in the UK. Suggested safety messages advocated the promotion of knowing how to escape from a rip current (n= 120, 32%), staying calm and not panicking (n= 76, 21%), and identifying a rip current (n= 45, 13%). Additionally, lifeguards were the most popular source to disseminate these safety messages, specifically on beaches where rip currents are present, and in schools.

7.7.4 Rip current education

The final aim of this thesis was to undertake a rip current education pilot. The programme was delivered to 185 teenagers in three secondary schools and two community groups in the coastal environment of Plymouth and Cornwall. There was a significant improvement ($p=0.0005$) in levels of rip current knowledge following the delivery of the education pilot. Participants self-rated their knowledge, where most rated themselves as 'poor' (n=71, 38%) before the pilot showing a positive increase to 'good' (n=130, 71%) after the pilot; an improvement in mean knowledge levels from 2.34 to 4.05 on a scale from 1 (know nothing) to 5 (know everything).

Correct answers on the post pilot questionnaire increased as participants were able to state that a rip current was a 'body of water flowing out to sea' (n=164, 90%), a positive increase of 56%, and that a rip current 'dragged you out to sea' (n=168, 92%), a positive increase of

29%. Participants were more capable of identifying the features of a rip current after the pilot. Participants identified a rip by a darker patch of water (n=161, 87%) and an area of no breaking waves (n=142, 77%), and were able to correctly locate the safe areas to enter the water (94%).

The retention of information remained after one month, but at the three month stage a reduction in knowledge (2%) began to show among the participants. This pilot can provide effective short term awareness of rip currents, and it is recommended that it be implemented to teenagers 1-2 months before peak holiday periods to ensure this information is still memorable. Further enhancements can be made to the rip current education programme to ensure effective long-term dissemination of rip current safety. Alternative educational methods, such as using dispersed delivery, can aid effectiveness over longer timeframes, and the programme could involve more interaction between students with small group work or games to further their understanding. There is also scope for this programme to be delivered to adult audiences with little adjustment.

7.8 Summary conclusions

Using an 8-year UK database of 7909 incidents recorded by RNLI beach lifeguards, the demographic found to be most caught in rip currents was teenage males, and the activity predominantly undertaken by the rip victims was bodyboarding. Rip current incidents principally occurred on the Atlantic facing beaches of North Devon and North Cornwall in Southwest England that develop Low-Tide Bar-Rip morphologies. It was established through 407 face-to-face questionnaires, that rip current awareness and understanding among beach users was poor. Analysis of 553 online questionnaires revealed that the most common reaction when caught in a rip current is panic followed by swimming directly against the rip to shore. These rip current victims recommended that beach and rip current safety messages should include practical advice and be provided by lifeguards. Synthesising these findings, a novel rip education programme was developed and trialled with 185 teenagers in a classroom environment. The education programme used both practical and multimedia based interactive activities which were delivered by a professional lifeguard. The programme proved to be successful at increasing rip current knowledge levels which were retained for 3 months.

The findings of this thesis can assist beach safety practitioners to reduce rip current incidents and fatalities, and also provides the field of rip current research with new contributions to literature and knowledge.

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APPENDIX

Appendix 1 – Face-to-face questionnaire: beach safety and rip current understanding and knowledge (Chapter 4)

Section 1: Beach Background

1. Why are you visiting the beach today?

- a). On holiday
- b). Visiting friends/family
- c). Day trip from home/live here
- d). Best conditions for chosen activity
- e). Other (please state).....

2. What sea based activities do you like to do during WINTER months?

- a). Don't go in the sea
- b). Swimming
- c). Surfing
- d). Bodyboarding
- e). Kitesurfing
- f). Kayaking
- g). Canoeing
- h). Paddling
- i). Other (please state).....

3. What sea based activities do you like to do during SPRING months?

- a). Don't go in the sea
- b). Swimming
- c). Surfing
- d). Bodyboarding
- e). Kitesurfing
- f). Kayaking
- g). Canoeing
- h). Paddling
- i). Other (please state).....

4. What sea based activities do you like to do during SUMMER months?

- a). Don't go in the sea
- b). Swimming
- c). Surfing
- d). Bodyboarding
- e). Kitesurfing
- f). Kayaking
- g). Canoeing
- h). Paddling
- i). Other (please state).....

5. What sea based activities do you like to do during AUTUMN months?

- a). Don't go in the sea
- b). Swimming
- c). Surfing
- d). Bodyboarding
- e). Kitesurfing
- f). Kayaking
- g). Canoeing
- h). Paddling

i). Other (please state).....

6. Did you buy or hire your equipment?

- a). Bought
- b). Hired
- c). No equipment (go to Q4)

Where from?

- a). Surf shop
- b). Supermarket
- c). Local beach goods store
- d). Surf school
- e). Online (state which website).....
- f). Other (please state).....

7. What influences your choice of beach? Give 3 primary reasons:

- 1.
- 2.
- 3.

8. Do you always go to a lifeguarded beach?

- a) Yes
- b) No

9. What are your reasons for this?

.....

Section 2: Beach Safety Knowledge

10. Do you know what the red and yellow flags mean on the beach?

.....

11. Do you know what the black and white chequered flags mean on the beach?

.....

12. Do you know what the red flag mean on the beach?

.....

13. Do you know why lifeguards place the flags in positions they put them?

.....

14. Do you stick to the designated flagged zones on the beach when you go in the sea at a lifeguarded beach?

- a). Yes
- b). No
- c). Sometimes
- d). I don't go in the water
- e). Other (*please explain*).....

15. What are the reasons for your choice?

.....

Section 3: Rip Current Knowledge

16. Do you know what a rip current is? (If don't know – go to Q18)

.....

17. Where did you gain your understanding of rip currents from?

.....

18. Have you ever been caught in a rip current?

- a). Yes (go to section 4)
- b). No (go to section 5)
- c). don't know (go to section 5)

Section 4: Rip Current Experience

19. What beach did you get caught in a rip current?

.....

20. What activity were you doing when you got caught in the rip?

.....

21. Do you remember when you were caught in the rip?

- a) What age were you.....
- b) What time of year was it.....

22. How did you get out of the rip current?

- a). Coped myself – swam parallel to the beach
- b). Coped myself – went with the flow
- c). Rescued by lifeguard
- d). Rescued by someone else
- e). Other (Please state).....

23. Did you signal to anyone?

- a). Yes – to a lifeguard
- b). Yes – to someone else
- c). Yes – to anyone
- d). No – please explain why not.....

Section 5: Rip Current Education

24. Have you received any rip current education?

- a) Yes
- b) No (Go to Q25)

24a) If yes, what.....

24b) If yes, from whom.....

24c) what did you find most useful?

24d) what did you find least useful?

25. What do you think is the best method to tell people about rip currents and why?

.....

26. What form of rip current information delivery would *you* be most receptive to?

- a). TV
- b). Radio
- c). Internet
- d). Face to face from lifeguards/RNLI
- e). Information booklets/leaflets
- f). Roadshows/demonstrations/beach talks
- g). Signage
- h). Smartphone App
- h). Other (*please state*).....

Section 6: Demographics

Gender: Male Female

Age:

Postcode:

Appendix 2 – Online questionnaire: Understanding and perceptions of rip currents of people who have been caught in a rip current (Chapter 5)

Demographic information

1. What is your gender?

- Male
- Female

2. What age bracket are you in?

- 0-13 years
- 14-17 years
- 18-30 years
- 31-59 years
- 60+ years

3. What is your country of birth?

- England
- Wales
- Scotland
- Northern Ireland
- Other (Please specify)

4. What is your postcode?

Postal Code:

Swimming experience and competency

5. How often do you swim or undertake water based activities (e.g. surfing, body boarding etc) at the beach during the summer?

- Everyday
- Several days a week
- Several days a month
- Once a month
- Several days a year
- Never

6. How often do you swim or undertake water based activities at the beach outside of the summer?

- Everyday
- Several days a week
- Several days a month
- Once a month
- Several days a year
- Never

7. On a scale from one to five (5 being highly competent and 1 being unable to swim) How would you rate your swimming ability in the sea?

- Unable to swim (1)
- Learning to swim (2)
- Able to swim (3)
- Competent swimmer (4)
- Highly competent swimmer (5)

8. Have you had swimming lessons or swimming training (even as a child)?

- Yes, in a pool
- Yes, in the sea
- Yes, in a pool and the sea
- No

Rip current knowledge

9. Can you describe what a rip current is?

10. Can you visually identify a rip current? If Yes what visual characteristics does a rip current have?

- Yes
- No

If Yes, please give details...

11. Do you know what to do when caught in a rip current? If yes, please explain.

- Yes
- No

If yes, please explain...

12. Do you recall reading/hearing any information about rip current safety from: (tick all that apply)

- RNLI leaflets

- RNLI Education programme
- Face-to-Face from lifeguards
- Lifesaving club
- Media (TV/Radio/Print)TV
- School
- Signage at the beach
- Internet
- Parents
- Other (please specify)...

Rip current experience

13. Do you know of anybody that has been caught in a rip current?

- Yes
- No

14. Have you been caught in a rip current?

- Yes
- No

15. When were you caught in a rip current?

16. Which beach did you get caught in a rip current?

17. Were you at a lifeguard patrolled beach?

- Yes
- No

18. Were you between the red and yellow flags?

- Yes
- No

19. Why did you choose to swim or undertake a water based activity in that location on the beach?

20. Think back to when you first realised you were caught in the rip current, describe how it felt physically?

21. Can you describe your immediate response to being caught in the rip current?

22. When you were caught in the rip current did you remember any specific beach safety messages or advice?

- Yes, please specify...
- No

23. Did you raise your arm and signal for a lifeguard?

- Yes
- No

24. Can you please describe how you got out of the rip current?

25. In retrospect would you react differently if you were caught in a rip current again?

- Yes, please specify....
- No

26. From your experience, what type of safety message, education or training do you think would best equip someone with the knowledge and skills to get out of a rip current?

27. Did your experience put you off going swimming or engaging in water based activities in the ocean?

- Yes
- No

28. Got more to say? If you would like to share more about your experience with rip currents, please provide contact details.

Name.....

Email address.....

Telephone number.....

Appendix 3 – Rip current education pilot: Pre-talk questionnaire

1. How often do you go in the sea? (Tick one)

- All year round
- Spring to Autumn months (April-November)
- Spring and Summer months (May-September)
- Summer months only (June-September)
- Never
- Other.....

2. How good are you at the following activities?

	Very poor	Poor	Average	Good	Very good
Swimming	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Bodyboarding	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Surfing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3. How much do you know about rip currents?

	Nothing	Not much	Some	A fair bit	Everything
Knowledge	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4. What is a rip current? (Tick one)

- A whirlpool
- A body of water flowing out to sea
- A sideways sweeping current
- A big breaking wave
- An undertow
- I don't know

5. What does a rip current do? (Tick one)

- Pulls you under the water
- Drags you out to sea
- Sweeps sideways across the beach
- Goes in and out like the tide

I don't know

6. What does a rip current look like? (Tick as many as you like)

- | | |
|--|---|
| <input type="checkbox"/> There is churned up sediment and sand | <input type="checkbox"/> A patch of shallow water |
| <input type="checkbox"/> An area of water with no breaking waves | <input type="checkbox"/> Have floating debris in it |
| <input type="checkbox"/> Invisible | <input type="checkbox"/> It's all foamy/frothy |
| <input type="checkbox"/> A darker patch of water | <input type="checkbox"/> Choppy/rippled surface |
| <input type="checkbox"/> A vortex | <input type="checkbox"/> I don't know |

7. Put a TICK on the photograph where you think it's safe to swim/go in the water. And put a CROSS where you think there is a rip current.



8. Have you ever been caught in a rip current?

- Yes No Maybe

9. Gender

- Male Female

10. What is your date of birth? (e.g. 25/07/1985)

Day: Month: Year:

11. Please write your initials

Appendix 4 – Rip current education pilot: Post-talk questionnaire

1. How much do you know about rip currents?

Nothing Not much Some A fair bit Everything

Knowledge

2. What is a rip current? *(Tick one)*

A whirlpool

A body of water flowing out to sea

A sideways sweeping current

A big breaking wave

An undertow

I don't know

3. What does a rip current do? *(Tick one)*

Pulls you under the water

Drags you out to sea

Goes in and out like the tide

Sweeps sideways across the beach

I don't know

4. What does a rip current look like? *(Tick all that apply)*

There is churned up sediment and sand

An area of water with no breaking waves

Invisible

A darker patch of water

A vortex

A patch of shallow water

Have floating debris in it

It's all foamy/frothy

Choppy/rippled surface

I don't know

5. Put a TICK on the photograph where you think it's safe to swim/go in the water. And put a CROSS where you think there is a rip current



6. How much do you think you have learned about rip currents today?

	Nothing!	A tiny bit	Some stuff	A fair bit	A lot!
Learned	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7. What key messages about rip currents do you remember from today? (Tick as many as you like)

- | | |
|---|---|
| <input type="checkbox"/> Don't swim against the current | <input type="checkbox"/> Stay calm, don't panic |
| <input type="checkbox"/> They are safe to swim in | <input type="checkbox"/> Swim towards waves if caught |
| <input type="checkbox"/> Rips happen only at weekends | <input type="checkbox"/> Rips are gentle and calm |
| <input type="checkbox"/> White water is good, dark water is bad | <input type="checkbox"/> I don't know |

8. Rate how much you enjoyed or were interested by each aspect of the talk

	Totally asleep!	A bit bored	It was OK	Liked it	Loved it!
News clip video	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rip current basics video	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pictures of rip currents (pointing)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Paddle machine	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Word cloud	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

9. How frequently do you use the following social media

	Never	Not often	Sometimes	Often	All the time
Facebook	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Twitter	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Instagram	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
YouTube	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Flickr	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
MySpace	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (Please state)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

10. Gender

Male Female

11. What is your date of birth? Day:

Month:

Year:

12. What is your age today?

13: INITIAL

Appendix 5 – 1 and 3 month post talk questionnaires

1. What is a rip current? (Tick one)

- A whirlpool A body of water flowing out to sea
 A sideways sweeping current A big breaking wave
 An undertow I don't know

2. What does a rip current do? (Tick one)

- Pulls you under the water Drags you out to sea
 Goes in and out like the tide Sweeps sideways across the beach
 I don't know

3. What does a rip current look like? (Tick all that apply)

- There is churned up sand and sediment A patch of shallow water
 An area of water with no breaking waves There is floating debris in it
 Invisible There is foam or froth on the surface
 A darker patch of water There is a choppy/rippled surface
 A vortex I don't know

Remember! Question 4 – read carefully.
Ticks for SAFE. Crosses for RIP

4. Put a **CROSS** on the photograph where you think there is a **rip current**. Put a **TICK** on the photograph where you think it's **safe** to go in the water

X = RIP CURRENT
✓ = SAFE



5. How can you escape from a rip current? (Tick all that apply)

- Swim back against the current towards shore Float and ride the current out
 Swim parallel to the shore/towards waves Dive down underneath the water
 Raise an arm or shout for help I don't know

6. Gender

- Male Female

7. What is your date of birth?

Day: Month: Year:

8. What is your age today?

9. Please write your initials:

Appendix 6 – Abstract: 2nd International Rip Current Symposium, Sydney, Australia, 30th October – 1st November 2012

Rip Current Victim Demographics: Analysis of Lifeguard Incident Data in the UK

Eleanor Woodward (Plymouth University), Emily Beaumont (Plymouth University), Paul Russell (Plymouth University), Adam Wooler (RNLI)

This paper presents initial results from a PhD project; ‘Rip Current Safety- Changing Behaviours to Save Lives’, a collaboration between Plymouth University and the RNLI (Royal National Lifeboat Institution). Rip currents represent the greatest risk to bathers, being responsible for the majority of lifeguard rescues worldwide (MacMahan, Thornton & Reniers, 2006; Scott *et al.*, 2007; Fletemeyer and Leatherman, 2010). Physical rip current research is extensive (Short, 1985; Brander, 1999; MacMahan *et al.*, 2005; Austin *et al.*, 2010) yet Sherker *et al.* (2010) indicate the need for behavioural science research to fully understand the implications of rip currents for beach safety.

This PhD study consists of three phases of data collection. This paper focuses on stage one, which aims to identify key demographic characteristics of an ‘ideal typical’ rip victim (Weber, 1905) and the spatiotemporal variation in the UK. Analysis is based on RNLI rip current incident data from 2006-2011.

The quality of the RNLI incident data provides a unique insight into victim demographics. The quantitative nature of the dataset enabled the adoption of a statistical analytical approach. Data relating to area, activity, age, gender and physical environmental setting were extracted for analysis the demographics of rip current victims.

Demographic characteristics highlight the ‘ideal typical’ rip victim as adult males, aged 18-64. Risk theories support the link between males overestimating abilities and underestimating risk, with increased exposure and frequency to water based activities. The range of UK beach types and wave environment control the spatiotemporal distribution of victim demographics. Identification of the demographics of the ‘ideal typical’ rip victim will help inform population targeting for a proposed National Rip Education Scheme which is the outcome of this PhD. Understanding behaviour of this population addresses how, when and where to effectively communicate the Rip Education Scheme.

The RNLI is the UK’s leading beach safety authority with a history of collaborative research with Plymouth University enhancing their ability to save lives at sea. This research is the first step in a pioneering project that aims to establish the first National Rip Current Education Scheme in the UK.

Appendix 7 – Abstract: 12th International Coastal Symposium, Plymouth, UK, 8th-12th April 2013

Rip Current Incidents and Victim Demographics in the UK

Woodward, E.¹, Beaumont, E.¹, Russell, E.¹ and Wooler, A.²

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Rip Currents are a major physical hazard on beaches worldwide and are responsible for the greatest number of beach lifeguard rescues and hundreds of drownings annually. In the UK rip currents account for 71% of lifeguard incidents. Research from Plymouth University has found that beach morphologies, wave climate, and high visitor populations combine to make rip currents the number one hazard on UK beaches.

This study presents some preliminary findings from a joint research project between Plymouth University and the UK Royal National Lifeboat Institution (RNLI) titled 'Rip Current Safety – Changing Behaviours to Save Lives'.

RNLI beach lifeguards record all attended incidents throughout the operational months of April to October which are then collated at headquarters. Incident records for 2006-2011 were analysed to examine the hazard posed to water users by rip currents. The 5798 incidents pertaining to rip currents were solely examined to determine a rip current victim demographic. This took into account the age and gender of the victim, what activity they were undertaking, what beach they were at, which area of the beach they were caught in as well as physical factors such as state of tide, wave height, and wind conditions.

The 3 main findings show that rip victims are likely to be male teenagers bodyboarding on north Devon and Cornwall beaches. Teenage males (13-17 years) are involved in 17% of rip current incidents, that when normalised by years within the age group gives 41%. Bodyboarding is the activity most prone to rip current incidents in most areas with 3065 out of 5798 incidents or 52.8%. Popular macrotidal beaches on the North coast of Devon and Cornwall, exposed to the prevailing Atlantic swell, recorded the most incidents. For example, Croyde, Woolacombe and Perranporth accounted for 1473 incidents combined, 25% of the total.

This study identifies key target groups for the communication of rip current education as well as outlining the best locations to deliver key messages. In addition these findings will aid RNLI lifeguard operational management throughout the UK. This is the first study of its kind in the UK and will contribute to international rip current research through increased understanding of the social interactions with this beach hazard.

Appendix 8 – Abstract: World Conference on Drowning Prevention, Potsdam, Germany, 20-22nd October 2013

Rip Current Education: An evidence based approach to inform targeted prevention programmes

Eleanor Woodward, Prof Paul Russell, Dr. Emily Beaumont (Plymouth University), Ross Macleod (RNLI)

This work aims to provide the UK with its first rip current education programme through the use of comprehensive lifeguard incident reports and public questionnaires in order to reduce incidents and drowning on UK beaches. The wider project is a research collaboration between Plymouth University and the Royal National Lifeboat Institution (RNLI), and contributes to the increasing worldwide rip current research efforts.

It is widely reported that rip currents are a major cause of drowning worldwide (1), and that the majority of lifeguard rescues are from rip current related incidents (2). The problem is global and in recent years various research has been undertaken to increase understanding about the physical nature of rip currents (e.g. 1) with parallel research being undertaken in the emerging social and behavioural aspects surrounding rip currents (3).

UK beaches are popular leisure and tourist destinations and with the enhanced popularity of watersports and improved wetsuit technology, year round water use continues to rise. This has resulted in extended lifeguard coverage from peak holiday months to 7 months of the year. In the UK, two thirds of all lifeguard rescues are due to rip currents, highlighting the need for lifesaving services as well as public education to prevent fatalities and promote understanding of rip currents. Using nearly 6000 detailed RNLI lifeguard incident report forms for 2006-2011, thorough analysis was undertaken to determine certain locations most prone to rip currents, demographic profiles of those most frequently caught in rips, the activity being undertaken and environmental conditions most associated with rip currents.

The results from these incident reports outline the UK's key rip current demographic to be male teenagers (13-17 years). In addition, people bodyboarding and people in non-patrolled areas of the beach are at higher risk. The location of the majority of incidents is on Atlantic facing beaches of Devon and Cornwall in the Southwest of England mostly occurring in the peak holiday months of July and August (4).

In addition to lifeguard incident data the use of two other different types of survey were used to strengthen our research aim, increasing our resources to develop a clear rip current education campaign. Through the use of semi-structured face to face questionnaires on a mixture of popular resort and rural beaches with high rip current incidents, 408 beach visitors were interviewed, enabling further exploration of public awareness levels of rip currents. An online survey is underway focussing on assessing rip current survivors experience and responses, both physical and emotional, of being caught in a rip current. The surveys obtained 1205 responses in 2011 and 1250 in 2012 targeting key water users such as surfers and those water users inadvertently caught in rips.

The mix of quantitative and qualitative research approaches described above have been used with breakthroughs in the physical understanding of rip currents (5) to inform and develop an effective and targeted rip current education programme. Specifically, an awareness campaign has been developed to target key demographic groups, certain activities, and specific locations.

The RNLI continues to expand its lifeguard resources across the UK, building relationships with local communities and having a nationwide influence on drowning prevention. Applying both the RNLI and Plymouth University's extensive connections with international lifesaving organisations such as Surf Lifesaving Australia and worldwide academic institutions, the operation to inform specific beach user groups of the rip current hazard has begun with the hope of reducing incidents and saving lives.

Appendix 9 –

Woodward, E., Beaumont, E., Russell, P., Wooller, A. and Macleod, R. (2013) 'Analysis of Rip Current Incidents and Victim Demographics in the UK', in *12th International Coastal Symposium*. Journal of Coastal Research, Special Issue 65, pp. 850-855.

Appendix 10 –

Woodward, E., Beaumont, E., Russell, P.E., Macleod, R., (2015) Public understanding of rip currents and beach safety in the UK, *International Journal of Aquatic Research and Education*,9, pp.49-69.

Analysis of Rip Current Incidents and Victim Demographics in the UK

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ABSTRACT

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Rip currents are responsible for 67% of all individuals rescued by lifeguards on UK beaches, representing the greatest environmental risk to water users. There are currently no measures of human awareness of rip currents in the UK, and the worldwide research on human behavioural aspects surrounding rip currents is a small emerging research area. In the last few years the physical understanding of rip current behaviour has been much improved by studies using GPS floats. The aim of this study is to discover the key demographic characteristics of beach users caught in rip currents and the spatiotemporal variation in the UK by analysing the Royal National Lifeboat Institutions lifeguard rip current incident data for 2006 to 2011. The results show male teenagers (aged 13-17 years) are the most likely demographic to be involved in a rip incident., In addition, people bodyboarding, and people in non-patrolled areas of the beach are at higher risk. Rip incidents are most common on the popular Atlantic-facing beaches of north Devon and Cornwall where low-tide bar-rip morphology enhances rip current activity, presenting a major hazard to beach users. This study presents a significant insight into rip victim demographics, identifying key target audiences for future awareness campaigns and rip education schemes. It also provides a benchmark for further research into the investigation of why specific demographics are getting caught in rips by understanding the behaviour of these groups.

ADDITIONAL INDEX WORDS: *Beach Safety, Rip Current Awareness, Risk Perception, Public Education.*

INTRODUCTION

This study is a research collaboration between Plymouth University and the Royal National Lifeboat Institution (RNLI) and forms the first of three parts to a PhD project. The aim of this study was to discover the key demographic characteristics of people involved in rip current incidents, henceforth referred to as 'victims', and the spatiotemporal variation in the UK through analysis of the RNLI lifeguard incident data between 2006 and 2011. The outcomes of this first study will form the basis for the subsequent deliverables of the PhD, culminating in a new rip current education scheme for the UK. This scheme will attempt to convey up-to-date physical rip current science knowledge to the public in the most effective way to increase awareness and understanding of rip currents.

Rip Currents are strong narrow channels of water which can reach high velocities (MacMahon 2006) pulling the unwary sea user offshore and thus proving to be a hazardous nearshore occurrence (Lushine 1991; Short and Hogan 1994; Brander 1999). Rip currents represent the greatest risk to water users on beaches worldwide (Brander and MacMahon 2011) and are responsible for roughly two thirds of beach lifeguard incidents in the UK (Scott *et*

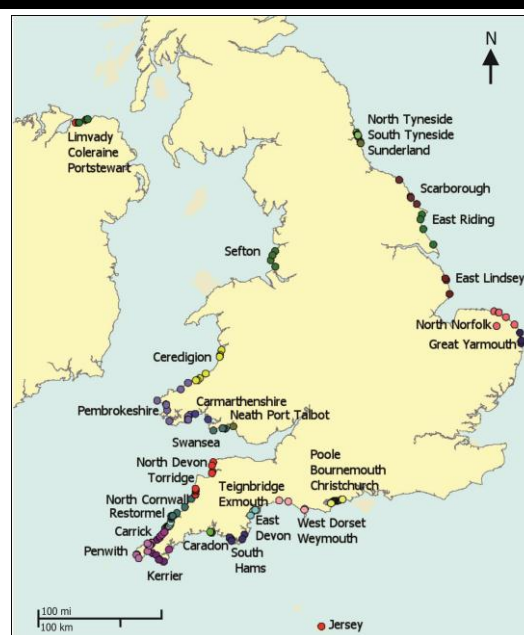


Figure 1. UK coverage of RNLI lifeguarded beaches 2011.

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Table 1. Overview of the number of rip current incidents responded to by RNLI lifeguards between 2006-2011.

Year	Number of lifeguard units	Number rip current incidents	Number of individuals rescued from rip currents	Overall % of individuals rescued from rip currents
2006	62	676	1352	59.9
2007	69	908	1989	76.0
2008	107	1007	2161	73.7
2009	141	1046	2638	70.5
2010	152	1077	2262	57.3
2011	163	1084	2205	62.1
Total	163	5798	12607	
Average		966.3	2101.2	66.6

al., 2007, 2008, 2009). The RNLI has managed the beach lifeguard service in the UK since 2001 and in 2011 it had 163 lifeguard units within 35 operational areas (Figure 1). The service aims to reach any beach casualty up to 300m from the shore within the patrol flags within 3½ minutes (RNLI, 2010).

The UK possesses a dynamic coastal setting presenting a variety of beach types, many of which demonstrate prime rip current forming environments (Austin *et al.*, 2010; Austin *et al.*, 2009; Scott *et al.*, 2011; Scott *et al.*, 2007). In particular the popular tourist beaches on the Atlantic coast of Devon and Cornwall typically exhibit a low-tide bar-rip classification according to Masselink and Short's (1993) beach classification model. These beaches receive an annual swell height of 2-3m and a mean spring tidal range of 4.2-8.6m (Scott *et al.*, 2011). The large tidal range allows a full range of water coverage from reflective upper beaches to the intermediate lower beach where exposed low tide bar and rip systems are often well developed (Austin *et al.*, 2010).

Knowledge of the human behavioural aspects surrounding rip currents is limited (Ballantyne *et al.*, 2005; Sherker *et al.*, 2008; Sherker *et al.*, 2010) and is focussed on locations such as Australia. Currently in the UK there are no measures of human rip current awareness. Previous studies have however provided a greater understanding of beach users' behaviour and perception of risks through the use of research methods such as questionnaires, surveys, awareness programmes and community education schemes (Drozdowski *et al.*, 2012; Hatfield *et al.*, 2012; McCool *et al.*, 2009; McCool *et al.*, 2008; Moran, 2011; Sherker *et al.*, 2010). Outcomes of the aforementioned research imply that in order to reduce rip current incidents and drownings, education on how to recognise rips and therefore avoid them is key (Ballantyne *et al.*, 2005; Brander and MacMahan, 2011; Sherker *et al.*, 2010).

Recent proceedings at the 2nd International Rip Current Symposium however, acknowledge that there is still some uncertainty towards the best safety messages to convey to the public, particularly when the physical science research continues to evolve. Scott *et al.* (2009) implied that rip current behaviour in the UK displays similar patterns to other beaches around the world but that due to the macro-tidal environment and differing beach morphologies has a unique behaviour. This outlines the need for a specific UK based rip education strategy, the content and direction of which will be derived through parts two and three of this collaboration; a beach safety and rip current awareness questionnaire, and a survey of rip current victim experiences. Until these further stages have been completed, it is unclear what the UK stance on public messaging will be.

METHODS

This study uses RNLI lifeguard incident reports for 2006-2011. Lifeguards record all water and beach based incidents responded to on every beach patrolled by the RNLI across the UK. Report forms are collated at RNLI headquarters and analysed, providing critical incident statistics for the organisation to monitor and improve performance, evaluate and respond to trends, and identify beach safety issues. Lifeguard managers also use the data to ensure an effective and efficient service by allocating resources, improving training, and re-evaluating risk assessments.

This is the first time this dataset has been analysed in depth for a social science research project and as part of a wider long term goal to explore the social interactions with rip currents. Simple descriptive statistical analysis was undertaken on the data to summarise the main features of rip current incidents, particularly scrutinised for relationships between gender, age, activity and geographical location of rip current incidents.

For the purpose of this study the analysis and interpretation of results was based solely on rip current incidents. Each incident contains a wealth of information including date, time, duration of incident, lifeguard area, lifeguard unit, number of people involved, age and gender, activity, environmental factors such as wind, waves, tides and sea conditions, and what equipment lifeguards used. The incident report is therefore a record of all these factors

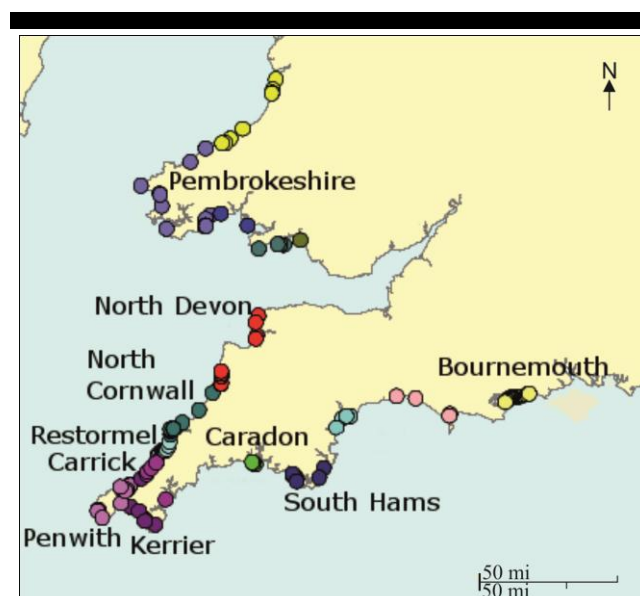


Figure 2. RNLI lifeguard area map of southwest England and Wales illustrating the geographical location of the ten areas with the highest number of rip current incidents.

during one rescue event which may include multiple victims and activities.

The period of analysis is from 2006-2011 over which 101 beaches became RNLI operated in several different areas across the UK as part of the RNLI's continued lifeguard expansion. A straight analysis of the incident numbers would be biased towards areas which have been online since 2006 so for this purpose the incident data has been normalised to show differences in incident numbers over years of operation and per unit. This normalisation is acknowledged in the relevant section in the results.

RESULTS

Between 2006-2011, RNLI lifeguards assisted 12,607 people from 5798 rip current incidents. Table 1 shows that the number of rip current incidents has increased over the five year period but this can be attributed to the RNLI's expansion of lifeguard units across the UK from 62 in 2006 to 163 in 2011.

The RNLI lifeguard service is divided up into 35 operational areas (2011) within which are a number of beaches (units). The results show a significant geographical distribution of rip current incidents. The ten areas recording the highest incidents for 2006-2011 are situated in southwest England and Wales (Figure 2) and account for 94% of all UK rip current incidents. Six out of these ten areas are located along the north coast of Devon and Cornwall and account for 80.5% of all rip incidents on UK beaches patrolled by the RNLI. 62% of all incidents occur in only 3 of these areas; North Cornwall (n.1417), Carrick (n.1126), and North Devon (n.1059).

As UK counties (as opposed to RNLI lifeguard areas), Devon and Cornwall contain 74 out of 163 (45%) of all RNLI patrolled beaches. 5177 rip current incidents were recorded on 69 beaches in the two counties, indicating an 89% share of incidents on just under half of all UK beaches patrolled by the RNLI.

Table 2. Overview of the top ten RNLI areas and beaches with the highest mean number of annual rip current incidents between 2006-2011.

Area (no. of units per area)	Mean Rip Current Incidents	Mean annual %
North Cornwall (15)	236.17	21.83
Carrick (7)	187.67	17.34
North Devon (2)	176.50	16.31
Penwith (15)	120.25	11.11
Restormel (9)	70.00	6.47
South Hams (8)	60.67	5.61
Kerrier (7)	41.25	3.81
Pembrokeshire (12)	39.00	3.60
Bournemouth (10)	29.67	2.74
Caradon (4)	18.33	1.69
AREA TOTAL	979.50	90.53
Beaches (area code)		
Croyde (ND)	106.67	9.77
Woolacombe (ND)	69.83	6.40
Perranporth (CK)	69.00	6.32
Porthtowan (CK)	45.33	4.15
Constantine Bay (NC)	42.17	3.86
Bantham (SH)	39.00	3.57
Gwithian (PE)	31.00	2.84
Porthmeor (PE)	29.25	2.68
North Fistral (RE)	27.17	2.49
Treyarnon (NC)	26.67	2.44
BEACH TOTAL	486.08	44.52

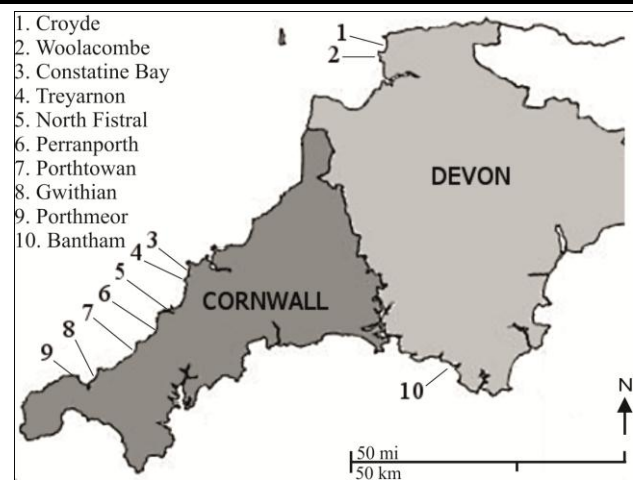


Figure 3. Map showing the geographical location of RNLI beaches with the ten highest average rip current incident numbers 2006-2011.

The data has been normalised to find an annual average number of rip current incidents per area and beach (Table 2). The RNLI beaches with the greatest average of hazardous rip currents are shown in Figure 3. Nine of the ten beaches with the highest incident averages are found on the north Devon and Cornish coastline (n.2631, 45%). The popular surf beach of Croyde in North Devon accounts for 11% (n.640) of all UK rip incidents, an annual average of 9.77% (Table 2). In addition, these ten beaches represent 45% of rip current incidents on all UK beaches, illustrating that nearly half of the UK's rip problem is concentrated on just 6% of RNLI lifeguarded beaches.

The number of beaches vary between areas with incident numbers per unit highest in North Devon with 529.5 as it only operates 2 beaches. The number of incidents per unit in Carrick (n.160.9) and North Cornwall (n. 94.5) are distributed between 7 and 15 beaches respectively. The number of rip incidents can also be averaged per year per unit to show North Devon (n.264.8) again to have the largest share, with Carrick (n. 23.0) and Caradon (n. 6.9) having a significantly less annual average per unit.

The activities most commonly associated with rip current incidents (Figure 4) are bodyboarding at 53% (n.3065), swimming (26%, n.1483), and surfing (20%, n.1172) (second and third highest respectively). Lifeguards record equipment hazards associated with incidents; inexperience accounts for 57% of all incidents (35% not recorded) with a breakdown of 32% of all bodyboarding incidents, 14% of surfing incidents and 11% of swimming incidents.

An important area of the results is the demographics of rip current victims; 66% are male, with the highest category being adult male (18-64 years) at 31%. Female teenagers are the largest female category (11%) yet the total of all females equals that of the adult male (18-64 years) category at 31%.

The RNLI's age group categories are uneven however; Children (0-12), Teenagers (13-17), Adult (18-64) and Senior (65+). This gives a significant proportion (46 years) to the adult category and hence the majority of incident numbers. The data was normalised (to ensure an even and unbiased scale) by dividing the number of incidents for each group by the number of years in each category to find an average of rescues per year per age group. The normalised data (Figure 5) shows that teenagers are the category with the highest margins at 67%; Males 42%, female 27%. The

adult category is now notably reduced but males still represent the greatest casualty numbers in all categories. Linking gender and activity, the data gives details of which demographics were caught in rips and the activity they were participating in at the time (Figure 6). Teenagers rank the highest for bodyboarding (34%), swimming (23%) and surfing (12%), with a higher male to female ratio (42%:27%). This trend continues through all other demographic groups apart from adult males where surfing incidents rank higher than swimming incidents (Figure 6).

Lifeguards record the area of the beach victims are rescued from with half (51%) of all rip current incidents occurring in the non-zoned areas of the beach, away from lifeguard patrols. 32% occurred in the vicinity of the red and yellow flagged zone, and 10% in the vicinity of the craft/surf zone.

DISCUSSION

From these results, links can be made to previous research studies. Geographically, 81% (mean annual 77%) of all RNLI rip current incidents occurred on the north Devon and Cornwall coast. The regions' exposed intermediate and dissipative beaches, typically exhibiting low tide terrace, low tide terrace and rip and low tide bar/rip morphologies (Scott *et al* 2011), are prime rip current forming environments already investigated by Scott *et al* (2007) to have the highest rip risk ratings in the UK. The results also show that the lowest incident numbers occurred on beach types or areas with reflective beaches presenting little or no rip hazard or on ultra-dissipative beaches that lack intense rip systems.

Regionally, the southwest peninsula has the highest concentration of lifeguard units (Figure 1) and therefore produces more rip current incident data compared to the rest of the UK. The number of beaches in each area range from 1 to 15 (mean 5.3 per area), and the ten areas with the highest rip incidents also have a higher number of beaches (North Devon remains an anomaly with 2 beaches) so in this respect there is an area bias towards those with a greater number of beaches.

However, refinement of the results from areas to units, with annual averages, revealed that nearly half (45%) of all RNLI rip current incidents occurred on only ten beaches. These beaches are

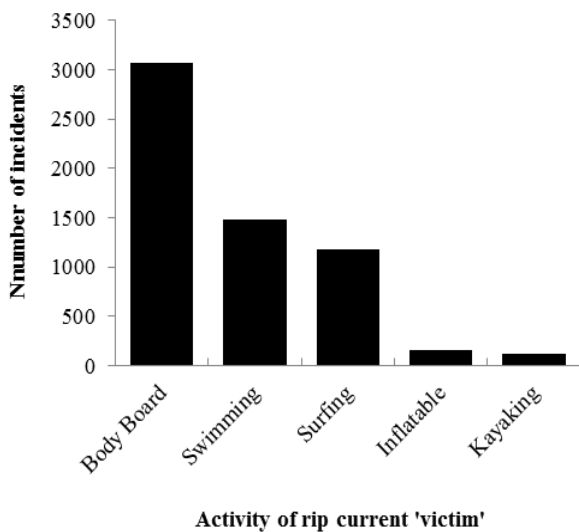


Figure 4. Bar graph to show the type of activity rip current victims were undertaking at point of rescue for 2006-2011.

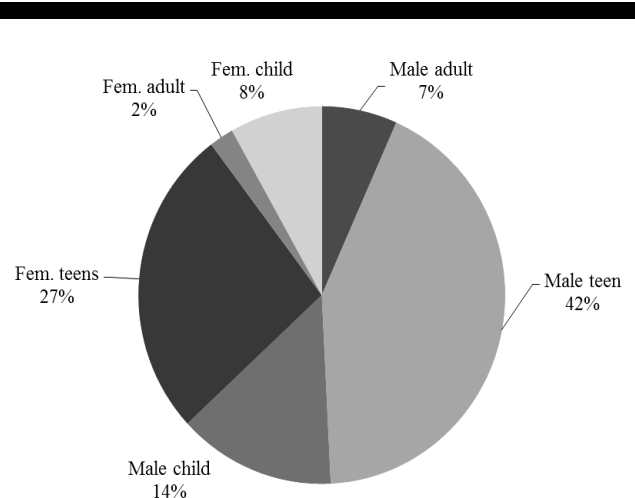


Figure 5. Pie chart displaying the age and gender categories with the greatest average rip current incidents per year per age group for 2006-2011

incidentally located in Devon and Cornwall, and this significant figure not only underlines a distinct geographical concentration, regardless of their operational area location, but also identifies these ten beaches as prime educational control sites.

These statistics are enhanced by the high seasonal visitor population. Devon and Cornwall received 41.9 million staying visitors between 2008-2010 (Visit England 2011) highlighting the hazardous combination of increased numbers of beach users and dynamic physical processes, amplifying the potential for increased lifeguard response in this region.

66% of rip victims are male; this links to other rip current statistics worldwide, particularly those of Australia where in 2011 85% of coastal drownings were male (SLSA, 2011), and the USA where males are six times more likely than females to be victims of rip currents (Gensini and Ashley, 2010). Research indicates that males are more likely to overestimate ability and underestimate risk (Goya *et al.*, 2011, McCool *et al.*, 2008, Moran, 2011) and that gender differences play a key part in risk taking and levels of confidence in relation to personal risk assessment (Lupton, 1999; Slovic, 2000). Relating this research to a coastal, beach and leisure environment, Morgan *et al.* (2009), attribute the gender bias towards men in coastal incident statistics to their increased frequency and exposure to water based activity, as well as using surf craft and venturing further into the surf zone. There are no statistics in the UK to show the ratio of males to females in the water, however anecdotally from lifeguards it is considered that males heavily outweigh females entering the water, particularly when surfing, in the UK.

51% of rip incidents occurred in non-zoned areas of the beach. There is some discussion into whether people are ignorant to the flag system or if they purposefully choose to be outside the flags (White and Hyde 2010). Sherker *et al* (2010) has shown that in Australia people outside the flags are more likely to be more experienced or have knowledge of rip currents. The next phase of social research in the UK is expected to discover the reason behind this statistic through the implementation of the aforementioned second deliverable of this collaboration; a beach safety and rip current awareness questionnaire.

Bodyboarding accounted for the highest number of rip current incidents which is representative of this popular water based activity. 'Inexperience' and 'misuse of equipment' are options for

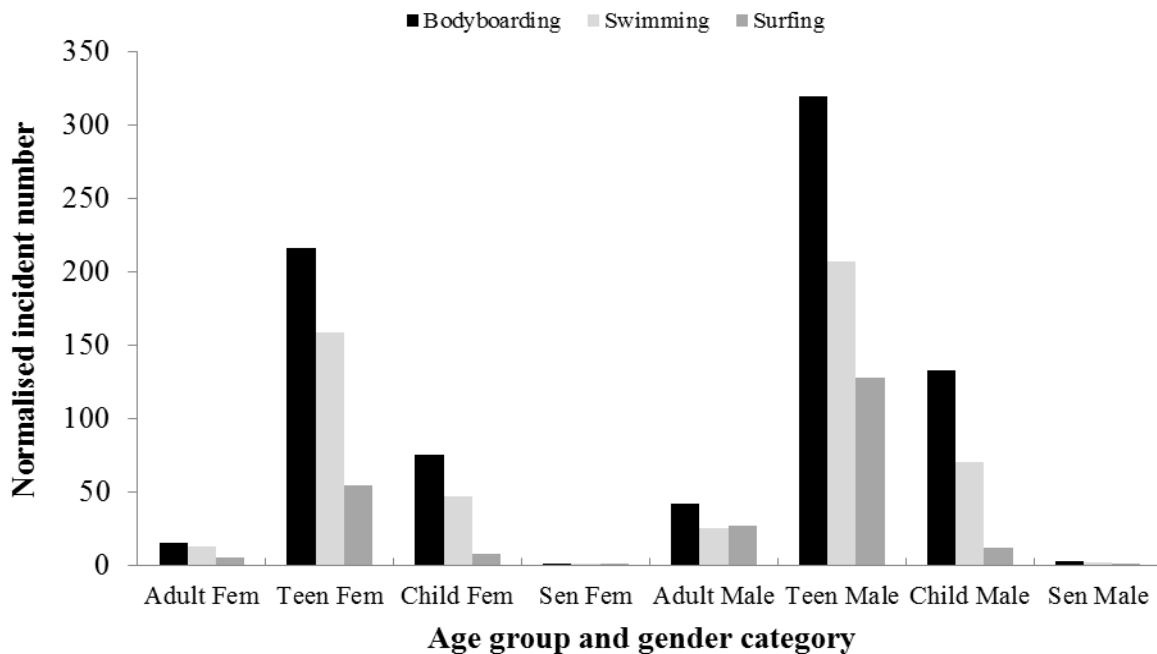


Figure 6. Bar graph showing the normalised data figures for the age and gender categories of rip current victims and the corresponding activities they were undertaking at point of rescue.

lifeguards to record on incident report forms as reasons for rescue. 32% of all bodyboard rescues were due to inexperience highlighting a major cause for rescues. Bodyboards are highly susceptible to nearshore currents, and lifeguards state that a large proportion of users tend to float on the boards becoming prime constituents within current movement. Lifeguards encourage bodyboard users to remain in contact with the seabed unless catching a wave in order to minimise the pull of rips. This group of rip current victims can be identified as a specific audience for rip current education. Due to the wide availability and low cost of generic bodyboarding equipment, a collaboration between equipment suppliers and rip education practitioners could be beneficial to ensure a joined-up approach to reducing the number of bodyboarders becoming victims of rip currents.

CONCLUSIONS

This is the first study that investigates the demographics of rip current victims in the UK. Analysis of 5798 rip current incidents responded to by lifeguards on RNLI patrolled beaches in the UK between 2006-2011 was undertaken, and the aim of discovering the ideal typical rip current victim in the UK has been achieved. This study contributes new research to the emerging field of human interactions with complex physical hazards worldwide. Physical rip current science continues to develop and it is important to use increasing knowledge to effectively and correctly communicate the risks of rip currents to the public. Reporting highly detailed nationwide beach lifeguard incident statistics is advantageous to the deployment of beach safety resources and lifeguard provisions. In addition it offers statistical comparisons to enable a global approach to facing the challenges of rip current incident reduction.

Based on this study of rip current incidents the following conclusions can be drawn.

- There is a significant nationwide variation to the geographical location of rip current incidents. Southwest England, in particular Devon and Cornwall, poses a substantial rip current risk (89%) to beach users and the north coast alone accounts for 81% of rip current incidents.
- Rip current incidents are affected by beach type, environmental conditions and visitor numbers; intermediate low-tide bar-rip beach types exposed to greater wave heights combined with busy summer beaches pose the greatest rip current risk.
- The typical rip current demographic is teenage (67%) aged 13-17 years, with a higher ratio of males (42%) to females (27%). There are notable gender differences of rip current victims; 66% of all rip incidents were male.
- The location of where beach users enter the water and the type of activity they undertake contribute to individual exposure to rip current risk. Half of all rip current incidents involved bodyboarding (52%) and occurred in non patrolled areas of the beach (51%).

This study is a platform for further social research in understanding the reasons behind why this demographic is at risk and to begin implementation of new rip current education strategies.

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Public Understanding and Knowledge of Rip Currents and Beach Safety in the UK

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Rip currents present a severe hazard for water users on beaches and account for the greatest cause of lifeguard rescues worldwide. The physical dynamics of rip currents are well studied, and more recently, the social and behavioral science research surrounding human interaction of rip currents has been expanding, providing a social perspective and feeding into public education strategies. The aim of this study was to assess levels of public understanding of rip currents and beach safety on UK beaches. A questionnaire was undertaken ($N = 407$) during the summer of 2012 on four beaches. Beach users had a poor knowledge of rip currents ($n = 263$), but those who have been caught in a rip before have a higher level of knowledge. Conversely, beach users had a good understanding of what the beach safety flags indicated ($n = 314$), and most people complied with this flag system ($n = 339$). In addition, those previously educated on rip currents had a higher knowledge, and lifeguards proved to be the most effective form of education. The study presents an insight into UK beach users' knowledge of rip currents and provides more evidence with which to pilot a rip current education scheme within the UK.

Keywords: drowning, rip currents, beach lifeguards, beach safety education

The purpose of this study was to determine levels of knowledge and understanding of rip currents and beach safety by typical summer beach users in the United Kingdom (UK). In addition, the study sought to establish where individuals obtained their knowledge about rip currents for two reasons: 1) to gauge the effectiveness of how and where this knowledge was obtained, and 2) how education strategies need to be developed or improved. In their study of a rip current intervention program, Hatfield, Williamson, Sherker, Brander, and Hayen (2012) concluded that education and campaigns do improve rip current awareness. Therefore to develop such a scheme in the UK, we needed to know current levels of understanding on

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UK beaches by measuring existing awareness, knowledge, and attitudes before attempting to influence or alter them. The broader aim of the work was to provide the basis for a new rip current education scheme for the UK using this baseline knowledge level.

Beaches present an attractive, enjoyable environment for recreation and tourism, drawing millions of visitors to the coastal regions of the UK and the rest of the world. Beaches exhibit a variety of hazards with visitors, often unknowingly, placing themselves within an inherently risky environment (Short & Hogan, 1994; Ballantyne, Carr, & Hughes, 2005; Scott, Russell, Masselink, & Wooler, 2009). These hazards are mitigated by the introduction of lifeguard services on beaches, for which the Royal National Lifeboat Institution (RNLI) is the operating organization within the UK. Lifeguard services operate on 214 beaches within the UK between May and September, with 29 beaches beginning the service at Easter and 14 of those beaches extending through to November.

At lifeguarded beaches in the UK, safe bathing areas are denoted by red and yellow flags, in accordance with the International Life Saving Federation (ILSF) recommendations, with lifeguard patrols present at the water's edge. Due to the large tidal ranges in the UK, bathing areas may vary in position during the course of the tide and as hazards become exposed or disappear depending on conditions. International research on beach safety flags has shown that people are safest to go in the ocean between the patrol flags and that most fatalities occur outside these areas (Sherker, Williamson, Hatfield, Brander, & Hayen, 2010). In addition, studies have found that people know the flags indicate safe bathing areas and know they should swim between them, yet a proportion of people still choose to swim outside the flags (Ballantyne et al. 2005; White & Hyde, 2010; Wilks, DeNardi, & Wodarski, 2007; Sherker et al. 2010).

The reasons behind why people choose to swim away from patrolled areas are complex and can be associated with intentions and decision making within the realms of the Theory of Planned Behavior (White & Hyde 2010). Swimming outside the flags also exposes water users to the risk of being caught in rip currents. It has been reported that 73% of rip current survivors were outside of patrolled areas at the time of an incident (Drozdowski et al. 2012). Rip currents are strong rapid seaward flowing channels of water capable of moving people from shallow to deeper water quickly and unexpectedly, thus presenting a significant hazard to shore water users (Brander & Short, 2001; MacMahan et al. 2010). Lifeguard best practice dictates that flags are placed on sandbanks as rip currents flow out to sea in channels flanking sandbanks, so it is not surprising that people are caught outside of these extents which mark the safest areas of the beach.

The morphodynamics of a beach dictates what type of hazard is prevalent within the surf zone and is a well-researched topic (Short & Hogan 1994; Benedet, Finkl, & Klein, 2004; Scott, Russell, Masselink, Wooler, & Short, 2007; Scott et al. 2009). Beaches that develop sand bars and troughs are prime for rip current development (Wright & Short, 1984). Scott et al. (2009) investigated rip rescues as a function of beach morphodynamics and hydrodynamic forcing and found that 59% of the UK's west coast beaches have 'Low Tide Bar/Rip' and 'Low Tide Terrace and Rip' morphodynamics that can produce multiple rip systems in this high-energy setting (Figure 1). On these beaches, small summer swell waves favor the intermediate beach morphodynamic systems associated with strong rip currents (Scott et al.



Figure 1 — Image of low-tide Perranporth Beach, UK, showing multiple sand bars and rip currents, lifeguard flag placement, and location of bathers (photo used courtesy of Tim Scott).

2007; 2008; 2009) at a time when large summer visitor numbers expose more people to the rip current hazard, resulting in higher numbers of rescues (Scott et al. 2007; Woodward, Beaumont, Russell, Wooler, & Macleod, 2013). The UK also has a large tidal range (mean 5.5 m) which has a major impact on the severity of rip currents, particularly as large spring low tides occur in the middle of the day, activating the low tide bar/rip morphology at the same time as maximum beach and bather populations appear (Scott et al. 2009).

The number of people drowning and being rescued from rip currents globally has received a lot of attention. In Australia, an average of 21 people per year drown in rip currents (Brighton, Sherker, Brander, Thompson, & Bradstreet, 2013); in the U.S., Gensini and Ashley (2010) reported that on average 35 people per year drown in rip currents. Kumar and Prasad (2014) recently presented data from India, where rip currents claim approximately 39 lives every year. Rip currents are largely quoted as the greatest cause of lifeguard rescues across the globe (Brander & MacMahan, 2011; Brewster & Gould, 2014; Brighton et al. 2013; Klein, Santana, Diehl, & Menezes, 2003). In the UK, rip currents represent 68% of all lifeguard rescues (Scott et al. 2008). Woodward et al. (2013) further scrutinized the UK pattern by investigating the demographics of rip current casualties and concluded that male teenagers were most likely to be caught in rip currents, and that people bodyboarding on beaches along the north coast of Devon and Cornwall in the southwest UK were at most risk.

The physical dynamics of rip currents has been well studied. Shepard, Emery, and La Fond, (1941) defined the traditional understanding of rip currents while

more recent studies have introduced GPS surf zone drifters to accurately measure the direction and circulation patterns of rip currents (Austin et al. 2010; MacMahan et al., 2010; McCarroll et al. 2014), greatly improving understanding of rip currents worldwide. This method also effectively relates the physical dynamics of rips to the human element, as the drifters mimic people in the water. This progression in rip current knowledge has further implications for beach safety, particularly with respect to rip circulation, as the flow of rip currents has an effect on what safety messages to disseminate to the public, especially swimmer escape strategies (McCarroll et al. 2014; Miloshsis & Stephenson, 2011).

In more recent years, there has been emphasis on the social and behavioral sciences as they relate to rip currents. A need for rip current intervention programs and research on beach users attitudes, behaviors, and understanding of beach safety and rip currents has been highlighted (Brander and MacMahan 2011; Sherker et al. 2010). Researchers in this field agree that beach users need to know how to identify a rip current to avoid swimming in one (Sherker et.al. 2010) and that rip identification needs to be a crucial part of rip education (Williamson et al. 2012). Social rip current research is developing and improving as studies such as those investigating the knowledge of how people behave in rip currents (Drozdowski et al. 2012). For example, in the U.S. it has been highlighted that the public has a generally poor understanding of rip currents (Brannstrom, Trimble, Santos, Brown, and Houser, 2014; Caldwell, Houser, and Meyer-Arendt, 2013). This survey study aims to provide a UK perspective on how much beach users know and understand about rip currents, adding to international research and effort on rip current awareness, education and prevention of drowning.

Method

Study Sites

Beach locations were selected based on the findings from Woodward et al. (2013) where beaches with higher rip current incidents were identified. A mixture of rural and resort beaches were chosen on the north coast of Devon and Cornwall in South-west UK (Figure 2) due to ease of access and exposure to large numbers of people. These beaches were Croyde (A) in Devon, and Constantine Bay (B), Perranporth (C), and Chapel Porth (D) in Cornwall. These four beaches accounted for approximately one quarter of all UK rip incidents over a six-year period (2006–2011). The beaches are macrotidal and are exposed to Atlantic swell and wind waves from the prevailing westerly winds. Each site was visited twice over a two-week period with the exception of Croyde which was visited once. The physical characteristics of each site are outlined in Table 1.

Survey Design

The public beach user questionnaire was semistructured with a mix of 26 closed and open ended questions to generate quantitative and qualitative data. It comprised six sections: general beach background, beach safety knowledge, rip current knowledge, rip current experience, rip current education, and demographic information. This was designed as a face-to-face survey to maximize the quality

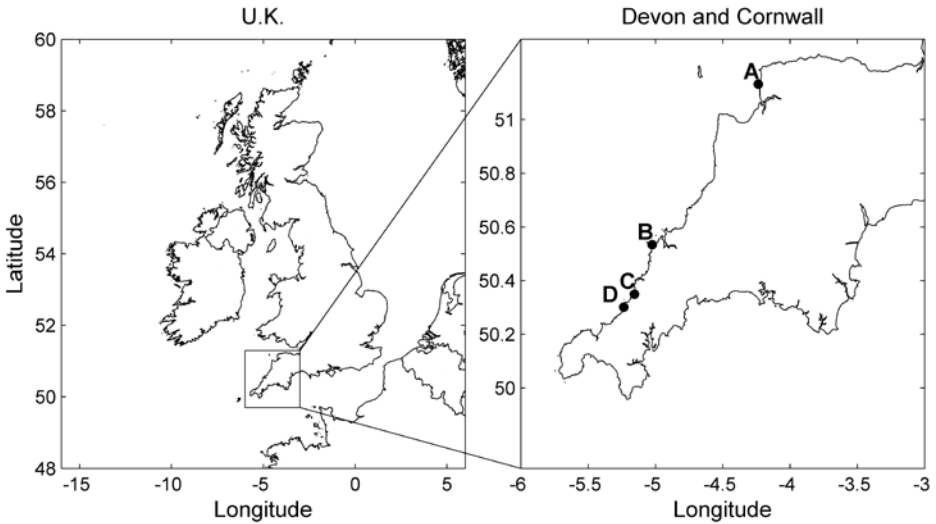


Figure 2 — Map showing location of study sites within the UK: A = Croyde, B = Constantine Bay, C = Perranporth, and D = Chapel Porth.

Table 1 Physical Characteristics and Public Amenities of Questionnaire Study Sites

Beach and morphology	Description	Rip incidents (2006–2011)
Perranporth LTB/R	Large exposed west facing sandy beach bounded by headlands at each end of a 3.5 km beach backed by dune system (0.5km at high tide) Resort town with several large car parks serving the high volume of seasonal visitors. RNLI lifeguards.	Total = 414 UK % = 7.14
Chapel Porth LTB/R	Small rocky cove at high tide becoming large sandy beach at low tide (1.25 km). Joins with Porthtowan to the south at spring low tide and bounded by headlands (2.5 km). National Trust beach and car park with limited numbers, other car park 10 min walk up hill. Small café and public conveniences. RNLI lifeguards.	Total = 153 UK % = 2.64
Constantine Bay LTT+B/R	Large sandy beach backed by dune system with rocky outcrops to the south and headland to the north. Joins with Booby’s Bay at low tide (1 km). Small car park in quiet village popular with seasonal visitors. RNLI lifeguards.	Total = 253 UK % = 4.36
Croyde LTB/R	Large sandy beach backed by dune system bounded by headlands (0.8 km). Resort village popular with seasonal visitors, accommodation close to the beach and several car parks and beach entrances. RNLI lifeguards.	Total = 640 UK % = 11.04

Note. The two beach morphologies are LTB/R = low tide bar and rip and LTT+BR = low tide terrace and bar rip.

of data collected and to obtain the highest response rates. Ethical approval was granted by the Human Ethics Committee of the Faculty of Science and Technology at Plymouth University, UK.

Procedure

The research team were present on the beach from 11:00 a.m.–5:00 p.m. (Table 2). A random sampling method was selected whereby a team of 2–4 interviewers approached beach users situated within a chosen transect anywhere between beach access points and the water's edge. Interviewers spent an average of 10 min with each participant, on occasion longer if there were questions or explanations needed after the survey. The questionnaires for this study were conducted during summer 2012 during July 30–August 9 to coincide with peak summer beach populations, ensuring higher survey responses.

Results

Respondent Profile

A total of 407 beach surveys were conducted with a 96% response rate owing to large receptive audiences (Table 2) and a margin of error of 4.76% at a 95% confidence interval. The mean age of respondents was 39 (median = 42, range = 9–75) and a near even split between males ($n = 198$) and females ($n = 209$). Eighty-three percent of respondents were on holiday, and those with postcodes corresponding to the beaches surveyed (TR, PL, EX) were deemed to be local and made up only 14% of respondents. The remaining respondents were from the rest of the UK (83%) with a small proportion from overseas (2%). Participants had undertaken an array of water-based activities throughout the year with swimming (29%), bodyboarding (28%), and paddling (19%) the most frequent. Conversely, during winter months (December–February) 74% did not go in the sea, although 10% surfed and 6% bodyboarded. Participants gave 1,314 responses to what influenced their choice of beach when asked to give three main reasons. It was noted that waves (26%), sand (26%), and cleanliness (19%) were the key influences for respondents' beach selection. These initial 1,314 responses were later coded into 19 themes where sea conditions (13%), physical features (12%), and safety (8%) then became the main influence categories.

Rip Current and Beach Safety Knowledge

Open-ended questions were used to gain what participants understood about rip currents. These qualitative responses provided richly detailed information and were analyzed and ranked on a scale of 1–5 (Table 3). Beach users' level of rip current knowledge was generally poor (Figure 3a); 32% gave entirely incorrect answers and another 33% gave poor responses which combined for almost two thirds (65%) of respondents who had wrong or poor knowledge about rip currents. Those who gave a good or excellent answer totaled only 10%. Male respondents had a higher knowledge level than females, where poor answers for males and females were 58% and 70%, respectively, and good answers 14% and 6%, respectively. Age group differences were not as pronounced as gender, but analysis found those aged 0–12

Table 2 Daily Study Site Information Where Estimated Beach Population (Minimum, Maximum, and Mean per Day), Weather, and Surf Conditions Were Recorded Every Hour

Beach	Est. Beach Populations							Resp. R (%)	Pers.	Wx
	Min.	Max.	Mean	Samp. R (%)	Resp.	Ref.	Resp. R (%)			
Perranporth.	150	5,500	4,000	2	72	3	95.83	4	Sun-cloud	
Chapel Porth	70	400	249	26	65	1	98.46	3	Cloud-sun	
Constantine	25	550	338	19	63	4	93.65	3	Rain-cloud-sun	
Croyde	800	3,000	1,820	2	36	3	91.66	3	Sun-heavy rain	
Perranporth	200	4,500	2,783	2	64	2	96.87	3-2	Cloud-sun	
Chapel Porth	0	40	19	42	8	1	87.50	1	Rain-drizzle	
Constantine	300	900	658	6	38	1	97.36	2	Cloud-sun	
Chapel Porth	180	800	588	10	61	1	98.36	3	Sun	
	1,725	15,690	10,455	4	407	16	96.06			

Note. Samp. R = sampling rate per beach (% of responses per mean beach population); Resp. = number of responses; Ref. = number of refusals; Resp. R = response rate (completed questionnaires/number of people approached); Pers. = personnel or the number of interviewers on the research team; Wx = weather condition.

Table 3 Examples of Respondents' Descriptions of Their Understanding of What a Rip Current Is and Subsequent Coding for Knowledge Scale

ID	Description example	Scale words	Scale	Numerical scale
375	"Undercurrent which you can't see"	Undercurrent, invisible—both incorrect	Incorrect	1
355	"Currents under the water that pull you out or under and down"	Undercurrent is incorrect, but stated direction	Poor	2
006	"When the current goes back out to sea, can drag you out"	Stated flow speed and direction	Satisfactory	3
173	"Water pushes you out, too strong and can't get back in, swim around the current"	Stated flow speed, direction, and hazard	Good	4
125	"An offshore directed flow, driven by waves and controlled by beach morphology, can be dangerous"	Stated direction and flow, mechanism of rip fed by waves, morphologically controlled, and hazard	Excellent	5

Table 4 Examples of Respondents' Descriptions of Their Understanding of the Red and Yellow Flags and Subsequent Coding for Knowledge Scale

ID	Description example	Scale words	Scale	Numerical scale
346	"Can't remember"	Incorrect statement, don't know, unsure, or no	Incorrect	1
096	"Don't know"			
257	"Safe surfing area"	Incorrect activity, but with one of correct action or indicated safety	Poor	2
003	"Surfers to stay inside"			
122	"You can swim"	Stated 1 of correct activity or location between the flags or indicated safety	Satisfactory	3
319	"Stay between"			
320	"Swim between them"	Stated combination of correct activity, that it should be carried out between the flags, indication of safety	Good	4
229	"Safe to swim"			
018	"Swim in between the red and yellow flags, it's the safest place"	Stated all of correct activity, that it should be carried out between the flags, and indication of safety	Excellent	5
391	"Safe to bathe between, and the lifeguards are watching you there"			

had the highest number of poor answers (64%), followed by those aged 36–45 (51%) and those 65 and older had the lowest number of poor answers with 36%. There were no large differences between study sites and knowledge, with each beach following the main trend.

Rip current knowledge levels were compared with knowledge of the beach flag system. The majority of beach users had a good understanding of what the red and yellow safety flags meant on the beach. Responses were again assigned a position from 1–5 on a knowledge scale (Table 4), and those who were incorrect or gave a poor answer combined to represent 4% of respondents (Figure 3b). Those with a good or excellent knowledge level accounted for 77% of respondents who mentioned all or a combination of safety, type of activity, and that the flags marked an area in which to stay between.

Sixty-four percent of respondents said they always went to a lifeguarded beach, and 97% of respondents were able to give a reason why the lifeguards placed the red and yellow flags where they do on the beach, with 61% outlining that they get placed in the safest areas of the beach and to avoid strong currents. Acting on this knowledge was similar, with 86% of those who went in the water while being compliant with the safety system stating they always go between the designated flagged zones for their chosen activity. The main reasons for this amenable action were predominantly safety and that there is a constant lifeguard patrol. Those who sometimes entered the water between the flags (11%) stated they went outside mainly due to the type of activity they undertook, where on occasion sea conditions were better in areas of the beach away from the flags, such as those who were going surfing. Others ventured into the water away from the flags because they sometimes believed the zones to be too busy with people and equipment. Individuals who typically do not go between the flags stated they would go to the patrolled areas when they were with their children or family members to set a good example.

The activities and frequency of water use were analyzed to investigate whether rip current knowledge is affected by time in the water and type of activity. Respon-

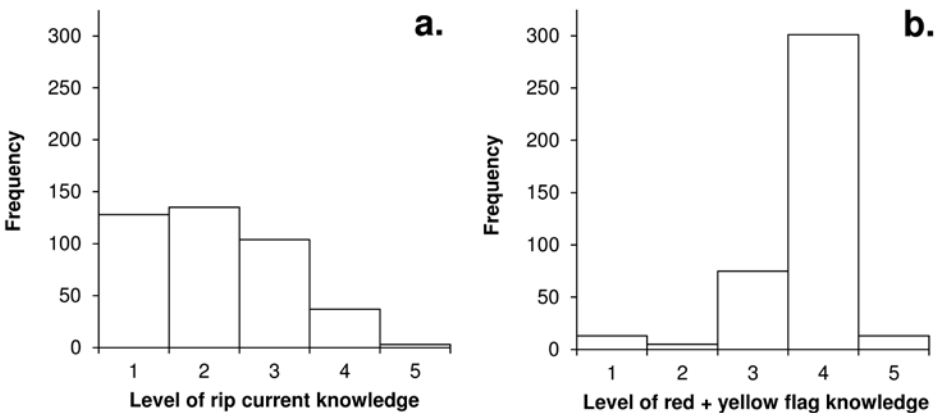


Figure 3 — Histograms showing frequency of responses for a) level of rip current knowledge and b) level of red and yellow flags knowledge. *Note.* 1 = incorrect, 2 = poor, 3 = satisfactory, 4 = good, and 5 = excellent.

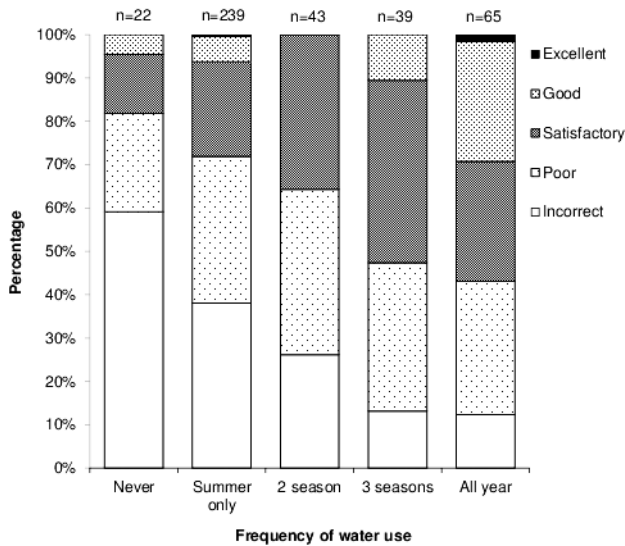


Figure 4 — Percentage of respondents' rip current knowledge levels per scale category against frequency of water use throughout the year.

dents were asked to state which activities they undertook throughout the year, broken down into the four seasons. The majority of people only went in the water in the summer months (59%), and those who participate in water-based activities on a year round basis mostly surfed. Figure 4 shows that rip current knowledge increases with a greater frequency of water use. The type of activity however, does not appear to have a bearing on rip current knowledge.

Rip Current Experience

When asked if the respondent had ever been caught in a rip current, 25% stated that they had, with more males answering yes than females (35% vs. 14%). The main activities at the time of incident were bodyboarding (35%), swimming (32%), and surfing (21%). The highest number of these incidents occurred on Perranporth, Chapel Porth, and Constantine Bay beaches in the UK. A proportion of respondents who had been caught in a rip stated they had been caught in them while at a beach in Australia. Escape strategies were chosen from a prescribed list, where 56% of people self-rescued, of which 26% swam parallel to the shore, and 80% did not signal to anyone for help. Reasons why people did not signal for help were varied: 35% felt confident and at ease with the situation, 5% were using the rip deliberately for their activity, and 12% were caught in a rip out of lifeguard hours or on a nonpatrolled beach. Lifeguards saw and were on their way to 10% of people whereas 7% were too busy swimming to be able to signal, and 3% were too proud to signal.

Figure 4 shows that rip current knowledge increases with water use. Subsequent analysis was therefore undertaken to establish whether there was a correlation

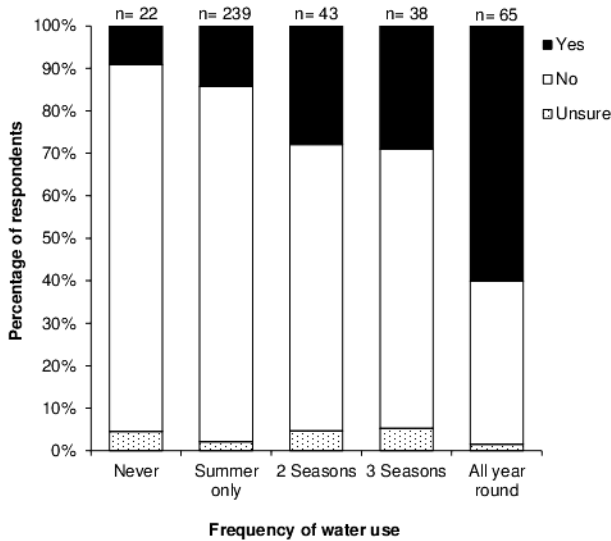


Figure 5 — Percentage of respondents’ frequency of water use throughout the year compared with their experience of being caught in a rip current, not caught, or unsure.

between being caught in a rip current and frequency of water use. Figure 5 shows that the probability of being caught in a rip current does increase with water use. Summer-only water users who had been caught in a rip total 14% compared with 60% of year round water users. The activity most participated in throughout the year was surfing, consistently averaging 22% per season, whereas bodyboarding and swimming peak in summer months but decreased for the other three seasons.

As frequency of water use increases, it appeared that water experience and possibly knowledge and identification of rips also increases. It should also be noted that with more water experience and rip current knowledge could come increased usefulness of a rip (e.g., for a surfer to get out beyond the break easily). Levels of rip current knowledge, therefore, were analyzed between the groups of ‘caught’ and ‘not caught’ to find that those who have been caught in a rip do indeed have a higher level of rip current knowledge (Figure 6). Those with the highest knowledge (good and excellent, 19%) predominantly frequented the water all year round (73%) and surfed (37%). There is still a high level of incorrect and poor knowledge of rip currents (49%) among those who have been caught in a rip, but there is a definite shift from poor to good knowledge (Figure 6). Incidentally, there was no difference in beach flag knowledge between those who had been caught or not caught in rips with averages of 3.8 and 3.7 on the knowledge scale respectively.

It should also be mentioned that 11 respondents were unsure whether they had been caught in a rip or not. Knowledge levels were analyzed with 82% giving an incorrect description of a rip current. This potentially indicated their uncertainty of the incident was due to poor identification. Water use analysis indicated 45% were summer water users and 9% didn’t go into the sea. Whether their rip current experience put them off going in the sea or not was unknown.

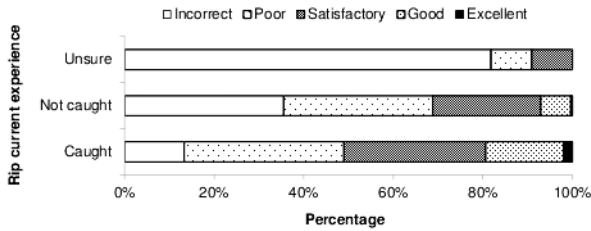


Figure 6 — Percentages of respondents' rip current knowledge per scale category of those caught in a rip current, not caught, or unsure.

Rip Current Education

Results from the questionnaire also established whether beach users had received or acquired any type of rip current education, and if so, where that education came from. Respondents were asked to state what form of rip current education they may have had, whether directly through being taught specific information during a course or from a lifeguard, or indirectly via signage, media, or entirely subliminally. Just over three quarters (76%) of respondents had never received any form of rip current education. Gender differences highlighted that 27% of male respondents had received education compared with 21% of females, and the age group with the highest proportion of education were 19–25 year olds (37%). It should also be noted that one third (33%) of 13–18 year olds, who were outlined from UK rip current rescue statistics to be most at risk (Woodward et al. 2013), had acquired rip current education, and those aged 65+ total the lowest proportion (6%). Respondents with a local postcode to the beaches visited (TR, PL, EX) had received the highest proportion of education (27%). Of the 24% of respondents who have had some form of rip education, courses such as water sport lessons and surf lifesaving clubs returned the highest proportion of responses (31%), followed by educational establishments (16%) and lifeguards (14%). The lowest, with less than 3% of all responses, included the factors of signage, Internet research, and television.

Analysis was done to establish which form of education yielded the highest and lowest rip current knowledge levels. Respondents without education returned 70% incorrect and poor on the knowledge scale combined, compared with 48% of those who had obtained education. Good and excellent knowledge accounted for 6% of those without education, and 21% of those with education. These results show that those who had received some form of education about rip currents had higher knowledge levels of the subject. The form of education which yields highest knowledge levels was lifeguards with 36% of that group registering within the 'good' scale category, and inversely leaflets yield the lowest with 50% falling within the 'incorrect' scale bracket.

Respondents were also asked to provide ideas for the best methods on how to educate the public about rip currents, what form of education that may be, how and where it could be delivered, as well as the form of education they personally would be most receptive to. Signage was suggested the most with 24% of responses, 5% of which were specific dynamic signs displaying rip current information as conditions changed throughout the day, mobile signs at the water's edge, and beach specific

signage that are highly noticeable. Communication from lifeguards was the second highest response (10%). When asked in the field, a vast proportion of people were very uncertain, often vaguely supposing some form of education would work. There were also, however, a small proportion of people who were firmly confident in their method suggestion. Half of all respondents thought any form of education should be delivered on the beach, in the environment where the hazard is present.

Respondents were asked to select, from a prescribed list, which methods of education they would be most receptive to if there were to be a new rip current education scheme (Table 5). Having a conversation face-to-face with a lifeguard was chosen the most (18%) followed by television and signage. Table 5 shows all respondents, and also gives a breakdown of answers from those caught and not caught in a rip current. The main differences between these two groups were that those who have been caught rank lifeguards above demonstrations and signage, and those who haven't been caught rank television above signage and lifeguards. Information via the radio or a smartphone application were the least popular methods.

Discussion

Beach Safety Knowledge

This study found that 77% of UK beach users surveyed had a good level of knowledge of the red and yellow bathing area flags. This proportion of respondents were able to state what activity should be undertaken, that the flags indicated a zone within which to stay, and that it was safe and patrolled by lifeguards. These flags denote the safest areas of the water between which to swim or use bodyboards, and also highlight that there is a lifeguard patrol present on the beach. Beaches with a high hazard rating will support a lifeguard patrol, and generally coincide with popular tourist destinations, therefore the high percentage of good, and even satisfactory understanding of the flags is expected due to the high presence of lifeguard patrols on UK beaches. Those with a poor knowledge totaled 1% and were only deemed poor due to stating an incorrect activity. Those with an incorrect response totaled 3% and could not give, or even attempt, an answer to the question. These figures are consistent with the findings of Caldwell et al. (2013) in the U.S., but are not as impressive as Australian beach users where a study found all but one respondent was correct (Ballantyne et al. 2005), perhaps showing a cultural difference, where beaches and surf lifesaving are such a major part of Australian coastal life.

With a good understanding of the safety flags, 86% of respondents stated that they always go between the flags when entering the water on a lifeguarded beach. Safety is the main reason cited, in addition to their knowledge that the area is patrolled by the lifeguards, and that some think it is best for their children and family. Going to a lifeguarded beach is a conscious decision for 64% of respondents, although coincidence and chance play a part for some, and once there RNLI lifeguards anecdotally report that British beach users are generally compliant with the safety flags and adhere to lifeguard advice (Figure 1). Whether this is due to a herd mentality, because people don't know any different, or because they do as they are told is unclear. This is in part due to a lack of depth when asking about lifeguard flag placement, as respondents provided an answer which was not wrong, but it is uncertain whether they knew *why* or if it was just a guess. What is known

Table 5 Methods of Rip Current Education to Which Respondents Would Be More Receptive

		Face-to-face from lifeguards	Information booklets/leaflets	Internet	Radio	Beach-based demonstrations	Smart-phone app	TV	Other	Total
All respondents	Count	173	98	88	38	114	45	165	90	973
	% of responses	17.78	10.07	9.04	3.91	11.72	4.62	16.96	9.25	100
Respondents not caught in a rip current	% of people*	42.51	10.07	9.04	3.91	11.72	4.62	16.96	22.11	239.06
	Count	110	67	65	29	72	31	134	62	690
Respondents caught in a rip current	% of responses	15.94	9.71	9.42	4.20	10.43	4.49	19.42	8.99	100
	% of people	36.91	22.48	21.81	9.73	24.16	40.27	44.97	20.81	231.54
Respondents caught in a rip current	Count	55	28	22	6	39	13	28	29	259
	% of responses	21.24	10.81	8.49	2.32	15.06	5.02	10.81	11.20	100
	% of people	56.12	28.57	22.45	6.12	39.80	13.27	28.57	29.59	264.28

Note. Rows show all respondents: those caught in a rip current, and those not caught in a rip current.

* = This was a multiple-choice question where several options could be selected by respondents, therefore, “% of people” can total more than 100%.

is that red and yellow flag knowledge among this group of beach users is good, and that there is a general respect for the lifeguards who are extremely preventative in their approach to keeping beach users safe.

In comparison, actions of individual beach users with a negative behavior and attitude toward safety flags in this survey (i.e., do not go between the flags) vary with experience, activity, the occupation of the flagged area, and levels of application in freedom of choice. Although this study does not provide enough evidence to investigate the psychological reasons behind beach users' water-based locations and their attitudes as to why they choose specific areas, the data does provide these short responses for going between the flags. Even with an understanding of the flag system, this minority don't always act on their knowledge and still undertake risky behaviors such as going outside of lifeguarded areas, as supported by similar studies (Ballantyne et al. 2005; McCool, Moran, Ameratunga, and Robinson, 2008; Sherker et al. 2010). Whether this is a conscious decision or peer pressure, or whether experience overrules subjective risk, or whether a sense of control over their actions comes to the fore is uncertain. These psychological implications are further found in studies by White and Hyde (2010) and Williamson et al. (2012) in relation to swimming location and rip current hazard. The importance of understanding motivational factors, intentions, and risk perception of beach users is therefore paramount in managing beaches effectively and developing education materials, and deserves a study in its own right.

Rip Current Knowledge

Safety is a concern for people visiting the beach in the UK, where the main influences of respondents' beach choice were the sea conditions, physical features, and safety respectively. Rip currents account for the highest number of lifeguard rescues in the UK, and worldwide, yet beach users are typically unknowledgeable or even unaware about them. This study found that 65% of beach users have a poor knowledge of rip currents despite having a good knowledge of the safety flags (Figure 3). Those within the 'incorrect' category generally stated that a rip current is invisible, an undercurrent, or something that will drag you under, whereas those with a 'poor' answer included an incorrect description counterbalanced with a correct statement such as offshore flow direction. A quarter of beach users gave a satisfactory response which included a statement that was correct but did not explain enough detail of the mechanics behind a rip current to be a good answer. Consistent with the findings of those in Australia (Sherker et al. 2010; Williamson et al. 2012) and in the U.S. (Brannstrom et.al 2014; Caldwell et al. 2013), this study adds to worldwide research that identifies a typical beach user to have a poor knowledge of rip currents.

Rip Current Experience

In this study, 25% of respondents had been caught in a rip current, with an overrepresentation of males compared with females (35%:14%). Respondents' descriptions of the incidents are consistent with results from UK beach lifeguard incident statistics which outlined male teenagers, the north coast of Cornwall, and bodyboarding to be the key demographics, location, and activity of people caught in rip currents (Woodward et al. 2013). Literature in this field has long established

a male dominance in drowning and incident statistics, and essentially links males with overconfidence in their abilities and an underestimation of risks, but also the simple fact that males are exposed to rip currents more than females by spending more time in the water and venturing further out to sea (Gulliver and Begg 2005; McCool et al. 2008; Moran 2008; Morgan, Ozanne-Smith, and Triggs, 2009).

Rip current knowledge levels of this group were analyzed and found that they were able to describe a rip current in more detail and had a higher level of knowledge than those not caught in a rip (Figure 5). This demonstrates that the experience of being caught in a rip current provides a greater level of awareness and understanding of the hazard, a finding similar to that of Drozdowski et al. (2012). It is uncertain however, whether rip victims have advanced levels of knowledge because of being caught in a rip, or if they are caught in a rip because of their advanced knowledge due to a developed water competence, confidence and rip identification skills. What can be inferred, and echoed by Sherker et al. (2010), is that those with rip experience are better placed to make decisions about where to enter the water, and are more confident in their reaction if caught in one.

This study has shown that more frequent water use increases the probability of being caught in a rip current (Figure 4). It is also known that rip current knowledge improves with increased water use (Figure 3). It is no surprise that increasing exposure to the hazard raises the risk of being caught, but perhaps activity, location, and time of year can somewhat account for this. It is also no surprise that increased participation of an activity will lead to a better understanding of the environment in which it is conducted. In this study, surfing accounts for the most consistently undertaken activity year round, with a quarter of all respondents surfing during winter months. In the UK, waves for surfing are often more consistent and powerful outside the summer months due to more frequent mid-Atlantic depressions, and with a dedicated cold water surfing community, exposes surfers to rip currents year round. In addition to this, lifeguard patrols cover beaches between the hours of 10:00 a.m.–6:00 p.m. from April through to October, enhancing the risk to water users entering the water outside of these hours. It is therefore even more important to educate this group of water users on rip currents, especially novices and improvers, who will continually be exposed to the rip current hazard, particularly year round, when lifeguard patrols may be absent and sea conditions more dangerous.

Rip Current Education

One quarter of beach users in this study have received some form of rip current education, and subsequently have a higher knowledge of rips compared with those who have not been educated on rips. These results provide an argument in favor of beach safety education and more specific rip current material, to provide beach users with information on hazards within their leisure environment, enabling them to make safe decisions, and present them with options if a danger presents itself. This is reinforced by findings from Klein et al. (2003) where a successful beach safety campaign led to an 80% reduction in fatal accidents, and Hatfield et al. (2012) where a campaign effectively improved beach users' knowledge of, and behaviors around rip currents. This study, supported by these examples of successful beach safety campaigns, provides further evidence for continuing the process of creating and implementing a rip current education pilot in the UK.

Rip current education has come in many forms to the respondents in this survey, and the largest proportion has come from courses and clubs on the beach, educational establishments and lifeguards. Lifeguards, however, proved to be the most effective form of education as 36% of those educated by lifeguards had a 'good' knowledge of rip currents. This provides support for the RNLI to continue to use their lifeguards to inform the public about rip currents on hazardous beaches. It is also noted that educating people in the environment where the hazard is present is successful, but whether specific audiences (such as teenage males) can be effectively reached in this situation remains ambiguous from this study. It has been shown, however, that an increase in lifeguard preventative actions, resources, and importance has positive results on incident and drowning statistics (Klein et al. 2003), so a concentrated effort to reach certain demographics with cleverly designed marketing or incentives utilizing lifeguards could be the key to rip current education.

As an alternative to lifeguards, signage was stated by 29% of respondents as the most effective way to educate about rip currents. Though a popular solution, signage only accounted for 0.5% of those who have received rip current education, and as 65% of these respondents had a poor knowledge of rip currents, they may have found it difficult to know the best methods to interpret the subject. A study on beach safety signage undertaken by Matthews, Andronaco, and Adams (2014) suggested that this method was not as effective as authorities believed, suggesting that public awareness campaigns may be the best and only way to communicate hazards on beaches. Signage, however, when researched and implemented correctly, can have a positive impact on transmitting hazards. Rousseau and Wolgater (2006) suggest the presence of warning signs have a significant effect on compliance behavior, and that attempting to communicate something is better than nothing, but more importantly, successful signs will display information on what people already know rather than expecting people to learn something new. In this respect, it could be argued that as the results of this study show people know more about beach flags than rip currents, information about the flags and *why* they are placed there (i.e., to avoid rip currents) should be conveyed via signage. Whether signage works effectively is uncertain, but studies undertaken on beach signage prove it is unsuccessful, and it is clear more research needs to be done on this topic to ensure the most effective rip current signage is used.

Conclusions

A questionnaire was delivered to 407 beach users during the summer on UK beaches to determine the current levels of awareness of beach safety and rip currents. This study not only provided an insight into the UK beach user, but further contributes to the field of social rip current research, and presents a benchmark from which to progress the education of rip currents to the public. Education in whatever form must develop from evidence and provide the public with the best tools, communicated in the most effective way, to keep them safe at the beach. The effects of educating the public on beach safety, in particular rip currents, are positive, and can lead to reductions in incidents. Based on this study the following conclusions can be drawn:

- The level of rip current knowledge among UK beach users is poor ($n = 263$, 65%), with only 35% ($n = 144$) giving a correct description of a rip current.

This poor level of rip current knowledge indicates the need to increase education on the topic.

- Conversely, this group had a higher knowledge of the beach safety flags with 96% ($n = 389$) able to give a correct description of what the red and yellow flags indicate. Good knowledge of this topic accounted for 77% ($n = 314$) of respondents.
- With a good understanding of the beach safety flags beach users complied with the flag system ($n = 339$, 86%) and three quarters ($n = 309$, 75%) had not been caught in a rip current. This demonstrated that entering the water between the flags reduced the risk of being caught in a rip current. This emphasizes the value of general beach safety and the importance of attending a lifeguard-patrolled beach during operational months and hours.
- Those who had been caught in a rip current have a greater knowledge ($n = 50$, 51%) of rip currents than those who have not been caught ($n = 93$, 31%). This provided further evidence that experience of being caught in a rip current was the best way to demonstrate the hazard, presenting victims with the physical and mental awareness of what a rip current does and how it can affect water users.
- Lifeguards have proven to be the most effective form of rip current education and a popular source for disseminating future education. Lifeguards should therefore be included in any rip current education schemes that may be developed.

With results from this study, the UK rip current incident statistics, and a further study of people caught in rip currents, efforts can be put forward into developing a rip current education pilot for the UK.

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