

RNLI | Research Project ID: 15-6

Exploring the effect of lifeguard preventative actions on beach safety

Sponsor: RNLI Lifeguard Management Team
Department: RNLI Operations Research Unit
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Contractor: Select Statistical Services
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This research project sought to explore the effect of preventative actions on incident rates across a sample of RNLI beach lifeguard units. The positive findings from the study illustrate the importance of a proactive approach to beach management. They also provide the first known quantitative evidence regarding the efficacy of prevention activity by lifeguards.

Summary

RNLI lifeguards pride themselves on their proactive approach to beach management, with the majority of their work being preventative in its nature. While the importance of prevention is stressed across the service, there is little robust quantitative evidence to demonstrate how and why it is effective at reducing incidents. In Summer 2015 the RNLI commissioned research to establish whether preventative actions have an observable effect on beach safety and to better understand the nature of the relationship between prevention and the rate of incidents.

Select Statistical Services was appointed to work with the RNLI to develop a series of hypotheses and to create statistical models that could be used to test each one.

The study team matched the RNLI incident data from 2006–14 with the records from the daily logs that lifeguards completed over the same time period. They were then able to explore the statistical relationships between different types of preventative action (face-to-face, public address announcements and moving flags) and the rates of rescues and assistance. (Assistance is hereinafter referred to as assists).

The findings from the project provide the first evidence known to the study team of the efficacy of lifeguard preventative actions. The results suggest that lifeguards' management of the bathing and surf craft areas, through moving the flags, has a significant negative effect on the rates of rescues and assists given by the lifeguard team.

Face-to-face interventions were also found to have a significant, though smaller, negative influence on rates of rescue and assists. The study team views the evidence as indicative of the value of prevention on lifeguarded beaches, bearing in mind a number of limitations of the analysis, which are explained later in this report.



Research aim and objectives

The aim of the study was to explore the relationship between the number of preventative actions conducted by RNLI lifeguards and the incident rates. Preventative actions, together with some of the other key terms that are used in this report, are defined below:

Definitions	
Preventative action	Any action taken by a lifeguard that provides advice, guidance or direction to a person that mitigates against risk.
Assistance/assist	Where a lifeguard aids a person in the sea who is at low risk but, if left, would be at risk.
Rescue	Where a lifeguard responds to a person at risk and physically returns them to shore or transfers them to another rescue craft.
Lives saved	Where, if a lifeguard had not intervened, a life would have been lost.
Public address announcement	Where a lifeguard uses a public address system to deliver a safety message to a segment of the beach.
Signs and flags	Signs and flags placed or moved on a beach by the lifeguard inform the public of important safety information on hazards specific to the area.
Face-to-face	A direct interaction between a lifeguard and a member of the public or small group. Conducted in person, not using a public address system.
Other	Any other form of preventative action, not otherwise described above.



Photo: RNLI/Laura Edwards

The specific objectives for the work were to:

1. Conduct statistical analysis that can be used to verify or refute a set of hypotheses relating to the relationship between preventative actions and incidents.
2. Advise the RNLI on the nature and strength of the statistical relationships between preventative actions and each stage of our incident chain (see Figure 1).
3. Identify the types of beaches or areas of the UK that conduct the greatest rate of preventative actions (per head of beach population) and, data permitting, that demonstrate the efficacy of preventative actions.
4. Produce a series of reports on the analysis conducted, in accordance with the RNLI's requirements.

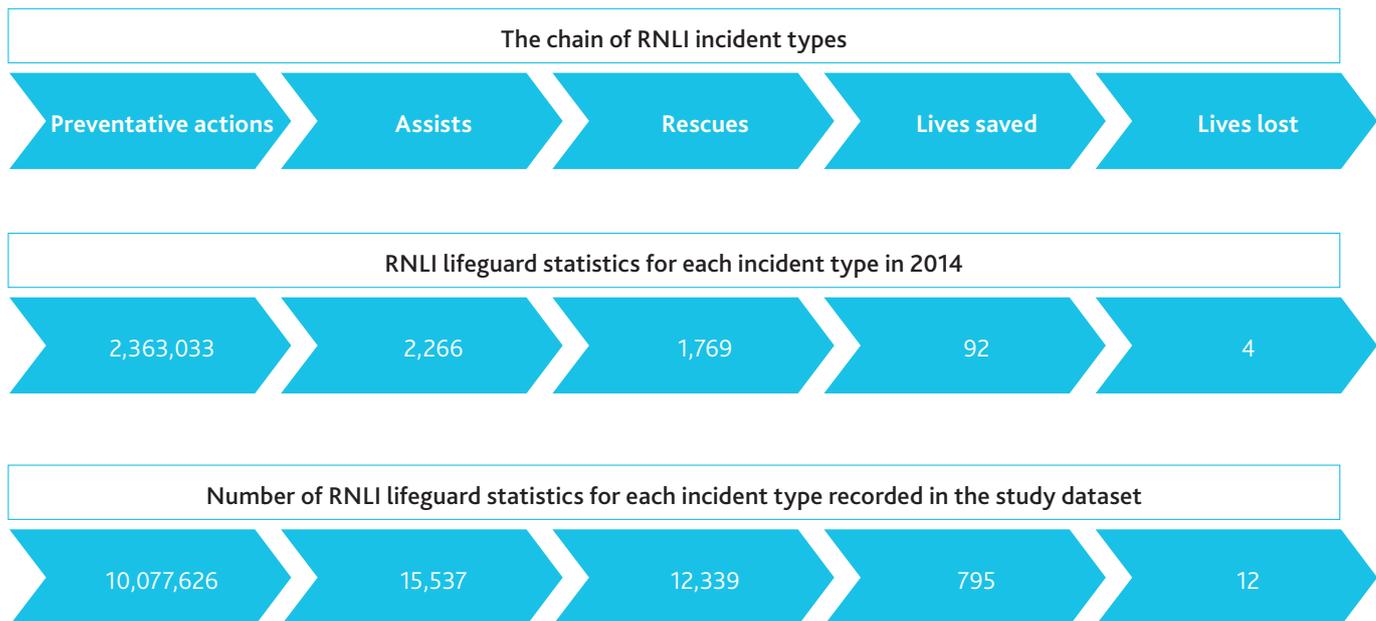


Photo: RNLI/Nathan Williams

At the heart of the research aim and objectives is the RNLI's desire to better understand the effect that preventative actions have on later parts of the incident chain.

Figure 1 illustrates the grading of this chain, when broadly equated to RNLI lifeguard interventions, with the least severe (preventative actions) on the left-hand side and the most severe (responding to a fatal incident) on the right-hand side.

Figure 1: RNLI lifeguard statistics across the incident chain



Lives lost: RNLI lifeguards responded to 12 incidents that they recorded as fatal between 2006 and 2014. Many of these cases required lifeguards to provide first aid in response to medical episodes on the beach, or to assist with incidents well outside of the flagged/zoned bathing areas. Eleven of these deaths were known to be well outside of the normal lifeguard patrol areas.

The RNLI uses the Water Incident Database (WAID) to collate information about fatalities that happen around the UK coastline. The sample size of fatalities on lifeguarded beaches during service hours was deemed too low to attempt to quantify the relationship between preventative actions and drownings, so these incidents were not considered as part of this study.

Lives saved: Following an assessment of the data available in the RNLI incident records, it was decided that the study team should first study the relationship between preventative actions, assists and rescues. Given the positive findings of this study, the relationship between preventative actions and lives saved will be the subject of exploration through future study.

Photo: RNLI/Nigel Millard

Method and approach

The study team devised a set of research questions. Six of the agreed questions looked at the relationships between different parts of the incident chain, accounting for relevant factors such as beach type, beach risk classification, year of data and frequency of red flags being present. The relationships looked at were:

1. The rates of rescues and assists and the rates of preventative actions.
2. The rates of rescues and assists and the beach type and risk classification, accounting for the rates of preventative actions carried out.
3. The rates of preventative actions carried out and the number of people in the water.
4. The rates of preventative actions carried out and the beach type/risk classification.
5. The rates of preventative actions carried out and the red flag status.
6. The ratio of rescues to assists and the rates of preventative actions carried out.

It was also hypothesised that lifeguards occasionally become so busy dealing with incidents that they do not have time to carry out preventative actions. A further question of the study team was whether these occasions can be predicted using information about what has happened earlier in the day.

Data availability

The lifeguard data used in the project covers 213 lifeguard units and spans the period 2006–14.

The analysis was carried out using the RNLI's daily lifeguard logs. These logs are completed every 2 hours by the lifeguards, recording information such as the number of people on the beach and in the water, as well as the number of preventative actions they have performed.

It is important to note that the historical daily log form, for 2006–11, collected only the overall number of preventative actions conducted by the lifeguards (shown in Figure 2 as Preventative actions (unspecified)). From 2012 onwards, lifeguards completed

records relating to four types of preventative actions: face-to-face interactions, public address announcements, signs and flags, and other actions.

The analysis also used the lifeguards' incident reports, which detail every assist and rescue carried out. The study team matched each incident to the relevant record of beach conditions and lifeguard activity in the daily log data.

Finally, the lifeguard data was supplemented by beach information held by the RNLI. This included the RNLI's beach type classification (with classes such as resort beach, remote rural beach and metropolitan/urban beach) and also a beach risk classification derived from the Plymouth University/RNLI UK Beach Safety Assessment Model (UKBSAM)¹.

Measures of lifeguard activity

The eventual dataset for the study was then used to create a series of measures of the variables of interest to the project.

For rescues and assists, the rates of activity were defined as:

- number of rescues and assists per day per beach visitor
- number of rescues and assists per day per person in the water
- number of rescues and assists per day per person in the water not surfing or on craft.

Similarly, it was agreed that the rates of preventative actions be measured by the:

- number of preventative actions carried out per day on a given beach
- number of preventative actions carried out per beach visitor on a given day on a given beach
- number of preventative actions carried out per person in the water on a given day on a given beach
- number of preventative actions carried out per person in the water (not surfing or on craft) on a given day on a given beach.

The analysis then looked into simple correlations between rates of assists and rescues and rates of preventative actions.

Detailed data on daily conditions was not available to the study team, so cannot be accounted for through modelling. In order to more accurately estimate the underlying relationship between rescues and assists and preventative actions, a second stage aggregated the daily log data into yearly data for each beach lifeguard unit.

Aggregating to yearly data has the effect of smoothing out daily variations caused by confounding variables such as weather conditions that tend to drive daily variation in rescues and assists and preventative actions. In the view of the study team, this is the more robust method to apply to the data available to the researchers.

After aggregating the data to an annual level, the relationships between the rates of rescues and assists and preventative actions were analysed by fitting statistical models known as generalised linear mixed models. These models estimate a function that predicts the mean daily number of rescues or assists in a given year and on a given beach using the following explanatory variables:

- the mean daily rate of preventative actions carried out, split into the four types
- beach risk (from the UKBSAM)
- beach type.

The analysis also accounted for variation between beaches not explained by the above variables by including a beach identifier in the models.

The advantage of including several explanatory variables in the model is that it makes it possible to estimate one relationship (for example, between rescues and assists and preventative actions) while accounting for other variables (for example, beach risk and type).

Having constructed the main statistical models, the study team were able to run each and begin the process of interpreting the findings.

¹ Data on the classification of beaches and their degree of natural hazard has been compiled by Plymouth University via the UK Beach Safety Assessment Model (UKBSAM). It contains environmental hazard information and classifications for 647 beaches in the UK.

Key findings

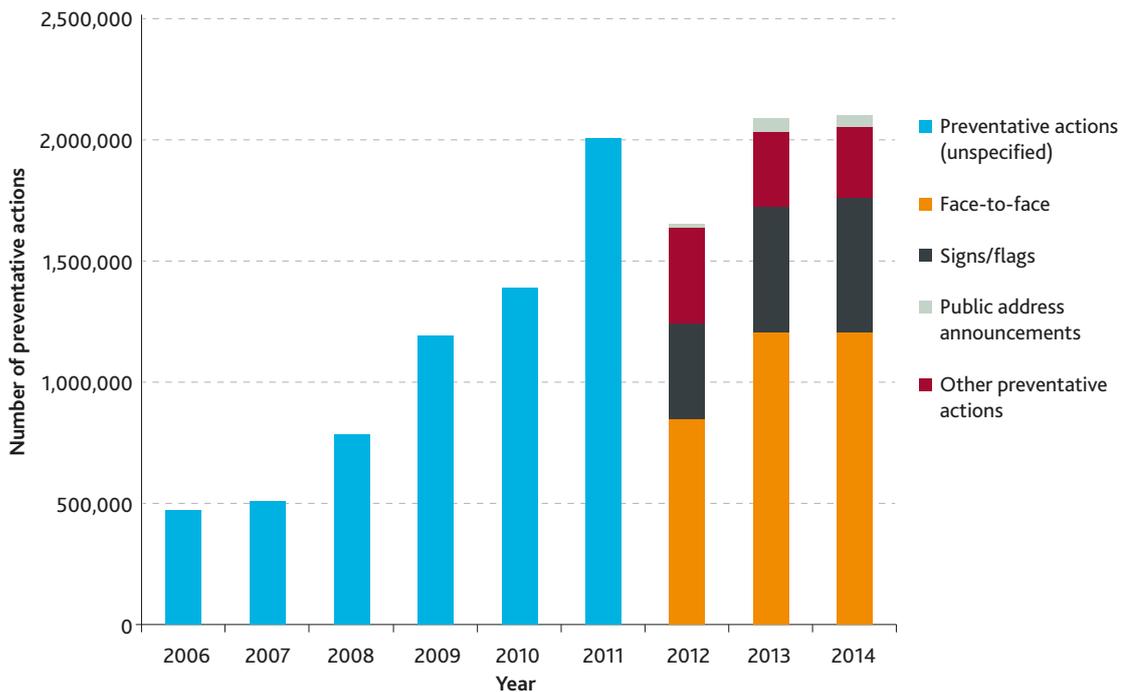
Figure 2 shows the number of preventative actions completed by RNLi lifeguards across the study dataset.

This graph shows how the number of preventative actions has steadily increased over time. It also shows, however, how the change in data collection in 2012 (from just asking lifeguards for a general number of preventative actions to asking about specific categories) appears to have affected the time series, with a drop in the number of preventative actions recorded in 2012, despite the number of beach lifeguard units increasing from 163 to 183.

The increase in the number of preventative actions over the study period largely reflects the growing number of RNLi units over time. The number of lifeguard units in the sample increases steadily with each year, from just 62 in 2006 to 213 in 2014.



Figure 2: The number of preventative actions completed by lifeguards across the study dataset (2006–14)



Research questions

1. What is the relationship between the rates of assists and rescues and preventative actions?

The statistical models developed to answer this first research question quantify the relationship between different types of preventative action and the rates of assists and rescues. Owing to the low number of incidents relative to water users, the rate is normalised and expressed as the number of assists or rescues per 1,000 bathers.

Figure 3 plots the relationships between the rates of assists and rescues and the different types of preventative actions. The study team found that the relationship varies depending on the number of bathers, so the figure plots the output from the model for four scenarios, each using 10, 25, 50 and 75 people in the water.

The in-water population is measured by the lifeguards every 2 hours. They do not keep track of the turnover of bathers during the day, which means that the study team does not know the total number of unique bathers covered in the study dataset. By contrast,

lifeguards do measure the total number of preventative actions that they have conducted during the day. This means that the total number of preventative actions in a day can exceed the average number of bathers across the six 2-hour periods.

Each graph shows the effect of increasing amounts of prevention on rates of assist/rescue. With the moving of signs/flags, there is a negative relationship – an increase in the numbers of these types of preventative action is associated with a decrease in the rate of assists/rescues. To illustrate:

- On a typical beach with an average number of 75 people in the water throughout the day (excluding surf/craft), an increase from 0 to 30 signs/flags preventative actions per day is associated with an estimated reduction in the assist rate of around 40% and an estimated reduction in the rescue rate of around 50%.
- Under the same scenario, an increase in the number of face-to-face actions from 0 to 70 per day is associated with an estimated reduction in the assist rate of around 35% and an estimated reduction

in the rescue rate of around 20%.

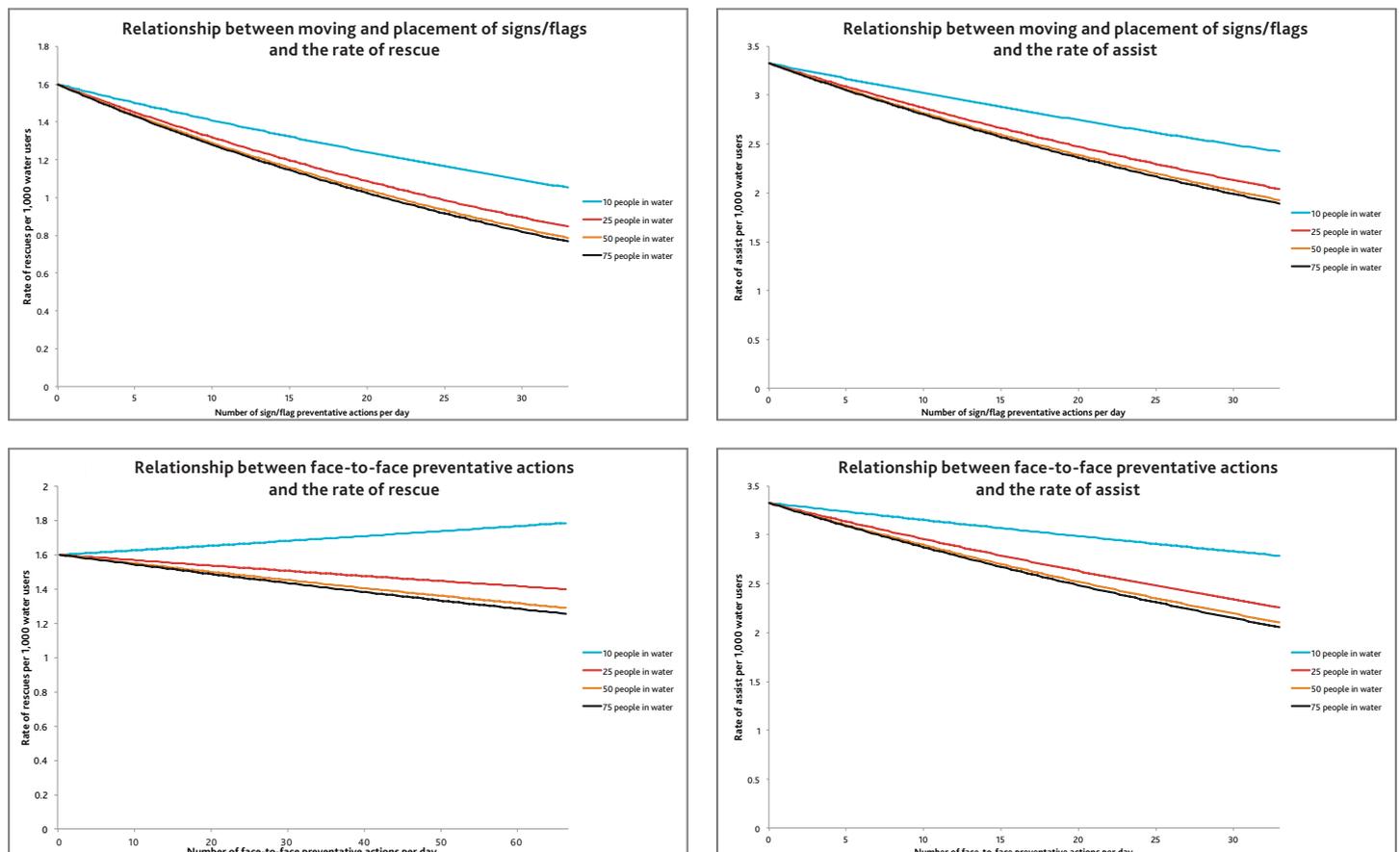
There is limited evidence of a relationship between public address announcements and other preventative actions and the rates of assists/rescues.

The figure also demonstrates the importance of quantifying the relationship under different numbers of beach users. When modelling the effect of face-to-face preventative actions with only 10 bathers, the study team found a positive relationship with the rate of rescues.

There is little in the findings that can explain why this relationship exists and it may warrant further research. The study team hypothesised, however, that lifeguards may consider surveillance and response an effective means of beach management for very low numbers of bathers and only increase their preventative activity in the event that either (a) assists or rescues begin to occur or (b) the number of people in the water increases.

Overall, the relationship for face-to-face actions was found to be negative for the other scenarios modelled (25, 50 and 75 bathers).

Figure 3: Relationships between the rates of rescues and assists and the different types of preventative actions



2. What is the relationship between the rates of rescues and assists and the beach type and risk classification?

There are statistically significant differences in both rescue and assist rates between some beach types and risk classifications.

For example:

- i. Beaches classified as high risk have rescue rates around two and a half times higher than low and medium risk beaches.
- ii. Remote rural beaches have assist rates three to four times higher than resort beaches or rural accessible beaches.

3. What is the relationship between the rate of preventative actions and the number of people in the water?

The relationship between the number of preventative actions that take place and the number of people in the water shows just how closely these two variables correlate over a season. Figure 4 shows this for Polzeath beach in north Cornwall.

An initial analysis showed that, on a daily level, rescues and assists are positively correlated with preventative actions. On days on which lots of preventative actions are performed, the lifeguards also tend to perform lots of assists and rescues (taking into account the number of beach users). A likely explanation for this is the presence of confounding variables.

4. What are the relationships between beach type/risk classification and preventative actions?

There are statistically significant differences in the number of preventative actions carried out per day between some beach types and risk classifications. For example, rural resort beaches have the lowest rates of total face-to-face and sign/flag preventative actions, but remote rural beaches have the lowest rates of public address announcements and other preventative actions.

However, there is no consistent pattern in the ordering of the beach risk classifications and beach types in terms of the estimated mean numbers of the various types of preventative action.

5. What is the relationship between the red flag status and preventative actions?

The total number of preventative actions carried out per day increases with the proportion of the day for which a red flag is present. Red flags for sea conditions and weather reasons are associated with the highest rate of preventative actions.

6. What is the relationship between the ratio of rescues to assists and the rates of preventative actions carried out?

It was hypothesised by the study team that preventative actions by lifeguards might reduce the severity of incidents and therefore change the type of rescue

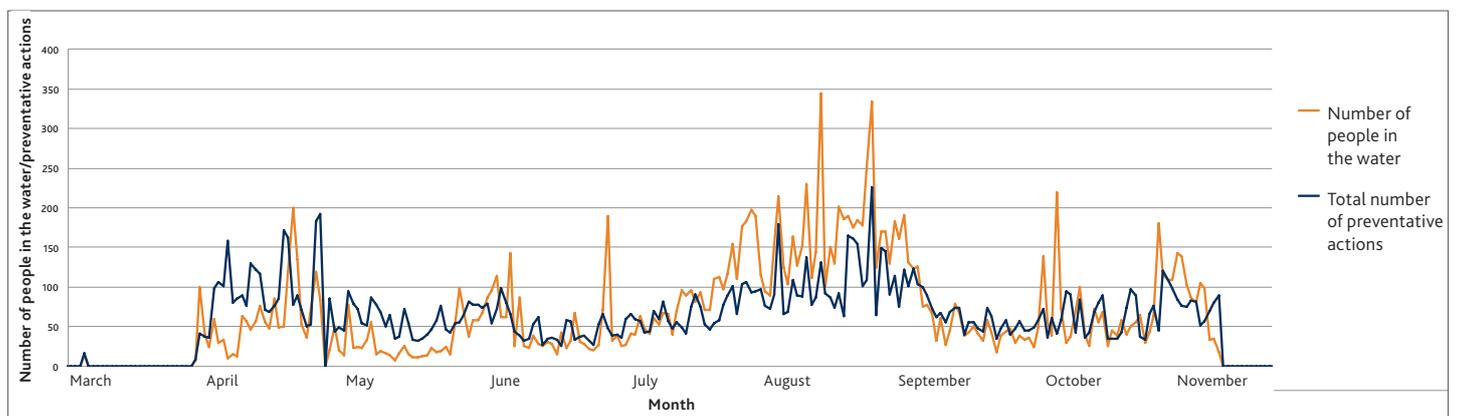
service required. The team was interested in whether the ratio of assists to rescues might provide an indication of the relative severity of the incidents to which lifeguards respond (with rescues more severe). If this were the case, then beaches where lifeguards conduct greater amounts of preventative actions would see a lower ratio of rescues to assists (that is, a higher numbers of assists).

The study team found different relationships between preventative actions and the ratio of assists to rescues, depending on the number of people in the water. However, the wide confidence intervals from the model meant that few conclusions could be drawn. Either preventative actions have no effect on the number of rescues per assist or there is insufficient information in the data to be able to detect the effect. It may also be the case that the ratio of assists to rescues is a poor indicator of the severity of incidents.

7. Can busy periods on the beach, when lifeguards do not have time to carry out preventative actions, be predicted?

The study team examined the data to see whether these occasions can be predicted using information about what happened earlier in the day. No relationship was found to indicate a tipping point of beach user numbers, which signals a reduction in the amount of preventative activity that lifeguards conduct.

Figure 4: A 5-year average from 2009–13, of the daily number of people in the water and the preventative actions for Polzeath beach, Cornwall



Limitations of the analysis

The evidence collected through this project provides strong evidence of the value of preventative actions on lifeguarded beaches. There are a number of important limitations to the study, however, which should be noted alongside the overall findings.

Firstly, the study assesses the role of prevention within a specific environment – lifeguarded beaches. It is uncertain whether these findings have any external validity in relation to preventative actions that take place elsewhere, such as educational activities including roadshows, talks and presentations away from the beach.

The effects reported should be interpreted in the context of the RNLI's holistic lifeguard service.

A similar methodological limitation to the analysis is that there was insufficient data available to make a comparison across lifeguarded and non-lifeguarded beaches. There was no control group for non-lifeguarded beaches. Instead, this study relied on the natural variation in the amount of preventative activity that takes place across different RNLI lifeguard units.

This means that the study cannot report any findings regarding the impact of placing a new service on a previously non-lifeguarded beach.

Finally, the study team was unable to construct a model that could account for daily variation in preventative actions and incidents. Such a model might help the RNLI to more accurately model the factors that influence both prevention and incident rates. It might also make for better-specified statistical results, depending on the availability of data.

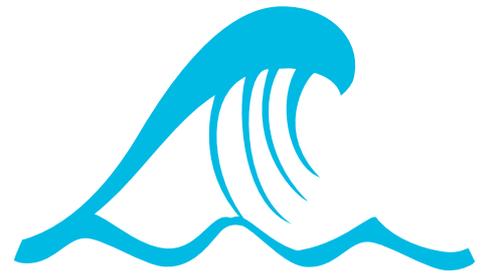


How the RNLI is using the evidence

The RNLI Lifeguard Management Team is in the process of interpreting and interrogating these results, which will be extremely valuable in helping to make the case for greater preventative activity by our lifeguard services. Future analysis may explore whether it is possible to better control for daily factors that might influence both incident rates and prevention activity, such as weather.

In the immediate term, the RNLI is working with Select Statistical Services to produce an academic article on the study findings for submission to appropriate articles.

The RNLI has disseminated the study findings at the World Conference on Drowning Prevention in Malaysia in November 2015 and also plans to promote them through other global forums.



Further reading

Lifeguard Effectiveness: A Report of the Working Group, Branche CM, Stewart S (Editors). Atlanta: Centers for Disease Control and Prevention, National Center for Injury Prevention, 2001. Available online at cdc.gov/HomeandRecreationalSafety/pubs/LifeguardReport-a.pdf.

Morphodynamic Characteristics and Classification of Beaches in England and Wales, Scott et al, 2011. Marine Geology, Volume 286, Issues 1–4, Pages 1–20, 1 August 2011.

Lifeguards Annual Report 2014, available from RNLI.org/aboutus/aboutthernli/Documents/lifeguard-report.pdf.



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We are also grateful to the Lifeguard Management Team at the RNLI, whose initial analysis prompted this research project.

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