Rip Current Visualization Final Report

September 12, 2017

Table of Contents

Table of Exhibits

EXECUTIVE SUMMARY

This report was funded by the National Weather Service and provides an evaluation of alternative graphics to represent rip current risk, based on the results of a national on-line survey and focus groups of water rescue and other professionals in coastal North Carolina. There were several goals we sought to achieve: 1) to identify the respondents' understandings of what each graphic is showing and how they anticipate it would influence their decision-making, 2) to distinguish the element or elements of each graphic that are most and least useful in understanding likelihood of hazardous rip currents, and 3) to determine the graphic or graphics they believe will be most and least effective in presenting rip current risk. Just over 1,080 individuals started the survey and 505 people responded to all questions. It is the 505 responses that were analyzed.

The online survey consisted of 49 questions that included:

- background information on each respondent;
- respondent knowledge of rip currents and what to do if caught in a rip current; and
- a series of graphics that they were asked to interpret, to provide their perceptions of various elements of each graphic and how the graphic might influence their beach choice and swimming decisions, and to indicate which they think is most and least effective and why.

Four focus groups with water rescue and other professionals were held, two each in of the regions of the WFOs in Newport/Morehead City and Wilmington. Each focus group session incorporated an audience response system, or "clicker" system, where participants were presented with a survey and they used the clicker devices to record their responses to each question. Following each response to questions about each graphic, participants were asked to discuss the results and their reasons for their responses. The sessions were audio recorded for transcription and were analyzed using content analysis software. A total of 26 individuals, representing a range of professions including lifeguards, local government officials, and a broadcast meteorologist participated in the focus groups.

The results of the on-line survey suggest that, overall, there is a generally good understanding among respondents of what the graphics show with respect to the probability categories. Survey respondents indicated that they will stay out of the water or avoid locations where the probability of rip currents is depicted as highest on the maps, generally irrespective of how the probability is presented, but many would do nothing different with the lowest probabilities, again irrespective of the legend. Among the differences in the graphics shown was the use of dots and strips to indicate the areas at risk. While the strips were preferred by more respondents, it became apparent that the dots led some to believe that they related to specific beach locations. Yet, even with the use of strips, there is a need for place names on the maps to help identify locations. The graphic that uses strips with categories of risk rather than percentages was preferred by more respondents than any other graphic.

The same graphic (strips with categorical information) was chosen as most preferred by the focus group participants with such characteristics as the simplicity of the information on it, how relatively easy it is to understand, and the order of the colors cited as reasons. A number of focus group participants chose it with the caveat that it needs to have only 3 categories, omitting the "extreme" category. Some discussion focused on a couple of the terms used, particularly *probability* and *low*. *Risk* is preferred in place of *probability*, particularly when percentages are not used. And some recommended the use of *lower* rather than *low* because the former implies that there remains some risk while *low* may not be interpreted as such.

The overall results do not lead to identifying one perfect graphic from anyone's perspective, though the graphic with strips and categorical information was preferred by more survey respondents and focus groups participants than any of the others. Despite the lack of overwhelming support for this graphic, the way in which the information is portrayed (the strips), the colors used and categories for risk were all cited as positive aspects of this graphic.

Color was a significant concern among many. Most preferred colors in the stoplight palette, in part because of its familiarity and because it is the international standard for the International Surf Lifesaving Association (ISLA) and the United States Lifesaving Association (USLA). Within the focus groups, there was some difference of opinion with respect to the use of green with some concerned that, since green means "go," people would think it is completely safe; others believe that this is the best time for people to go in the ocean, so the use of green is appropriate. Some suggested a red, orange, yellow color scheme to indicate that caution is always necessary, but this does not conform to international convention and distinctions between orange and yellow could be problematic on different devices. The use of probabilities on the graphics was not supported by many survey respondents or focus groups participants.

The following are recommended revisions to the preferred graphic, along with supporting reasons:

1. Use three discrete categories: Three categories are familiar to many beach-goers and to water safety professionals, as this is what has been used for rip currents internationally. The use of categorical information as opposed to probabilities is preferred and as a result, the legend should state Risk of Hazardous Rip Currents
2. Use a stoplight palette: This is the color scheme used by the USLA and the ISLA and thus is nationally and internationally recognized by many beach-goers and by professionals.
3. Use *lower* not *low*: There was great concern among the participants in the focus groups that the use of *low* sends the wrong message. *Lower* is believed to be much more likely to communicate that there is still a risk.
4. Include place names: This was recommended specifically by both survey respondents and focus group participants. This recommendation is in line with findings of other research on warnings, which has found that locational specificity is more likely to generate actions on the part of those at risk.
5. Provide a dynamic environment: Providing the opportunity to click on a location and obtain additional information would be particularly helpful as professionals help others understand the risk, and others desiring the additional information can obtain it.
6. Develop marketing and outreach campaigns: There is a need for marketing and outreach, to be widely disseminated beyond coastal areas, on what rip currents are, how to identify them and how to know when caught in one.
7. Integrate with the Beach Forecast page: The National Weather Service may want to consider merging the recommendations here with the Beach Forecast graphics, particularly with respect to the use of color and terminology so that there is consistency in products and information provided.
8. Consider extending analyses: The National Weather Service may want to consider extending the analyses with respect to reaching other locales.

The reader should note that, as detailed in the request for proposals, the geographic region used in the graphics is coastal North Carolina. While survey respondents represent many states, the majority are from North Carolina, though there was no significant difference in results between North Carolinians and other respondents. The focus groups included only North Carolina professionals, though some had experiences in other locations. Nonetheless, this may be a limitation of the research.

Many graphical options were considered for testing, with numerous variations in symbology, legends, and color palettes. The decisions to limit the number to five and the five chosen for testing were made by mutual agreement of the NWS partners and the ECS team. As it was, five graphics led to a rather lengthy and repetitive survey that led about half of those who started the survey to exit before completing it. Despite this, the number of completed surveys reached the goal set by the team.

1. INTRODUCTION

Coastal beaches provide recreation opportunities to millions of people every year, which is why it is imperative to ensure timely, accurate and accessible information on coastal hazards and safety measures. Rip currents represent the greatest risk to beach-goers both worldwide and in the United States, accounting for at least 68 deaths in 2016 (http://www.ripcurrents.noaa.gov/fatalities16.shtml) and at least 31 in 2017 through June 30 (http://www.ripcurrents.noaa.gov/fatalities.shtml). These data illustrate the need for rip current forecasts that are timely, accurate, and understandable to the public. To that end, this project supports efforts of the National Weather Service (NWS) to improve communication of rip current forecasts to the public. The ultimate goal is to increase the likelihood of the public taking appropriate action to protect themselves when faced with rip current dangers and to ensure "beach-readiness."

As described in detail below, working with rip current specialists at NOAA, the ECS Team developed five variations of a public-friendly product that illustrated the same rip current risk information for the same region (coastal North Carolina) using different symbols, legends and color schemes. Input on the variations was gathered from the public through an online survey and from water rescue professionals and local decision-makers (emergency managers, local officials, and broadcast meteorologists) through focus groups regarding the understanding, ease of use, and utility of the variations as a risk assessment tool.

2. GRAPHICS

2.a Approach

The overall approach sought to visualize probabilistic rip current forecast information for enhanced risk communication and decision-making across a wide viewing public as well as meeting the advanced needs and parameters of public officials such as lifeguards, emergency management staff, and beach managers. This entailed a translation of rip current model output with geovisualization and iterative testing among multiple groups. A first phase involved acquiring and developing a wide range of alternative potential cartographic representations of rip current forecast data, ranging from the most native, raw format at model points to refined and interpolated multi-variable visuals. The end-goal of 3-5 mockups of map-delineated graphics was intended to convey forecast conditions as well as other potential concerns (longshore current, tide, sea breezes that are germane to broader beach weather forecasting).

2.b Design Goals

The tested products developed were expected to reflect the modeled rip current probability with the greatest fidelity possible, while also communicating that risk unambiguously across the wide range of potential users. Thus, several parameters guided as well as constrained the visualization for the selected test area of North Carolina. The maps should 1) identify gradational differences in the alongshore risk of rip currents (across a range of swell and surf conditions, tides, and agnostic to forcing meteorology); 2) provide for the concurrent use of other graphics such as bar charts or line graphs in pop-up windows or secondary time-delimited daily or multi-day graphics; 3) incorporate a range of best practices and utility for map visualization (graphical scalability/interactivity, color blind-friendly design, and simplified, implicit

cognitively unambiguous classification); and 4) have derived and tested graphics available for operational implementation as graphic symbol sets and accompanying source code (e.g., Javascript or HTML and other API). Map extent, scale, color, and classification categorization or ontology also required explicit decision-making prior to testing. Emphasis was focused on a daily rip current forecast product, and limited discussion ensued through the project on a potential 3-day outlook or integration with a parallel graphic or plot of hourly or multi-day outlooks.

2.c Visual Variables

A great many graphical design considerations were incorporated into our prototype and end-user tested graphics. These considerations were made to ensure the risk is accurately reflected, displayed, and perceived, that location awareness and geography were depicted in a straightforward base map, and that graphics would maximize legibility for readers with color-blindness or minimal visual acuity, and these factors would also help ensure legibility in multiple media and hardware display platforms.

Figure-Ground Relationships. Maximizing the visual impact of the rip current graphics would favor the use of bold, saturated colors and a muted, lower contrast (yet still legible) background base map. A great deal of evaluation was given to the use of alternative base maps, including transportation or imagery backgrounds (e.g., Google Earth or "Bird's eye view") and even the use of dot placemarks for particular beaches (see appendices for prototype examples not used in the survey and focus groups). It was ultimately decided by consensus with the NOAA partners that final graphics would use a common light gray basemap that enhances land-sea contrast and geographic locations (although without placemarks for towns and beaches).

White Space, Visual Balance, and Layout. The geography of the selected coastal area stretches a very long north-south distance, which allows a great deal of whitespace for legend placement and symbology, yet also required consideration of the variation of rip currents as a function of swell exposure and potentially even multiple swell directions in the modeling (east-facing vs. south and other beaches).

Overall, the study opted to use a single, common layout with the right-middle of the graphic balancing the north-south trend of the coastline. This provided ample space for symbology, legend (fixed at lower right) and the topology and familiarity provided by the shape of North Carolina's barrier islands, sounds, coast. White space to the inland side of the study area could also provide for placement of placemarks for towns and forecast points easily in future variations.

Whitespace in the ocean between the legend and coast and symbology also provides for popup space to highlight localized data in future, interactive maps.

Color and Color-Blindness Considerations. Given 5-7% of the population may exhibit degrees of color blindness, our use of color gave priority in mockup designs to reducing ambiguity among classes or gradients in hues. Spectral hue classifications, commonly used and oftentimes default in GIS and mathematical modeling, were avoided. We used ColorBrewer to guide many of our early designs and other software to test the selected prototypes prior to feedback with NWS and use in surveys. RGB colors (and other possible color models) were obtained for final selected classes and used in mockups in GIS and the HTML graphics. Besides symptomatic color blindness, color representation is also prone to misperception when large numbers of classes are used across a limited range of hues (and potentially, over multiple platforms.) Most tested graphics used a multi-hue, classified legend. However, we also experimented with a continuous color range that was deemed color-blind-safe, if, however, a non-traditional palette.

Alternative Symbology Approaches. A number of early mockups were explored and shared for potential visual representation, such as pictographs and icons (rip currents as waves, or channels of water, arrows, for instance), range graded proportional symbols (circles of varying range-graded or proportional symbology for rip current probability or wave height), and vane plots (for wave direction). After multiple prototypes were shared, NWS feedback prompted the team to not ultimately test these map symbologies. Appendix A concisely summarizes some of these representative examples.

Dot maps were used in two of the tested maps (Graphics A and B), which were spatially distributed and set to a fixed size (i.e., not range-graded or proportionally sized, thus only using color to portray rip probability.) Bars or "strip maps" were used in three tested maps (**Figures 1, 4, 5, and 6**). One of the maps used a multi-hue color range similar to that of NWS experimental storm surge graphics (four classes, blue-yellow-orange-red) (**Figures 1 and 4**). Two other strip maps used five classes and a color-blind safe pale yellow-yellow-red-purple-dark violet multi-hue ramp. Within each color symbolization, permutations were thus able to compare survey and focus group responses and preferences to alternative classifications and terminology.

Classification and Legend Designs. Legend locations and general size and layout were fixed in the tested maps, allowing the survey and focus groups to differentiate the preferences for using percentages, range labels of hazard, or an unclassed continuous legend. The key factors in the approach were to ensure that use of percentages matched the probability of occurrence of rip currents, that the number of classes could be visually and cognitively distinguished and that the terminology used to convey risk and probability were unambiguous. All graphics portrayed the same variable, probability of rip currents, yet the number of classes ranged from 3 to 5 (with the final unclassed).

Typography. The study opted to use a sans serif typeface and minimal overall text to reduce graphic complexity. Sans serif types are optimal for digital visual display and scalable with lower potential to reduce legibility at distance or with low resolution devices. Lato type, similar to Arial is used across the base map and legends as it is the default font for the web interface that was used. Text size was selected to ensure legibility as well. Word and letter spacing and limited kerning were incorporated into the legend. Leading line space was used in the legends to ensure legibility between classes.

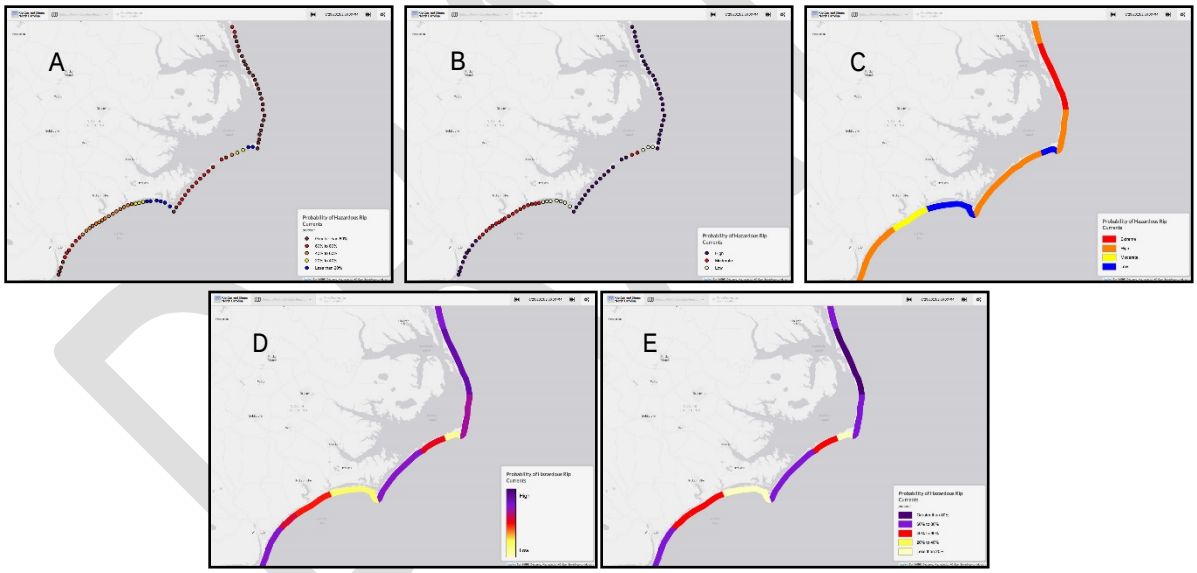


Figure 1. Graphics used in Survey. ¶A) dot map with color range-grade and percentage probability; B) dot map with color and three probability classes; C) strip map with color symbology (and multi-hue range blue-yellow-orange-red) and four-class legend; D strip map with color symbology (yellow through red and purple) and percentage probability legend; and E) strip map with color symbology (yellow through red and purple and continuous gradient probability legend (no percentage range classifications).

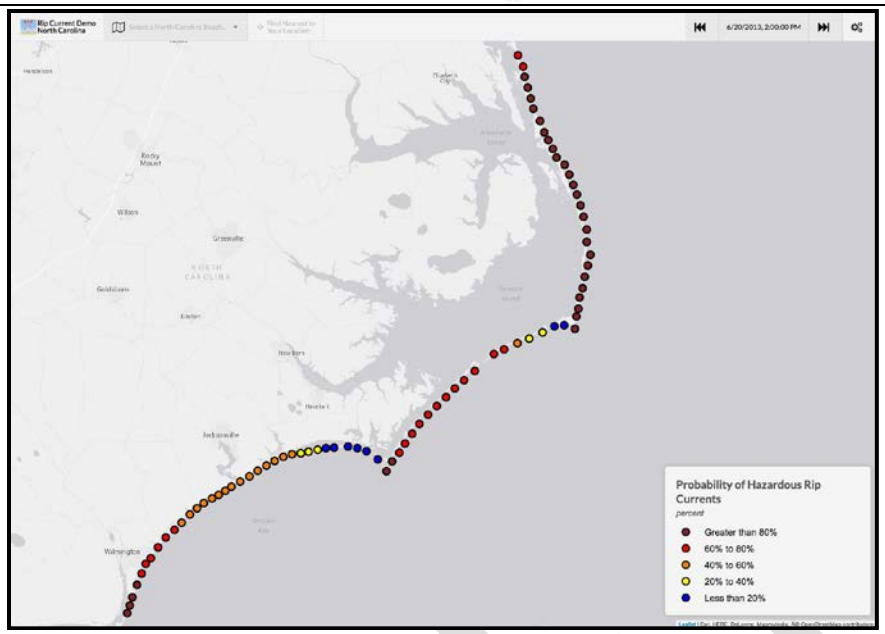


Figure 2. Graphic A: Dot Map with Percentage Legend

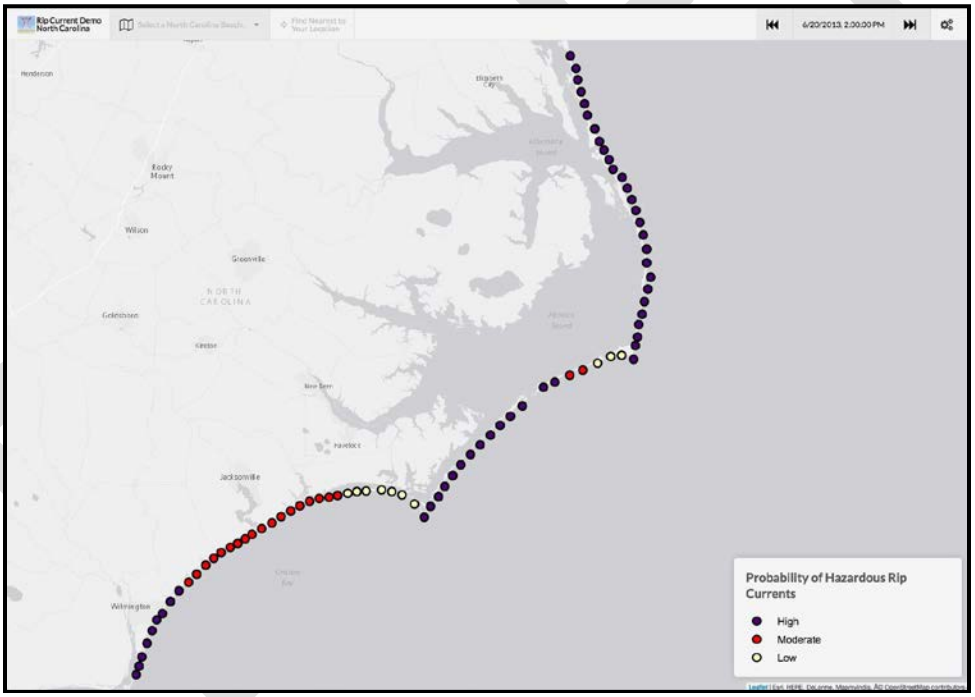


Figure 2 Graphic B: Dot Map with Text Legend

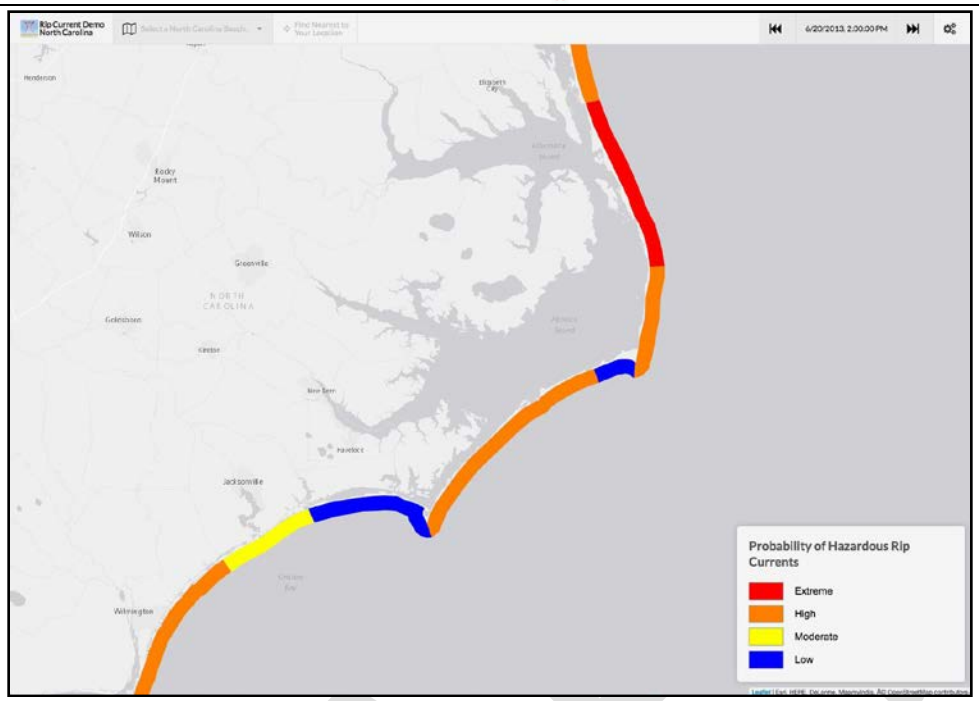


Figure 4. Graphic C: Strip Map with Text Legend

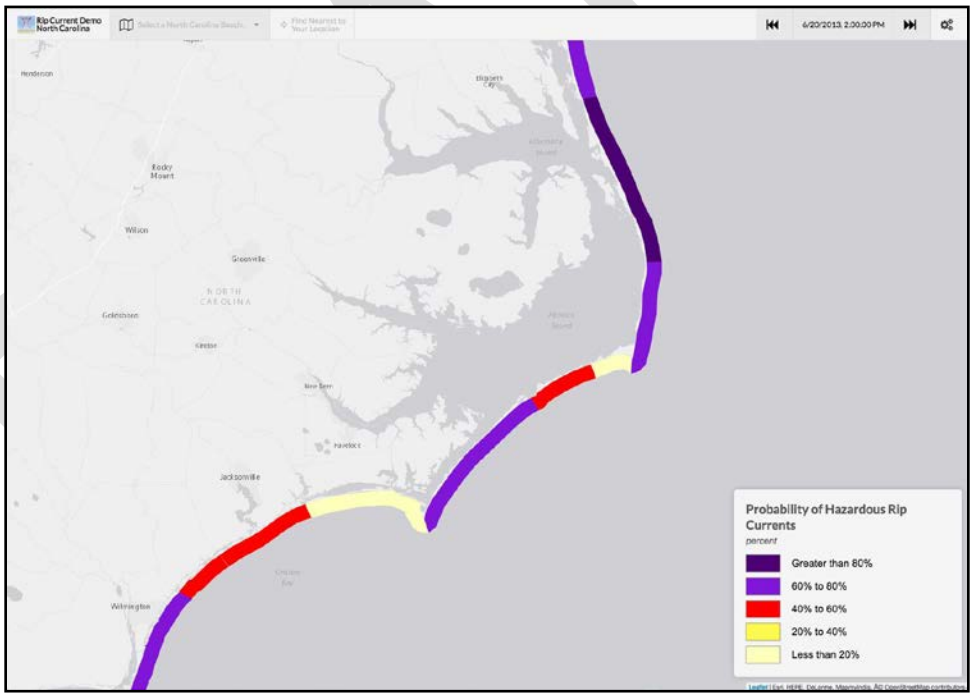


Figure 5. Graphic D: Strip Map with Percentage Legend

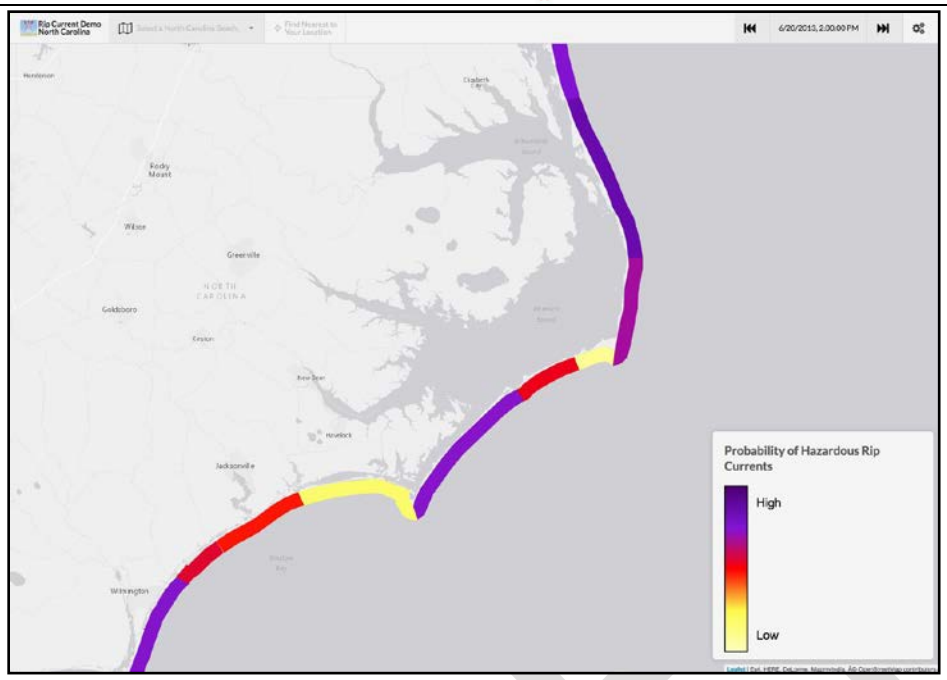


Figure 6. Graphic E: Strip Map with Unclassified Legend

3. DATA COLLECTION METHODS

As mentioned in the Introduction, the graphics were tested using an on-line public survey and focus groups involving local decision-makers to understand which, among a series of graphics, best fosters understanding of the likelihood of rip currents. The same graphics were used with both groups as were some of the questions relating to the graphics. The process for developing and conducting both approaches is described below, followed by a description of methods of data analysis.

3.a On–line Public Survey

Working in close consultation with NOAA partners, the ECS team developed a 49 question survey (Appendix B). The first part of the survey, consisting of 12 questions, covered background information on each respondent including age, state of residence, whether and for how long they have vacationed in North Carolina and their knowledge of rip currents and what to do, among other items. The remaining questions centered on the graphics, with the same questions following each. These questions included some that required the respondents to interpret the map as well as others that asked, using Likert scales, how they perceive various elements of the graphic as well as how the graphic might influence their decisions on going to the beach, going in the water, and swimming near a lifeguard. The final questions asked respondents to choose the graphic they think is most and least effective and to indicate why (choosing from a list with an option to add additional reasons).

The survey was originally entered into Qualtrics software and pre-tested by students at East Carolina University and other contacts of team members to identify questions that might be confusing, that might introduce bias, or that might lead to erroneous responses. Pre-testers were also asked to provide comments about the survey. Based on the results of this phase, the survey was modified and was hosted on an ECS server. The public was able to access it through a distinctive web address and the link was posted on various NWS and partner websites. The survey was a “responsive” web-based survey, meaning that its display adapted to a desktop or mobile device screen allowing the public to take the survey whenever they have internet access. The web-based survey’s “landing” page had a brief description of the survey, and a “Completely Automated Public Turning test to tell Computers and Humans Apart” (CAPTCHA) component to prevent “robots” from entering multiple copies of the survey.

Just over 1,080 individuals started the survey. However, given its length and the repetition associated with similar questions for five graphics, under half, 505 individuals completed the survey. While some of the pre-testers commented on both the length and the repetition of the survey, the NOAA/ECS team agreed that it would be impossible to obtain the full range of information needed any other way. With this recognition, the target number of responses was 300-500, in order to obtain a statistically valid sample, and that goal was met. Data were analyzed using SPSS statistical software, while the comments were subjected to content analysis in NVivo.

3.b Focus Groups

The ECS team worked with the rip current point person on staff at the Newport/Morehead City WFO and the Wilmington WFO to identify both potential participants and venues for the focus groups. Two were held in each of the WFO regions. Each focus group session incorporated an audience response system, or "clicker" system, where participants were presented with a survey in a PowerPoint presentation and they used the clicker devices to record their responses to each question. The full survey included questions addressing years of experience, age, and other demographic characteristics, as well as questions in a similar format to the public, on-line survey. Following each question, responses were automatically and anonymously shared with the whole group on the screen. At that point, participants were asked to discuss the results and their reasons for the responses. The sessions were audio recorded for transcription and later analysis. This format allowed for quantitative analysis of survey results, as well as qualitative data to provide a deeper understanding of this group's perceptions of the value and utility of the different products as well as suggestions for possible revisions.

A total of 26 individuals participated in the focus groups. Given the small sample size, the survey data were analyzed using Excel while content analysis software, NVivo, was to evaluate responses captured in the transcripts.

4. RESULTS: SURVEY

4.a The Respondents

Most of the 505 respondents, almost three-quarters (70%) are from North Carolina, but 27 other states as well as the District of Columbia and the Federated State of Micronesia are represented in the sample. The neighboring states of South Carolina and Virginia accounted for the next largest number of respondents (at 9% and 5.5% respectively). More than half of all respondents (55%) are 50 years of age or older and 35% are between 30 and 49 (**Table 1**).

Table 1. Age of Respondents

Age	N	Percent
Under 20	6	1%
20-29	47	9%
30-39	70	14%
40-49	106	21%
50-59	126	25%
60-69	111	22%
70+	39	8%

Fully 80% of all respondents have vacationed in North Carolina, with 72% having vacationed in the last year and an additional 12% having their last vacation in the state since 2011. Half of the respondents reported spending 14 days or less at the beach each year while 24% indicated that they visit the beach more than 30 days each year, and some (5.5%) reported more than 300 days each year. While at the beach, most (86%) go in the water though non-North Carolina residents are more likely to go in the water (93%) than North Carolinians (83.5%).

Overall, respondents were quite informed about rip currents, with all having heard of them and just over 80% responding correctly to the question about which statement describes what a rip current is. However, those with fewer days at the beach were somewhat less knowledgeable, though the differences are not statistically significant (**Table 2**). Further, with the exception of "stay afloat," more than 85% of all respondents knew common advice about what to do when caught in a rip current and less than 1% said they had not heard or seen such advice. This knowledge does not vary much by state of residence, age, or days at the beach. Finally, over one-third of respondents (38%) report having been caught in a rip current in the past and just under 58% know someone who has been caught in one.

Table 2. Days at the Beach and Knowledge of Rip Currents

	N	Correct	Incorrect
7 days or less	173	75%	25%
8-14 days	89	77.5%	22.5%
15-21 days	73	84%	16%
22-30 days	49	84%	16%
31-60 days	54	91%	9%
61-120 days	32	91%	9%
>120 days	35	83%	17%

Respondents get information about the weather from NOAA/NWS websites (91%), smartphone apps (53.5%), television (50%), and other weather websites (47%). Over 90% of respondents indicated that they check the weather forecast at least once a day, with 64% checking it several times a day. Further, more than 70% have checked an ocean wave forecast or tide prediction before going to the beach.

These results suggest a rather knowledgeable group of respondents with respect to rip currents. This is not surprising given the venues through which the survey was promoted (on NWS and partner websites) and the willingness of the respondents to complete the survey. The survey asked respondents to identify a correct definition of rip currents from several provided, but this does not necessarily mean that they are able to identify them on the ground, nor that they would be able to describe one. In fact, in a study undertaken in Florida, at least 95% of those surveyed were unable to describe a rip current (Fletemeyer 2011). Further, other studies have shown a disconnect between knowledge of what a rip current is and what to do in one and the ability to correctly identify them on photographs (Ballantyne et al. 2005; Williamston et al. 2008). Thus, respondents' rip current knowledge is likely to be lower than our results indicate. This combined with their beach experience suggests that their reactions to the various graphics will be representative of those needing rip current forecast information.

4.b The Graphics

As can be seen in Appendix B, with a few exceptions, the same questions were asked for each of the 5 graphics. There were several goals we sought to achieve: 1) to identify the respondents' understandings of what each graphic is showing and how they anticipate it would influence their decision-making, 2) to distinguish the element or elements of each graphic that are most and least useful in understanding likelihood of hazardous rip currents, and 3) to determine the graphic or graphics they believe will be most and least effective in presenting rip current risk. The discussion that follows is organized around these three goals.

4.b.i Understandings of Graphics and Influence on Decisions

There were no differences among the graphics with respect to what the product shows respondents (**Table 3**). Virtually all understood that the graphics show likelihood, although with three of the graphics, close to 5% chose the option "how strong the rip current is likely to be." It should be noted, however, that understanding that the graphics show likelihood and recognizing what that means from an NWS perspective is not necessarily the same.

Table 3. What Does This Product Tell You?

	A	B	C	D	E
How strong the rip current is	0.4%	0.4%	1.8%	1.0%	1.2%
How strong the rip current is likely to be	1.4%	4.6%	1.5%	5.3%	5.1%
The likelihood of a hazardous rip current	97.8%	94.3%	91.5%	92.5%	91.1%
Not sure	0.4%	0.8%	0.2%	1.2%	2.6%

A subsequent question relating to understanding the legend was asked for Graphics A and B. (It was decided that repeating the question for the other graphics would lead to unnecessary repetition.) The questions specifically asked what either "less than 20%" for Graphic A or "low" for Graphic B means. The results are shown in **Table 4**. There are similarities among the responses with close to 75% in both cases recognizing that rip currents can be present some of the time, but the differences with respect to "rip currents are not present" are somewhat striking, even though the percentages are relatively small. Some of the comments relating to this question for Graphic A reiterated 20% in different ways such as "less than 20% chance of rip current," "20% of the time with these conditions," and "Only a 20% chance of rips, if present, being hazardous." Other comments included: "Tells me not to worry, normal ocean currents," "Rip currents are very unlikely," and "Not much chance of rip current." Comments on Graphic B are similar to those for A, without the 20%. Examples of comments that perhaps signal some misunderstanding are "Rip current is not likely to happen," "Rip currents rarely occur," and "Low means forecaster is not sticking his/her neck out." Despite these comments and those who do not understand that rip currents can always be present, more than 70% recognize that there is always the probability of rip currents.

Table 4. Meaning of Lowest Category on Graphics A and B

	A: Less than 20%	B: Low
Rip currents are present all of the time	2.2%	3.0%
Rip currents can be present some of the time	76.0%	74.9%
Rip currents are not present	6.7%	12.1%
Other	14.2%	9.1%

These results suggest that, overall, there is a generally good understanding among respondents of what the graphics show with respect to the probability categories. However, separate from the graphics, the results also suggest the need for continued education of the public about rip currents specifically that the possibility of rip currents always exists.

In addition to documenting understanding of the graphics, the anticipated impact of the graphics on decision-making is of concern. The first question relating to decisions addressed the legend, specifically the terms used to characterize probabilities of hazardous rip currents for each graphic. There is little difference among the graphics with respect to the stated decisions of respondents within probability levels (higher or lower) (**Table 5**), but there is a difference in decisions between probability levels. Survey respondents indicated that they will stay out of the water or avoid locations where the probability of rip currents is depicted as highest on the maps, generally irrespective of how the probability is presented. On the other hand, more than half of respondents said they would do nothing different with the lowest probabilities, again irrespective of the legend. There is somewhat more variation in the middle categories, with fewer suggesting they would avoid the location or stay out of the water than with the higher probability. The middle category also shows a wider range of decisions with between 56% and 61% checking either with lifeguards or with what others are doing.

Table 5. Decisions with Different Probabilities (in rounded %)

	Greater than 80% or High					40-60% or Moderate				Less than 20% or Low				
	A	B	C	D	E	A	B	C	D	A	B	C	D	E
Avoid that location	24	22	23	26	24	6	3	4	5	1	1	1	1	2
Still go; stay out of water	48	49	47	45	42	24	20	21	23	2	2	2	2	3
Still go; check with lifeguard	15	14	14	13	13	37	41	41	38	19	21	20	21	20
Still go; check with others are doing	6	8	8	8	9	20	21	19	18	21	19	19	18	18
Nothing different than planned	7	7	8	9	12	13	15	15	15	58	58	58	58	57

The next decision-related question for each graphic used a Likert scale to determine how likely the graphic would be to generate specific decisions. The information shown in **Figure 7** presents the mean Likert score of responses to questions that asked how likely would this graphic affect your decision to…. (with 5 being very likely and 1 very unlikely). With the exception of the decision to go to the beach, Graphic A shows the highest likelihood to influence all decisions and Graphic E the least likelihood, though the differences are very small. Perhaps more telling is that the graphics are least likely to influence the decision to go to the beach or to choose a beach.

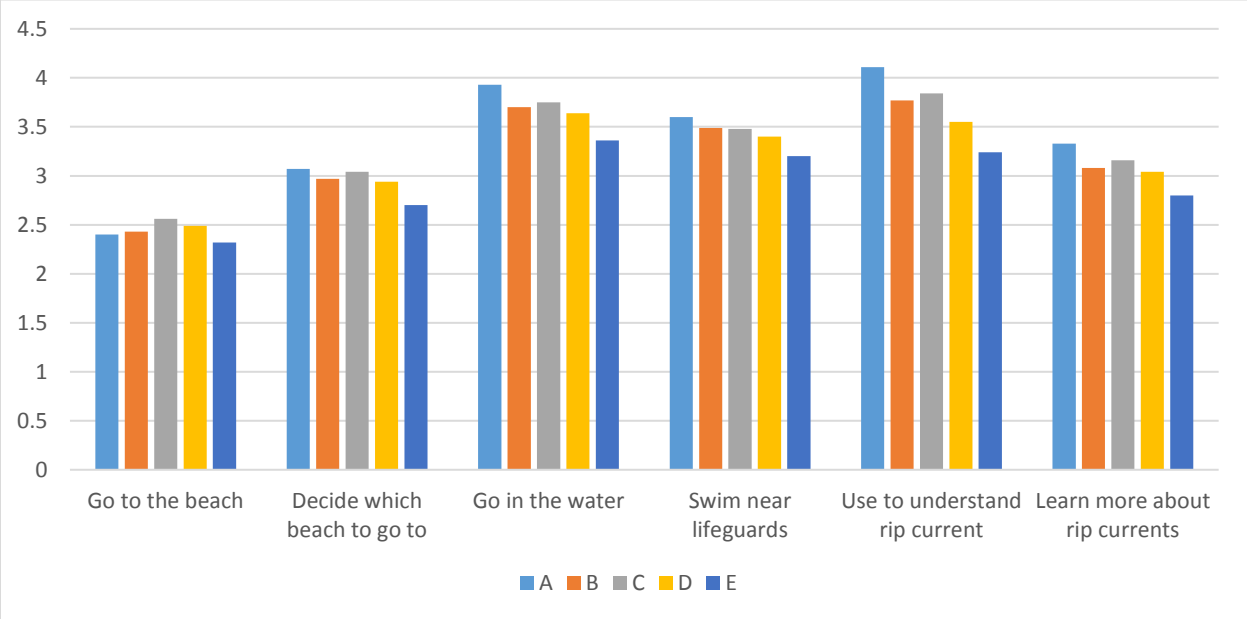


Figure 7. Mean Likert Scores for Likelihood of Decisions

4.b.ii Effectiveness of Graphic Elements

The first questions in the survey addressing effectiveness asked about the usefulness of various elements of the graphics in understanding rip current risk forecasts. Respondents were able to choose as many of the elements as they wanted. Overall, there is not much difference among the graphics (**Figure 8**), although Graphic E shows the lowest percentages for all elements. Both the use of color and the locational information were chosen by more than half of respondents for all graphics, with the use of color standing out, particularly for Graphics A, B, and C. In contrast, the categories used were least frequently chosen, with Graphic C's categories seen as useful to more respondents than is the case with the other graphics.

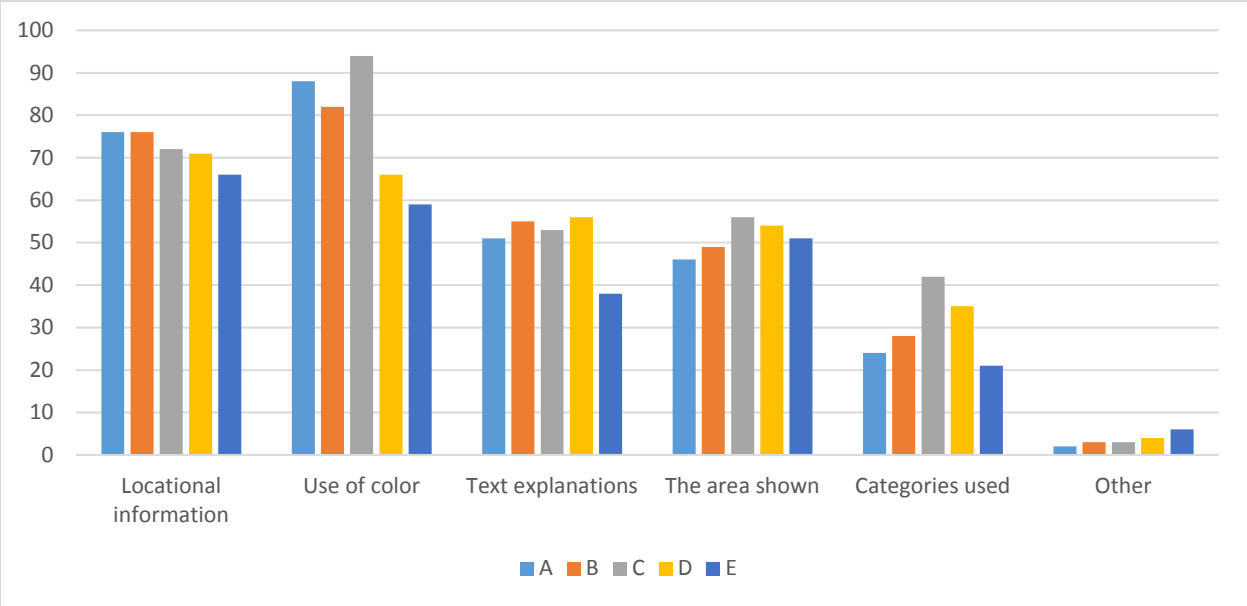


Figure 8. Most Useful Elements in Understanding Risk of Rip Currents (%)

The other question addressing elements of the graphics used a Likert scale asking respondents to record their perceptions, from very positive (5) to very negative (1), of the characteristics of each of the graphics (Figure 9). The scores for Graphics A, B, and C differ rather markedly from those of C and D, with Graphic E showing the lowest scores overall. A and C appear to have elicited very similar perceptions, with A edging out C slightly on information included and format, and with C edging out A, again very slightly, on understandability and use of color. They evoked very similar perceptions with respect to graphics/symbols, and text despite there being quite different on both of these features. It is interesting to note that Graphic B, which is the same as A with the exception of the legend, did not generate the same perceptions as did A on the same features.

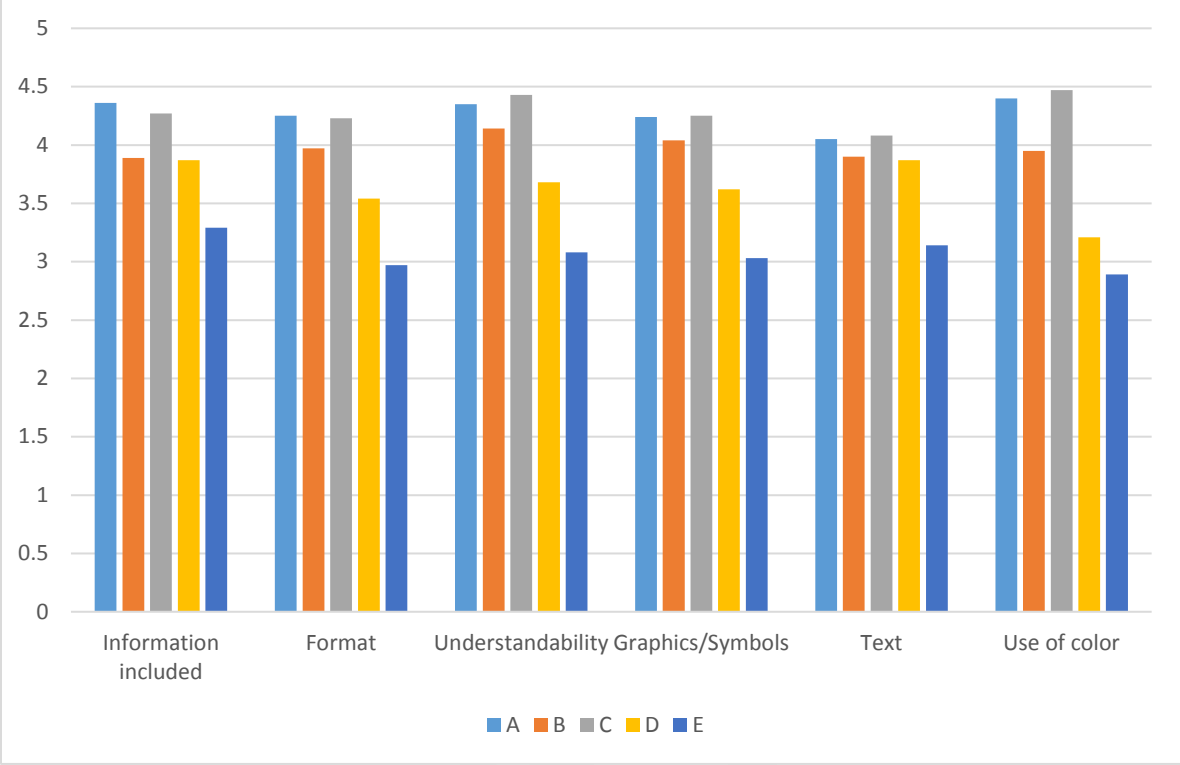


Figure 9. Mean Likert Scores for Perceptions of Characteristics

4.b.iii The Most and Least Effective Graphics

The final set of questions in the survey asked which of the five graphic respondents thought are most and least effective and why, with the ability to choose multiple responses when indicating why. No graphic was chosen as most effective by a majority of respondents, but Graphic C was chosen by more respondents than any of the others (**Table 6**). In contrast, one graphic, E, was seen as least effective by a majority of respondents. It is interesting to note that, while Graphic A was the 2nd most preferred graphic, it was also the 2nd least preferred (though the margins between 1st and 2nd are quite different).

Table 6. Most and Least Effective Graphics

	Most Effective	Least Effective
A	28.1%	15%
B	6.9%	14.9%
C	47.1%	3.6%
D	12.5%	7.9%
E	4.8%	55.2%
None	0.6%	3.4%

The reasons vary for why respondents chose their preferred (i.e., most effective) graphic, and respondents cited several reasons for their preferences (**Table 7 and Figure 10**). The data represent the reasons chosen by those who identified a given graphic as preferred, so the N is different for each one. For instance, for those who chose Graphic C, 238 respondents, approximately 90% (215) said that the colors make sense to them while for those who chose Graphic A, 142 respondents, some 87% (123 individuals) prefer it because it is easy to find the situation at a particular beach. It is important to note here that Graphics A and B were misinterpreted by some respondents, who apparently believed that the dots represent specific beach locations rather than location associated with model output. At the same time, the results associated with the categories suggest that probabilities, as is the case with Graphics A and D, were chosen by large

percentages of those who preferred those graphics, while B showed the most preference for the categories used (high, moderate, low). On the other hand, for those who chose C the categories were important to many but not to as many as with those who preferred A, B, or D -- and comments were made about the problem of using the term *extreme*.

Table 7. Percent of Respondents Citing a Given Reason for Effective Graphic

Reason	%
The categories make sense to me	72.7
The colors make sense to me	83.6
The symbols makes sense to me	51.1
It is easy to find the situation at a particular beach	67.3
I can see what the risk is at a number of places	67.9
It is easy to interpret	75.2

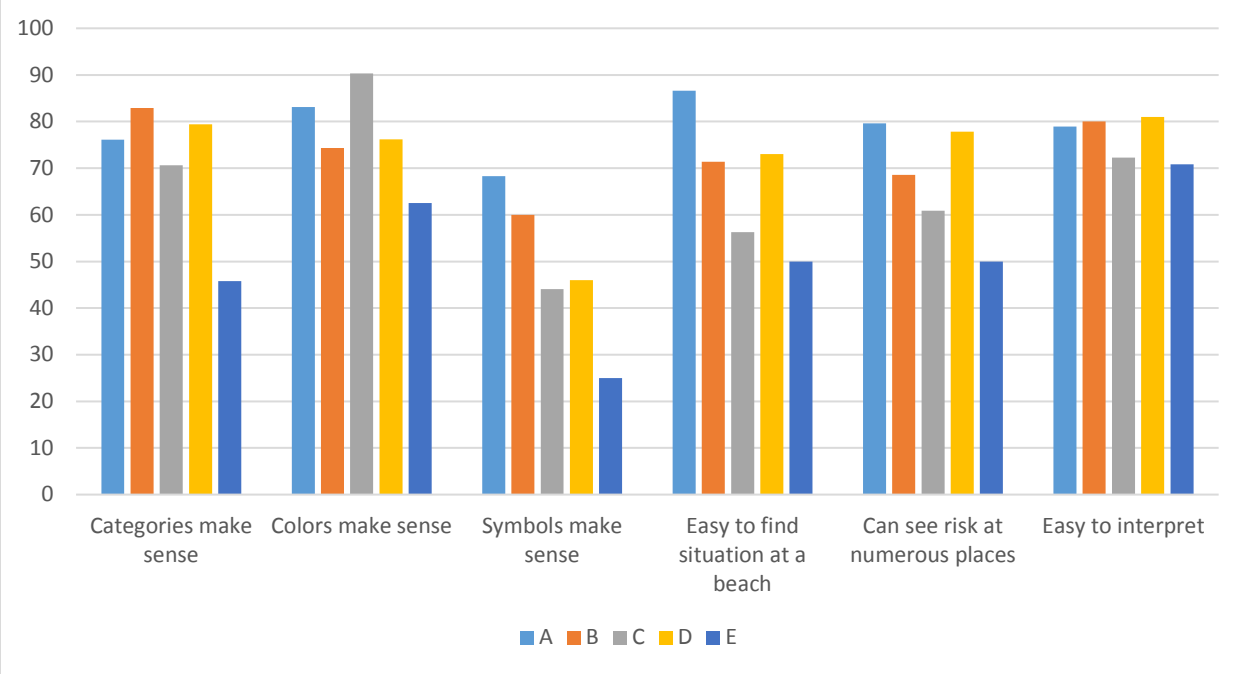


Figure 10. Reasons for Choice of Most Effective Graphic

In a similar fashion, the reasons for finding graphics least effective also vary, but the number of reasons cited by respondents is less than was the case for those identified as most effective (**Table 8 and Figure 10**). In fact, each respondent identified an average of just over 4 reasons for choosing a graphic as most effective but an average of just over 2 reasons for choosing a graphic as least effective. This might suggest that it is easier to isolate what does not work on a graphic than what does. To wit, the symbols were generally not seen to be problematic, as only about 11% overall identified them as a problem in effectiveness, with Graphic A being least effective on this item at just over 20%. Colors were seen to be unhelpful with 4 out of 5 graphics having been cited by 40% or more of respondents as contributing to ineffectiveness. Graphic D certainly stands out here.

Table 8. Percent of Respondents Citing a Given Reason for Least Effective

Reason	%
The categories do not help me understand the risk	30.1
The colors used are not helpful	46.7
The symbols do not make sense to me	10.7

Reason	%
It is difficult to find the situation at a particular beach	34.9
It is difficult to distinguish risk at one location from another	45.3
It is difficult to interpret	43

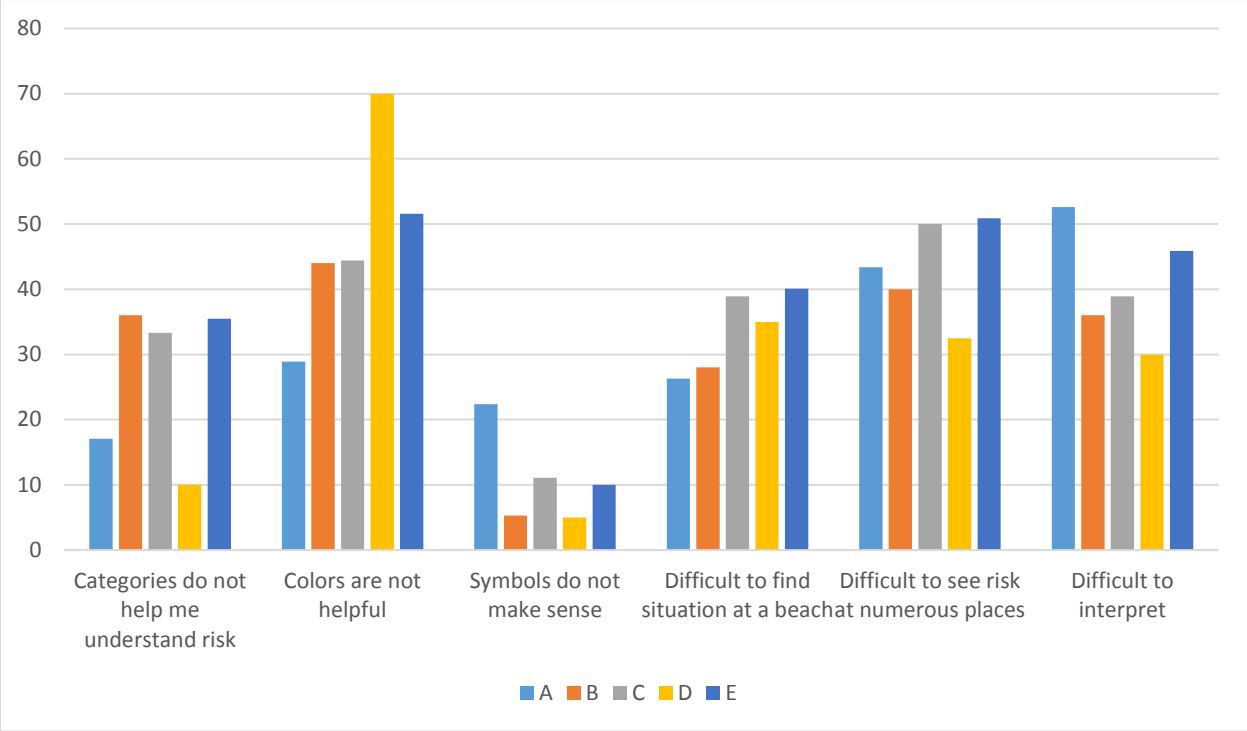


Figure 11. Reasons for Choice of Least Effective Graphic

4.c Summary

Overall, none of the graphics was overwhelmingly preferred by the respondents to the public survey, though more respondents chose Graphic C as most effective. And while every graphic was identified by some respondents as least effective, Graphic E was chosen by a majority of respondents. A number of reasons were cited for the choices of both most and least effective, complicating decisions about what will work best.

Several conclusions can be drawn from both the quantitative results and the comments provided by respondents. While there is much concern in the NWS and elsewhere about the ability of the public to understand probabilities, many respondents preferred these to the categorical classifications of risk. This, combined with the results shown in **Table 4**, suggests that while most understand what the categories indicate, low risk was misinterpreted by 12% of respondents as indicating that rip currents are not present, compared to under 7% choosing that option with the percent probability given. Further, a large percentage of those who chose Graphics A and D as most effective cited the categories as being important to their choices, while about a third of those who chose Graphics B, C, and E as least effective cited the categories as a reason. Colors were found by relatively large percentages to contribute to making graphics both most and least effective. As an example, commenters noted that red should represent the highest risk, not blue or purple. Finally, as noted above, the dots led some to believe that they related to specific locations. At the same time, there were numerous comments about the need for place names on the maps to help identify locations.

5. RESULTS: FOCUS GROUPS

5.a The Participants

Four focus groups were held, one each in Nags Head, Emerald Isle, Wrightsville Beach, and Wilmington, with a total of 26 participants. Participants identified as lifeguards, water safety professionals, emergency managers, other emergency support functions, and media and just over 60% have experience rescuing swimmers from rip currents. The age breakdown and years of experience are shown in **Table.9**.

Table 9. Age and Experience of Focus Group Participants

Age		Experience	
Under 20	8%	Less than 5 years	38%
20-29	23%	5-10 years	23%
30-39	35%	11-15 years	12%
40-49	12%	More than 15 years	27%
50-59	19%		
60+	3%		

As mentioned earlier, participants were presented with a survey in PowerPoint (see **Appendix C**) to which they responded using clickers. Prior to gathering information on the participants' perceptions of the graphics, they were asked the extent to which, in their experience, the public pays attention to rip current warnings as well as their views of the public's understanding of rip currents. None suggested that the public pays no attention to warnings, but 88% chose *somewhat* instead of *to a great extent*. When asked how they would characterize the public's understanding of rip currents, they were split with 50% choosing "very little understanding" and the other 50% choosing "some understanding." They were also asked what they, from their professional experience, think the public most understands and least understands about rip currents (**Table 10**). Not surprisingly, the results are, for the most part, mirror images of one another. During the discussion, one participant mentioned another aspect he believes is poorly understood, that of knowing when one is in a rip current so they can act sooner rather than later.

Table 10. Public Understanding

	Most understands	Least understands
What a rip current is	50%	0%
How dangerous a rip current can be	13%	38%
Their ability to get out of the rip's pull	38%	0%
How to spot a rip current	0%	63%

Following this background on public understanding, participants were led through each graphic with a series of questions asking about their perceptions with respect to various elements of each one. A Likert scale running from very positive (5) to very negative (1) was used throughout, except for the questions on how helpful the product is to their day-to-day operations, where the categories ranged from very helpful (5) to entirely unhelpful (1). The overall results are shown in Figure 12. Graphic C has the highest mean scores for all but one category, and Graphic B is close behind with very small distinctions on some elements. Graphic D appears to have generated the least positive perceptions.

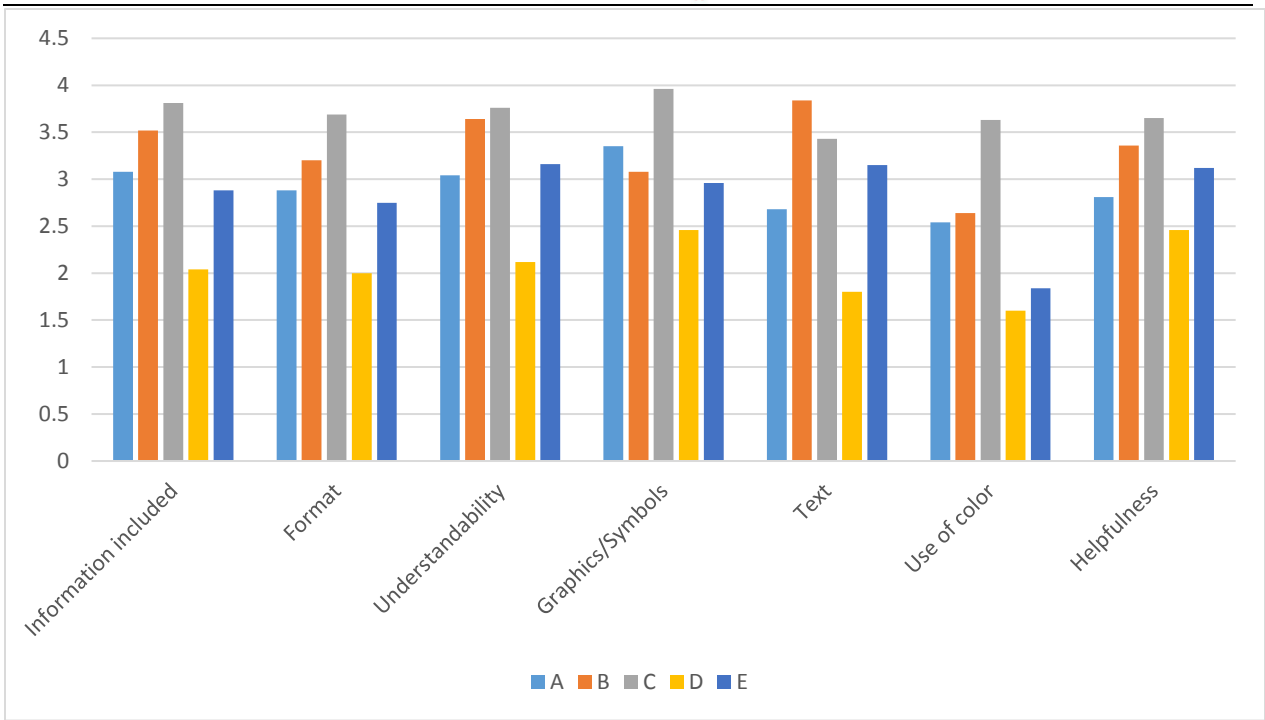


Figure 12. Mean Likert Scores for Focus Group Perceptions

5.b Discussion of the Graphics

In the following sections, each graphic is considered in turn so that the discussion that follows each can be seen in the appropriate context. A summary of participants' most and least preferred graphics along with relevant comments.

5.b.i Graphic A

Participants seemed to be of two minds about this graphic. Some saw it as positive because of the detail it has and one individual liked the dots because they are "…not sweeping everyone under a green line." On the other hand, others believed there are too many categories, making it too complicated for the public, with one participant noting that the public will not know the dots represent output points from a model. The legend was seen to be clear, but very busy, with many complaining that there are too many categories. This led to discussion about both the colors and the use of probabilities. It was noted that there are too many colors, making them hard to distinguish. Many said they prefer the "old bold colors" and the stoplight palette. In addition, there was concern about the use of probabilities, with the recognition that percentages do not necessarily translate into behavior modification. It was agreed in one group that they do not look at 60-80% and greater than 80% differently, and one person pointed out that the perception of 40% could be different with different people (which aligns with the findings from the survey shown in Table 5).

A theme throughout the focus groups was that any information is good. One said he ranked this as somewhat helpful because anything is better than nothing. However, others suggested that it is what resonates best with their users that is most important, and there was concern about this product to that end. As one said, "Whatever you put out there, I will learn to read and use it. I wouldn't hand that map to the public."

5.b.ii Graphic B

The first reaction to this graphic is that it is better than the first one because there are fewer categories and no percentages and, as a result, it is simpler, which was seen as a step in the right direction. Concern remained about the use of dots because the gaps could be confusing. It was mentioned that both graphics miss "impact" and a suggestion was made to perhaps use "high threat." Colors were a concern, particularly the use of purple. When this graphic was shown, in all focus groups it was made clear that purple cannot

be used because the International Surf Lifesaving Association (ISLA) and the United States Lifesaving Association (USLA) use purple to indicate dangerous marine life. It was also suggested that blue does not work and, again the stoplight palette was preferred. It was at this stage that discussion centered on the use of green, where some worried that it gives the impression that it is safe (as in green means go), while it was also pointed out by others that when rip current probability its low, that is when people should swim, so maybe green is appropriate. There is some difference among communities in the use of green flags, where some use no flag with low rip current probability while others use green flags.

It was generally agreed that this graphic is more helpful than the first, as can be seen on Figure 12. Overall it is seen a good product, but it may not be helpful for their use because they would have to explain it to people. It is not believed to be a graphic that can just be posted with no explanation.

5.b.iii Graphic C

Participants reacted most positively to this graphic as soon as it was shown. Comments like "simple," "clear distinctions," and "it tells me what I need to know" were made when asked about why they scored it as they did on Information Included. At the same time, there was concern about the use of the term *extreme*. It was seen as a problem because there were questions about how the public will understand it or if they will understand it at all. Participants preferred the strips to the dots, in part because it is familiar; it is "…more what we're used to, like hurricane warnings and watches." There was concern about a lack of site specificity; being able to look broadly and then zoom in was seen as necessary. Further, while some commented about the good contrast among the colors, others did not like the use of blue, again preferring the red, orange, and yellow or green palette.

This graphic was seen as most helpful of all presented. This is one graphic that participants believed they could put out and people would understand it, being viewed as easy to explain to others. A broadcast meteorologist said he could put it out on social media and not be worried that people would not understand it.

5.b.iv Graphic D

The first comments about this graphic were that there are too many choices in that five categories are too many, colors are too close to be easily distinguishable, and percentages are not helpful. The Likert averages for this graphic shown in Figure 12 can be best explained by a quote from one participant: "This wraps up all the negatives in one graphic." There was general agreement that the strips are helpful, but the colors are not, with the problem of using purple coming up again. Overall, this graphic was characterized as not being intuitive. Because of the general dislike of this graphic, there was not as much discussion as for the others.

With respect to helpfulness, it was recognized that it still gives information and as a result would be part of their daily use, but it would need to be repackaged significantly for if it were to go out to the public. In addition, for their purposes, the differences between 20%and 30% (or 35% and 45%) are not important.

5.b.v Graphic E

Much of the discussion surrounding this graphic centered on the use of two categories, with some preferring this because it is simple and more digestible and others preferring three, though there was acknowledgement that using two categories is better than five. A few participants liked the gradient scale but most did not, remarking that it is not decisive and "I don't like how in the middle you don't really know." The fact that the map itself has distinct boundaries between colors while the legend does not was seen as a significant problem, specifically, there are two categories in the legend but more on the map. Some wondered how a map with a gradient would be developed, but most agreed that they need to match. Again, the colors were seen as problematic because purple was used and one suggested it should be "yellow to blazing red." On the positive side, participants remarked on the use of strips over circles.

Again, it was noted that the graphic provides information and any information is helpful. Helpfulness would improve if the map and legend matched better. As it is, with the wide color scheme, in the opinions of a majority of participants, the graphic leave a lot open to interpretation, which detracts from its helpfulness.

5.b.vi Overall preferences

Graphic C was most preferred by the focus group participants and Graphic A was least preferred (**Figure 13**). Graphic C was not chosen as least preferred by any participant nor was Graphic A chosen as most preferred by anyone. While each graphic was chosen by just over 50% of participants, no other graphic came close to these in their respective categories. Those who chose Graphic C cited such characteristics as the simplicity of the information on it, how relatively easy it is to understand and the order of the colors. Some chose C but with the caveat that it needs to have only 3 categories. In the general discussion following the survey, one participant said that on Graphic C, it "…would be exceptional if you left it at 3 categories – take the extreme out. If it is high, people shouldn't be out there." A few chose Graphic B, remarking that it follows what beaches use, with three categories, and the site specificity was seen as a positive aspect (though this is not beach specific). Those who chose E liked it because of the use of two categories, though they noted the need to change the color scheme.

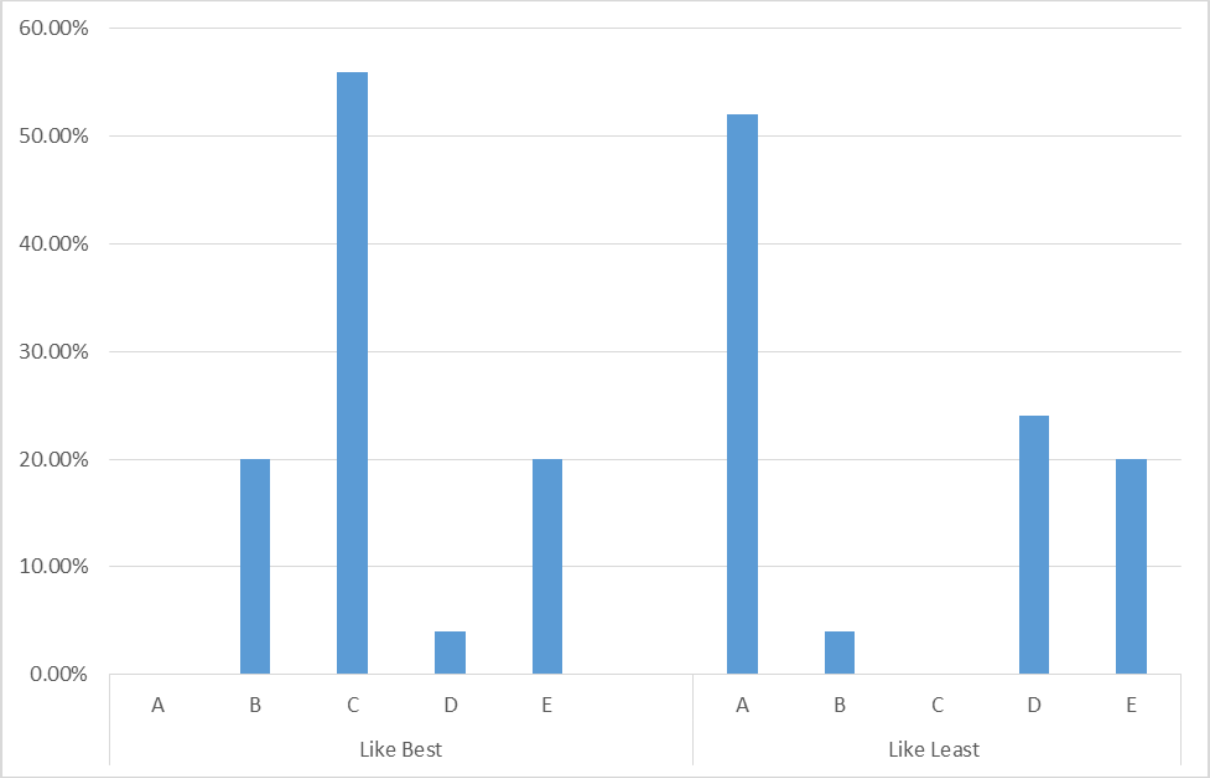


Figure 13. Most and Least Preferred Graphic by Focus Group Participants

Reasons for choosing Graphic A as least preferred centered on the percentages and the dots, remarking on how complicated it is to interpret. For instance, there was concern that people who see dots "…might think that particular spot is where we had x number of y type of rip currents rather than thinking it is going to be affecting the entire coastline." Further, it was suggested that percentages are not efficient at all in that people will interpret them differently. One asked, "will the average beach goer know difference between 60 and 80%?" Graphics D and E were also chosen as least preferred by a few participants. The comments on D are quite similar to those about A, relating to the use of percentages and the number of categories, and for Graphic E comments centered on the confusion likely to be generated by the use of the gradient.

5.b.vii General discussion following survey

The final portion of the focus group discussion centered on any aspect the participants wanted to address.

An important addition to the graphics, according to many, is locational specificity. It was agreed that people need to know their locations and the risk with respect to that. One person wondered in it would be possible

to drop a pin for where people are. In the absence of that (or in addition to it), having opacity to it so one could see through the line to identify locations was suggested.

Other discussion focused on some of the terms used. A question that arose was: Is it necessary to say *hazardous*, since all rip currents are? On the flip side, without that, the fact that even low probability can be hazardous might be missed. This led to consideration of the words *probability* and *low*. A number of participants prefer the word *risk* to probability, particularly when percentages are not used. And some recommended the use of *lower* rather than low because that implies that there remains some risk while *low* may not be interpreted as such. Finally, there was a recommendation for some sort of subtext, without getting too text heavy, that evokes action and a caveat that even the lowest risk has some risk.

6. IMPLICATIONS

The overall results do not lead to identifying one perfect graphic from anyone's perspective, though Graphic C was preferred by more survey respondents and focus groups participants than any of the others. This is not really a surprising outcome, as rarely does one product meet everyone's' needs and preferences completely, especially when dealing with probabilistic, complex phenomena such as rip currents. At the same time, the overall sentiment from all was that any information is good and would be helpful. Indeed, the focus group participants expressed that what works for the public works for them, because they want to be able to distribute something useful to the public. The water safety professionals and lifeguards look at many sources of data, so this would be only one part.

Within the survey results only, there was a significant association (X^2 significance = 0.01) between knowing what a rip current is and the preferred graphic. Specifically, a larger number of those who chose the wrong response to the question asking about which statement describes a rip current preferred Graphic C (57.3% compared to 45% of those who were correct), and a smaller percentage (21.9%) chose A compared to those who were correct (30%). There was no significance with respect to rip current knowledge and the least preferred graphic.

Strips were preferred to the circles, particularly by the professionals. Most of them recognized that the dots are model sampling points rather than beach locations, which seems to be what some of the survey respondents thought, given some of the comments of respondents. For instance, one preferred A because of the "frequent location points" and "The maps with % at each location is more useful."

Color was a significant concern among many. Most preferred colors with which they are familiar, the so-called stoplight palette. However, among the focus groups, there was some difference of opinion with respect to the use of green. Some were concerned that, since green means "go," people would think it is completely safe. Others remarked that conditions that merit green are, in fact, when people should do in the water, compared to yellow or red. Some suggested a red, orange, yellow color scheme to indicate that caution is always necessary.

The use of probabilities on the graphics was not supported by many survey respondents or focus groups participants. Some preferred the detail, but others questioned the ability of the public to understand how the numbers might translate into threat or risk and survey results support that concern. None of the focus group participants thought that the use of probabilities was helpful for their day to day needs. With respect to the use of text to differentiate probabilities, there was concern about the use of the term *extreme* and how that would be interpreted by a beach-goer. The same was said about *low* with the concern that those with less knowledge of rip currents would interpret it to mean no risk.

Finally, the need for geographic specificity was mentioned in both survey comments and in the focus groups. Not only was there a desire to be able to zoom into a location (which would be available in a dynamic web environment compared to a static survey), but the addition of place names, specifically individual beaches and towns, was a theme throughout.

7. RECOMMENDATIONS

While not resulting in an overwhelming call for one of the graphics presented in the survey and focus groups, the results of this project indicate that a graphic similar to Graphic C, with some revisions, will be the most effective. More participants in the project chose Graphic C as most effective than any other graphic, and fewer chose it as least effective. Further, those least knowledgeable about rip currents chose Graphic C as most effective, and these are the people most in need of information they can understand. There are numerous reasons not to use the other graphics, including misinterpretation of the dots, misunderstanding of percentage probabilities, and the number of categories.

The following are recommended revisions to the graphic, along with supporting reasons:

1. Use three discrete categories: Three categories are familiar to many beach-goers and to water safety professionals, as this is what has been used for rip currents internationally. While two categories may appear at first glance to be simpler, they are not because there is often not such a clear distinction in probabilities. Further, a gradient is difficult for many to interpret. More than three categories can be confusing and can make it difficult for beach-goers to understand the risk within the intermediate categories. Finally, there was very strong preference in both the survey and the focus groups for categorical information as opposed to probabilities. Because of this, the legend should be revised to Risk of Hazardous Rip Currents.
2. Use a stoplight palette: This is the color scheme used by the USLA and the ISLA and thus is nationally and internationally recognized by many beach-goers and by professionals. Although there is some difference of opinion about the use of green to indicate lower risk because it suggests "go," credence also needs to be given to the sentiment that these are the best conditions for people to go in the water. In addition, the use of red, orange and yellow, which was suggested by some, may cause difficulties because of the variability in the devices people use to check such forecasts which may not make the distinction between yellow and orange sufficiently clear. Purple cannot be used because of the meaning it has within the USLA and the ISLA, and blue was found to be problematic from an interpretation perspective.
3. Use *lower* not *low*: There was great concern among the participants in the focus groups that the use of *low* sends the wrong message. The results of the survey validate this concern, as some respondents interpreted *low* to indicate no risk. *Lower* is much more likely to communicate that there is still a risk.
4. Include place names: This was a recommendation made by respondents throughout the survey and by the focus group participants. This is especially crucial for tourists who are less likely to have an understanding of where they are with respect to the risk. This includes beach and town names, and perhaps ultimately to have a pin dropped on the graphic showing an individual's location. This recommendation is in line with findings of other research on warnings, which has found that locational specificity is more likely to generate actions on the part of those at risk.
5. Provide a dynamic environment: Both professionals and knowledgeable beach-goers desire additional information (some of which is shown on the graphics in Appendix A). Providing the opportunity to click on a location and obtain additional information would be particularly helpful as professionals help others understand the risk and others desiring the additional information can obtain it. This recommendation goes beyond the information now available by clicking on a location on the experimental page. This project did not test different products for the focus groups as it was seen as important to understand their views of what will work with respect to their interactions with the public. The overarching attitude of the professionals was that any information is useful to them and that they are interested in products that they can distribute to a range of groups with varying levels of rip current knowledge. The dynamic environment recommended here would provide additional information that will be useful to them, as appropriate, recognizing that professionals in different positions have differing needs.

6. Develop marketing and outreach campaigns. It was pointed out in the focus groups that many of the rescues are of individuals who come from non-coastal states. Further, given the inability of many to identify rip currents, as shown in the studies cited here and in others, there remains a need for marketing and outreach relating to both the products and rip current safety, including how to identify rip currents and how to know when one is caught in a rip current. These campaigns should be developed in consultation with water safety professionals and others with experience in rip current rescues and in public outreach.
7. Integrate with Beach Forecast page: The National Weather Service may want to consider merging the recommendations here with the Beach Forecast graphics. The use of gray instead of green does not conform to USLA and ISLA colors and therefore may not be understood by many. Similarly changing *low* to *lower* may relate better to the description that accompanies that category on the experimental page.
8. Consider extending analyses. The National Weather Service may want to consider extending the analyses with respect to reaching other locales. Before undertaking this, however, several considerations are appropriate. First, the respondents to the survey represent a number of locations other than North Carolina, and the results between North Carolina residents and others are not significantly different. In addition, the North Carolina coast has a wide range of coastal configurations including gradients along the Outer Banks from North to South as well as angular beach orientations, presenting as wide a range of situations as are likely to be found in other places. Similarly, while there was some disagreement in the focus groups about the use of green to represent lower risk, this is the international standard. It might be useful to find out if there is such variation at other beaches.

References

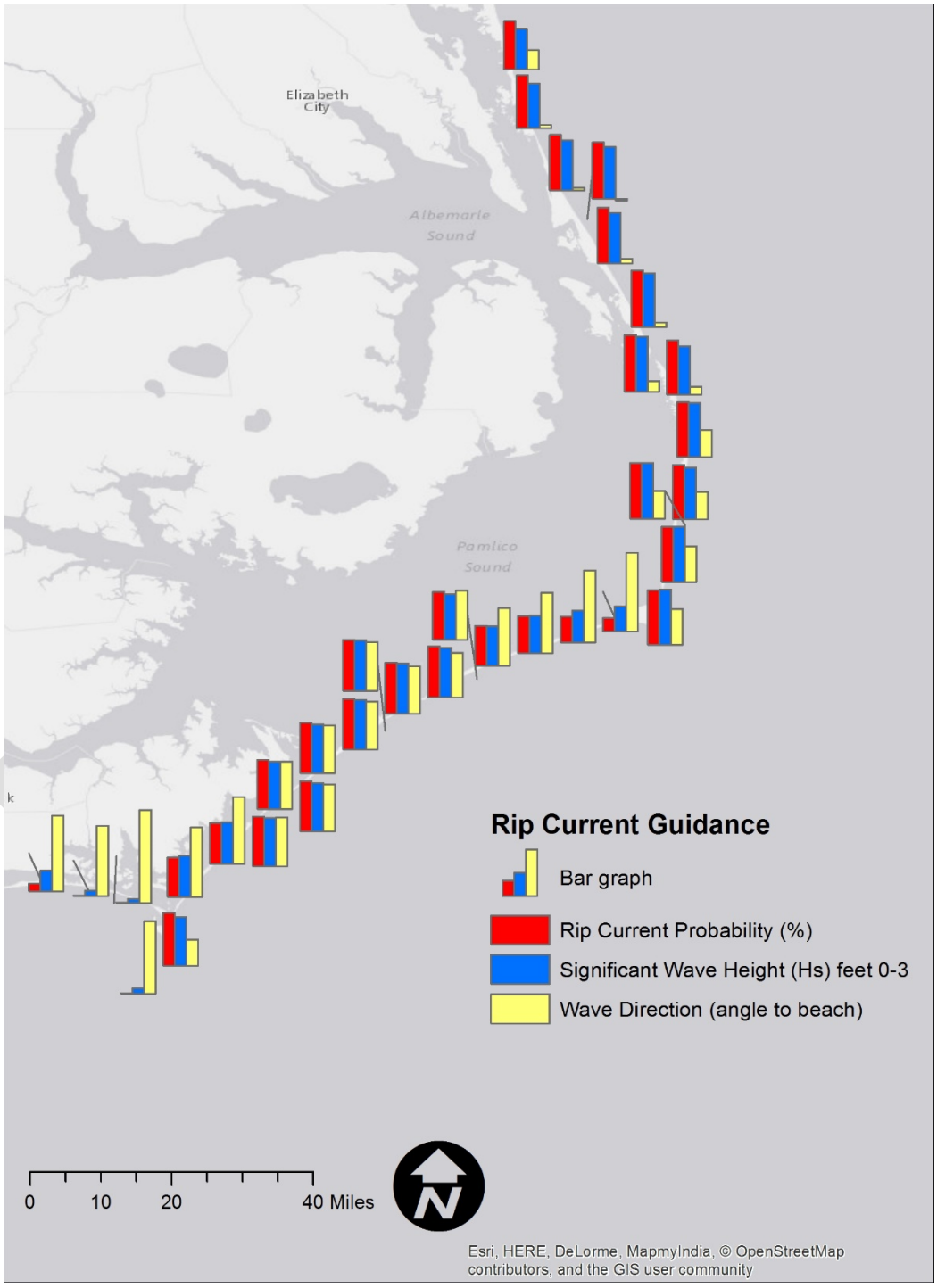
Ballantyne, R., Carr, N., and Hughes, K. 2005. Between the flags: an assessment of domestic and international university students' knowledge of beach safety in Australia. *Tourism Management* 26: 617-622.

Fletemeyer, J.R. 2011. Effectiveness of Panama City beach safety program. In Leatherman, S. and Fletemeyer, J. (Eds.) *Rip Currents: Beach Safety, Physical Oceanography, and Wave Modeling*. New York: CRC Press. Pp. 147-160.

Williamston, A., Hatfield, J., Sherker, S., Brander, R., and Hayen, A. 2008. Improving beach safety: the Science of the Surf research project. *2008 Australian Water Safety Program and Proceedings*. https://www.royallifesaving.com.au/__data/assets/pdf_file/0009/4014/AWSC_Final_Program_and_Proceedings_Booklet.pdf

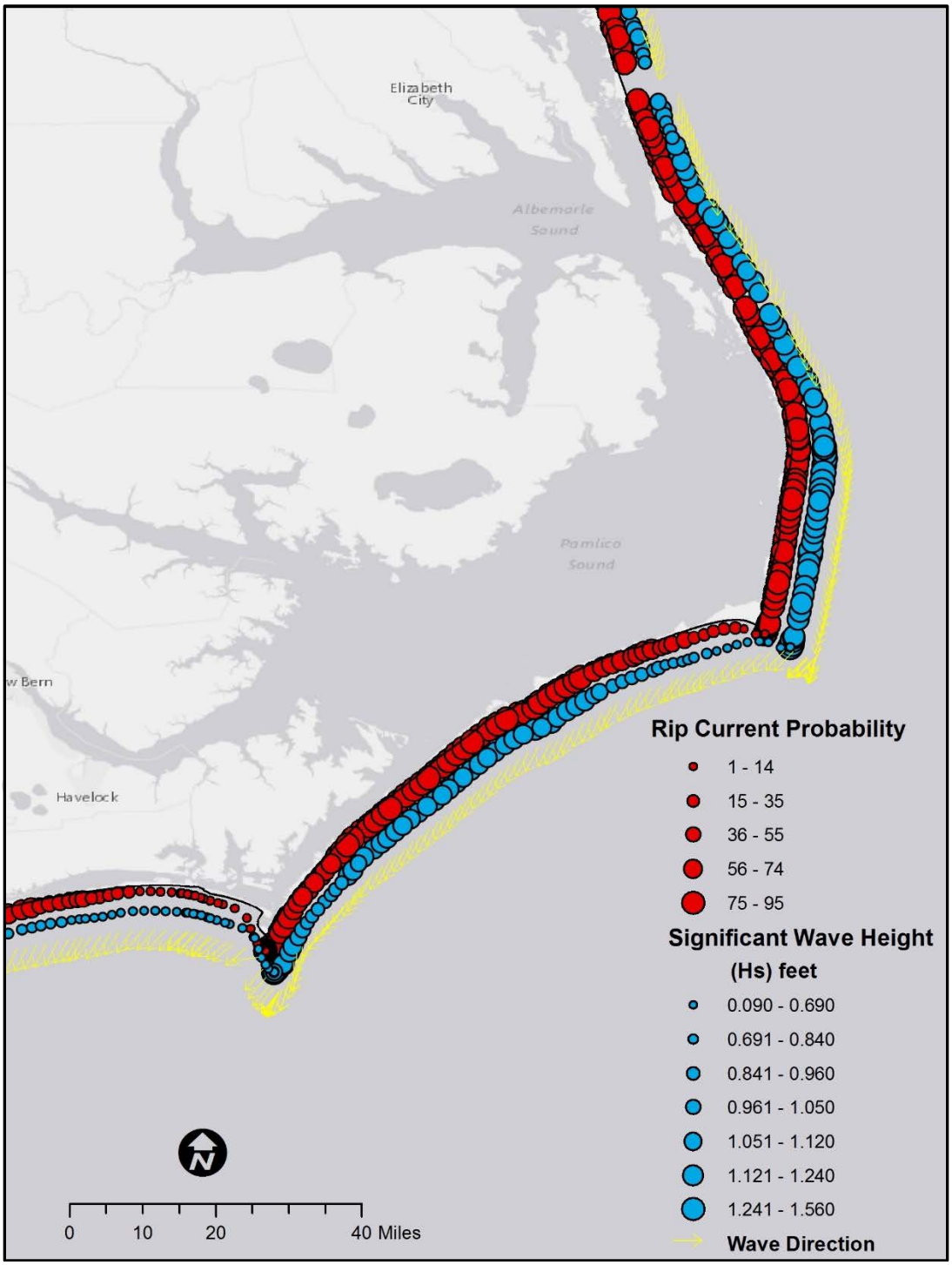
Trivariate Bar Chart

First of a series of prototype multivariable maps, the bar chart map was evaluated for portraying rip current probability, significant wave height and direction (angle from oblique to the beach.) General feedback was positive, although concerning for the use of bars and the linear representation of angle of incidence.



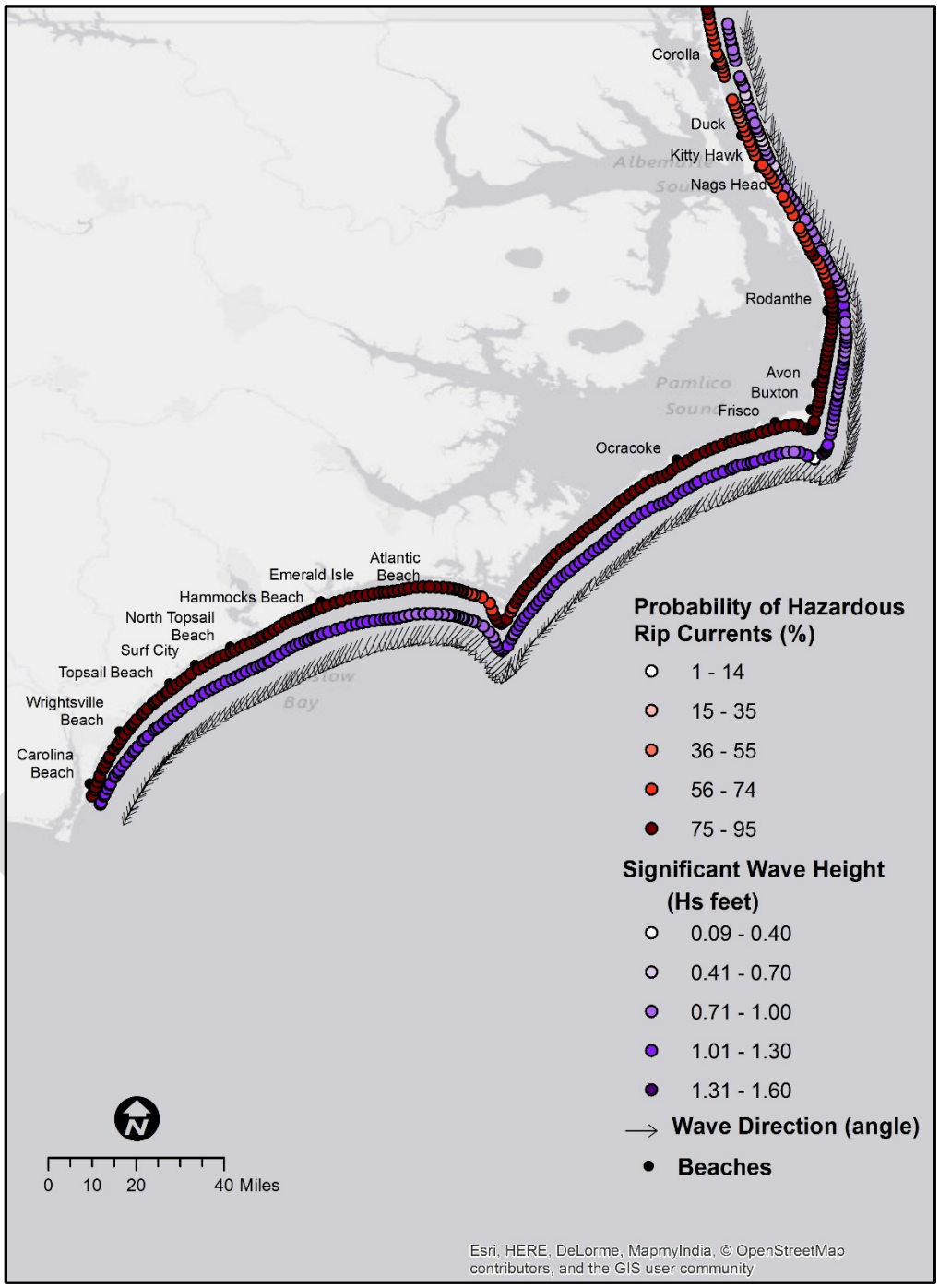
Trivariate Dot and Vane Map

Multivariable prototype maps were developed towards the objective of providing advanced users and offcials wider information on the rip current probability, such as swell, significant wave height, angle of incidence of swell or longshore current. These maps variously also incorporated proportional symbols, color, and vane plots (for direction of swell.)



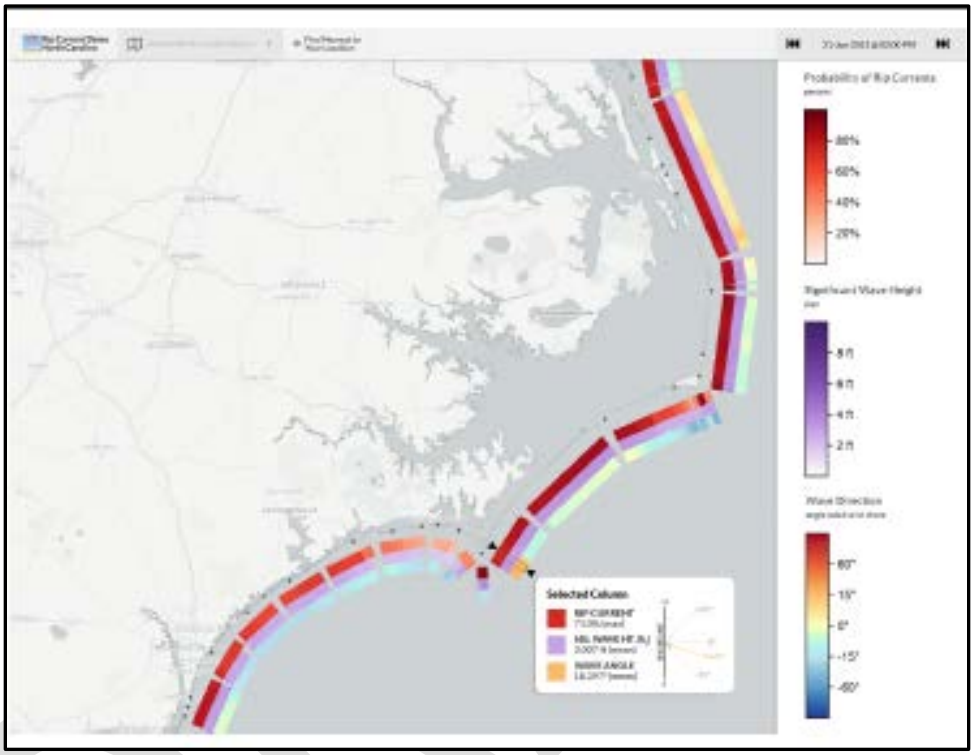
Trivariate Dot and Vane Map (Refined Arrows)

NWS feedback critiqued this map as too visually busy, and although the information is relevant, it could be confusing. NWS feedback also noted that water level should also be included, possibly in a pop-up box. Responses did not like the mixed use of colors and shape symbols. In addition, early discussions on the project also covered inclusion of beaches and toponyms for popular locations.



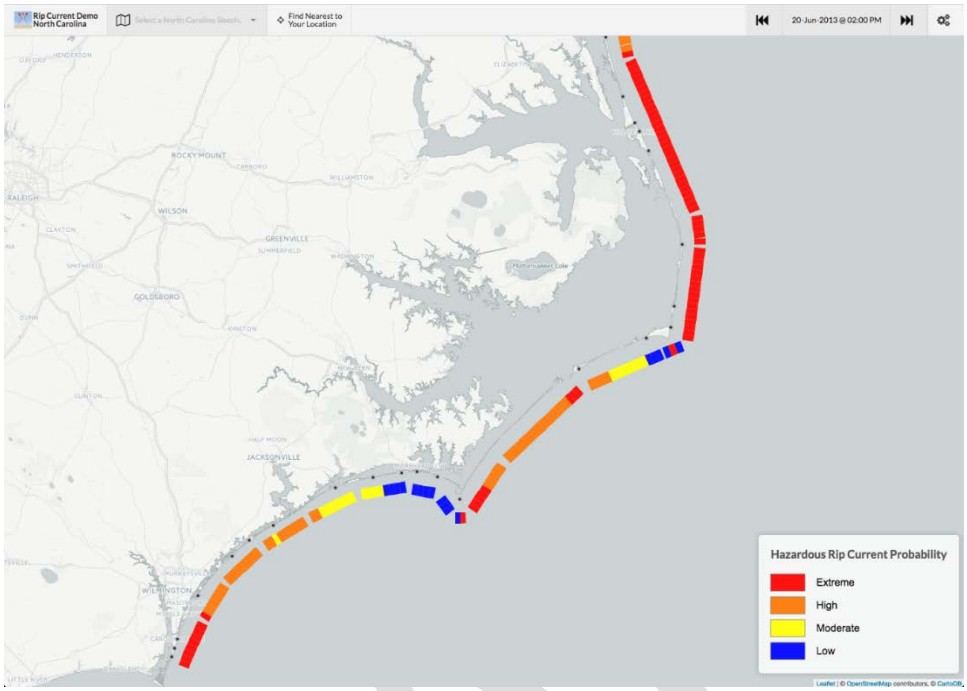
Multivariable Strip Map Test

This map combined rip current probability with significant wave height and direction predictions. Bars were noted to better portray the model resolution. This graphic was the most preferred among NWS scientists, forecasters and SOOs for advanced users among the multivariable maps created. However, NWS feedback did not prefer the inclusion of wave height and directions, for concern public-facing graphics could be confusing. Future consideration was also noted that wave height and period may preferably be visualized as a continuous field or reported in pop-ups.



Strip Map with Single Variable and Textual Classified Rip Current Probability

Strips in this untested symbology used the same color variation as two tested maps with segments and dot placemarks at popular recreational beaches and forecast points.



APPENDIX B: ON-LINE SURVEY

Rip Current Survey

Thank you for logging into this survey. The survey is voluntary and any information you provide will be anonymous.

The purpose of this research is to understand which, among a series of graphics, best helps you understand the likelihood of hazardous rip currents. By doing this research, we hope to learn what will best motivate people to protect themselves from rip currents.

We are asking those who are willing to complete the survey that addresses knowledge of rip currents as well as perceptions of various ways to illustrate rip current potential. The amount of time it will take you to complete this survey is approximately 30 minutes.

If you agree to take part in this survey, you will be asked questions that relate to how often you visit the beach, what you know about rip currents and what aspects of several graphical warning products you like and do not like. In addition, we will be collecting some demographic information.

This research is being conducted by an independent contractor on behalf of the National Weather Service. You are not required to take part in this research, and you can stop at any time.

Thank you for taking the time to participate.

Notwithstanding any other provisions of the law, no person is required to respond to, nor shall any person be subjected to a penalty for failure to comply with, a collection of information subject to the requirements of the Paperwork Reduction Act, unless that collection of information displays a currently valid OMB Control Number.

If you have any questions, please contact Michael Churma, National Weather Service, michael.churma@noaa.gov.

Enter the code shown above:

Start the Survey

Demographic Information

Q1. What is your age?

- ○ Under 20
- ○ 20-29
- ◉ 30-39
- ○ 40-49
- ○ 50-59
- ○ 60-69
- ○ 70+

Q2. Do you live in North Carolina?

- ○ Yes
- ◉ No

Q2a. In what state do you live?

State

Q2b. Have you vacationed in coastal North Carolina?

- ○ Yes
- ◉ No

Q3. On average, how many days do you visit the beach each year?

Days

Q4. When you visit the beach, do you or your family typically go in the water?

- ○ Yes
- ◉ No

Rip Current Survey

Knowledge questions

Q5. Where do you get information about the weather? (Please check all that apply)

- [ ] NOAA (National Weather Service) websites
- [ ] Other weather websites
- [ ] TV
- [ ] Radio
- [ ] Smartphone App(s)
- [ ] Twitter
- [ ] Facebook
- [ ] Other(Please specify) Other

Q6. How often do you check the weather forecast?

- ( ) Several times a day
- ( ) Once a day
- ( ) Several times a week
- ( ) Once a week
- ( ) I rarely check the forecast

Q7. Have you ever checked an ocean wave forecast or tide prediction before going to the beach?

- ( ) Yes
- ( ) No

Q8. Have you ever heard of a rip current?

- ( ) Yes
- ( ) No

Q9. What statement describes what a rip current is?

- ○ It is an undertow that pulls you under the water
- ○ It is a tidal movement that can carry you alongshore
- ○ It is a strong current that carries you through the surf just past the breaking waves
- ○ Don't know

Q10. Have you ever been caught in a rip current?

- ○ Yes
- ○ No

Q11. Do you know someone who has been caught in a rip current?

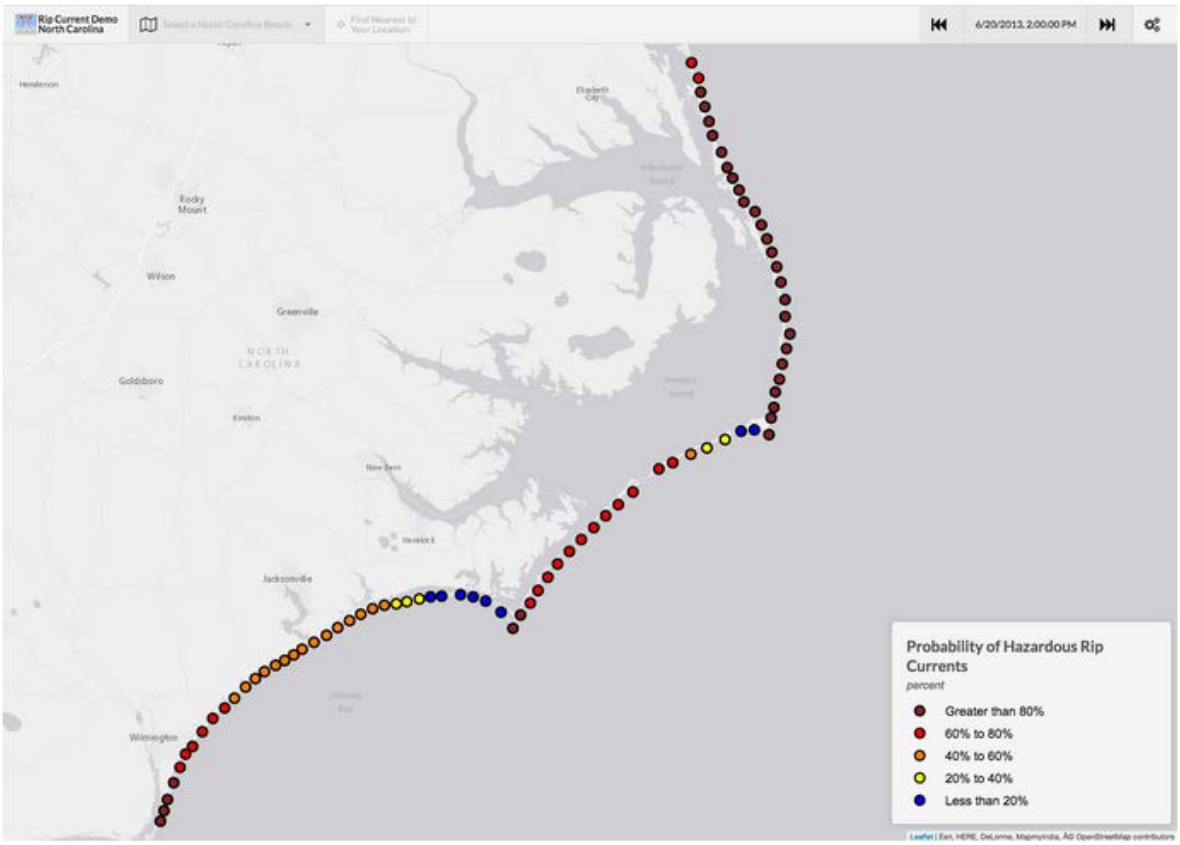
- ○ Yes
- ○ No

Q12. What common advice have you heard or seen about what to do when caught in a rip current? (Please check all that apply)

- ☐ Swim parallel to beach
- ☐ Stay afloat
- ☐ Stay calm/don't panic
- ☐ Don't swim against the rip current
- ☐ Have not heard or seen advice about what to do
- ☐ Other (please specify): Other

Below we provide several visualizations with questions relating to each. For each, please respond to the questions that follow the graphic.

Graphic A



Q13. What does this product tell you?

- How strong the rip current is
- How strong the rip current is likely to be
- The likelihood of a hazardous rip current
- Not sure

Q14. What element or elements of this product are most useful in understanding the rip current risk forecast? (Please check all that apply)

- [ ] Locational information
- [ ] Use of color
- [ ] Text explanations
- [ ] The area shown
- [ ] Categories used
- [ ] Other (please specify): Other

Q15. What is your perception of this product with respect to the following qualities or characteristics?

	Very negative	Somewhat negative	Neutral	Somewhat positive	Very positive	Don't know
Information included	○	○	○	○	○	○
Format	○	○	○	○	○	○
Understandability	○	○	○	○	○	○
Graphics/Symbols	○	○	○	○	○	○
Text	○	○	○	○	○	○
Use of color	○	○	○	○	○	○

Q16. What does "less than 20%" on this graphic mean to you?

- ○ Rip currents are present all of the time
- ○ Rip currents can be present some of the time
- ○ Rip currents are not present
- ○ Other (please specify): Other

Q17. How would each of the following categories affect what you would do?

	Avoid that location	Still go but stay out of the water	Still go but check with a lifeguard before going in the water	Still go but check what other people are doing before going in the water	Nothing different than originally planned
Greater than 80%	○	○	○	○	○
40-60%	○	○	○	○	○
Less than 20%	○	○	○	○	○

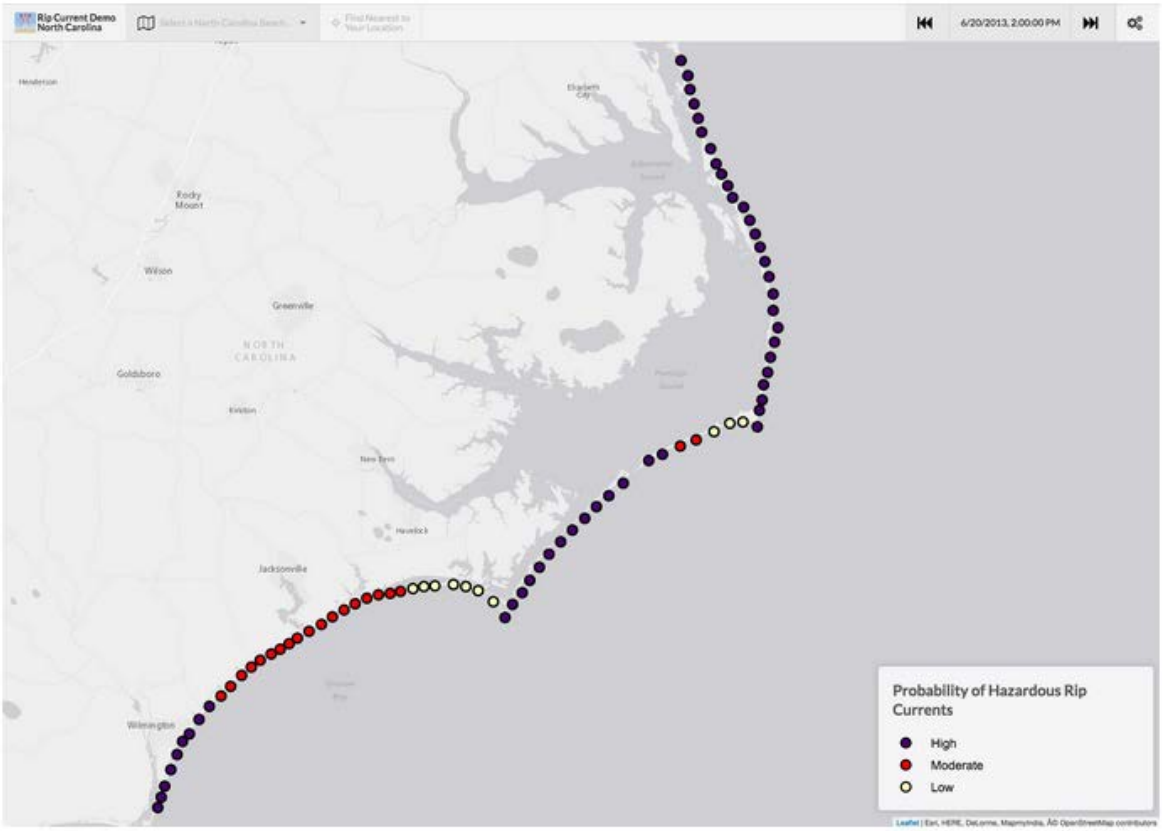
Q18. Considering all of the information shown above, how likely

	Very likely	Somewhat likely	Undecided	Somewhat unlikely	Very unlikely	Don't know
Would this product affect your decision to go to the beach?	○	○	○	○	○	○
Would this product affect your decision on which beach to go to?	○	○	○	○	○	○
Would this product affect your decision to go in the water if you were already at the beach?	○	○	○	○	○	○
Would this product affect your decision to swim in an area with lifeguards?	○	○	○	○	○	○
Is it that you would use this product in the future to understand rip current risk?	○	○	○	○	○	○
Would this product lead you to learn more about rip currents and what to do if caught in one?	○	○	○	○	○	○

Q19. If you were to use this product, when would you look at it?

- ○ Prior to going to the beach
- ○ While at the beach
- ○ Both
- ○ I wouldn't use it

Graphic B



Q20. What does this product tell you?

- How strong the rip current is
- How strong the rip current is likely to be
- The likelihood of a hazardous rip current
- Not sure

Q21. What element or elements of this product are most useful in understanding the rip current risk forecast? (Please check all that apply)

- [ ] Locational information
- [ ] Use of color
- [ ] Text explanations
- [ ] The area shown
- [ ] Categories used
- [ ] Other (please specify): Other

Q22. What is your perception of this product with respect to the following qualities or characteristics?

	Very negative	Somewhat negative	Neutral	Somewhat positive	Very positive	Don't know
Information included	○	○	○	○	○	○
Format	○	○	○	○	○	○
Understandability	○	○	○	○	○	○
Graphics/Symbols	○	○	○	○	○	○
Text	○	○	○	○	○	○
Use of color	○	○	○	○	○	○

Q23. What does "low" on this graphic suggest to you?

- ○ Rip currents are present all of the time
- ○ Rip currents can be present some of the time
- ○ Rip currents are not present
- ○ Other (please specify): Other

Q24. How would each of the categories shown below affect what you would do?

	Avoid that location	Still go but stay out of the water	Still go but check with a lifeguard before going in the water	Still go but check what other people are doing before going in the water	Nothing different than originally planned
High	○	○	○	○	○
Moderate	○	○	○	○	○
Low	○	○	○	○	○

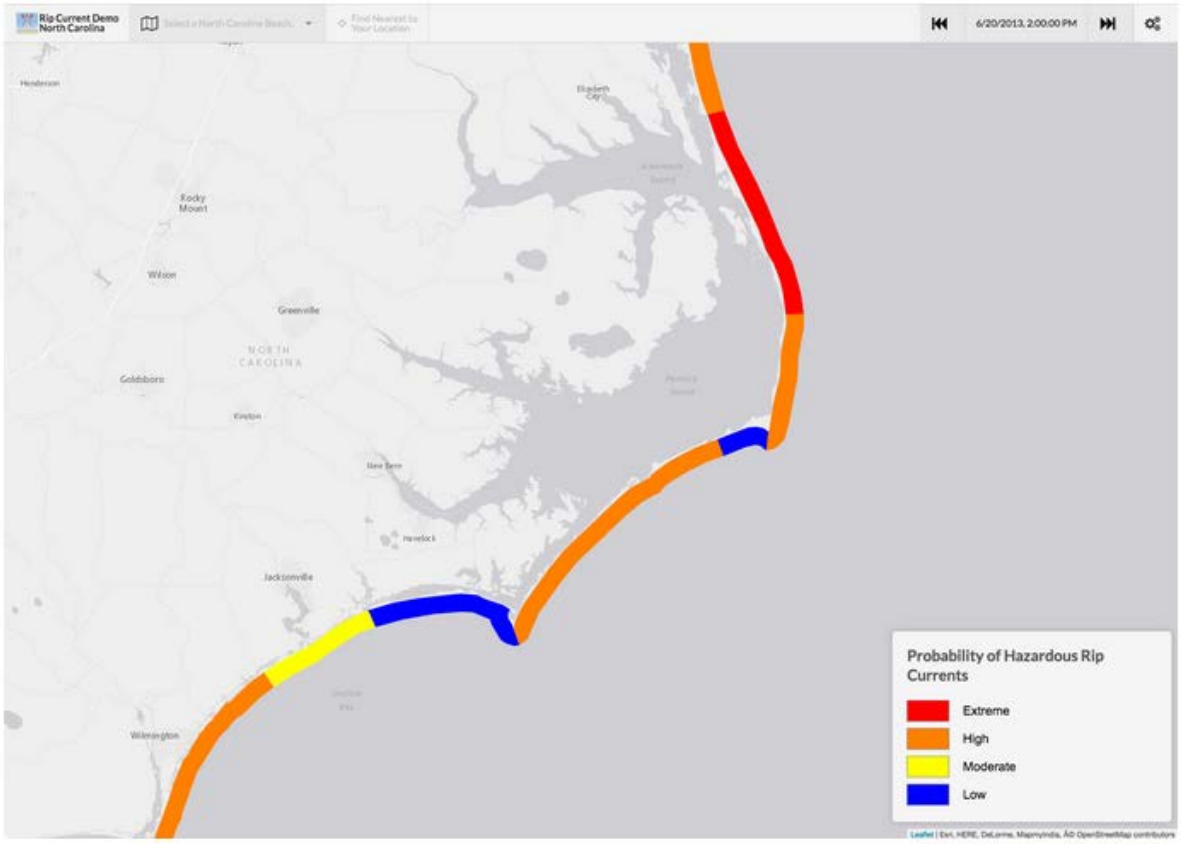
Q25. Considering all of the information shown above, how likely

	Very likely	Somewhat likely	Undecided	Somewhat unlikely	Very unlikely	Don't know
Would this product affect your decision to go to the beach?	○	○	○	○	○	○
Would this product affect your decision on which beach to go to?	○	○	○	○	○	○
Would this product affect your decision to go in the water if you were already at the beach?	○	○	○	○	○	○
Would this product affect your decision to swim in an area with lifeguards?	○	○	○	○	○	○
Is it that you would use this product in the future to understand rip current risk?	○	○	○	○	○	○
Would this product lead you to learn more about rip currents and what to do if caught in one?	○	○	○	○	○	○

Q26. If you were to use this product, when would you look at it?

- ○ Prior to going to the beach
- ○ While at the beach
- ○ Both
- ○ I wouldn't use it

Graphic C



Q27. What does this product tell you?

- How strong the rip current is
- How strong the rip current is likely to be
- The likelihood of a hazardous rip current
- Not sure

Q28. What element or elements of this product are most useful in understanding the rip current risk forecast? (Please check all that apply)

- [ ] Locational information
- [ ] Use of color
- [ ] Text explanations
- [ ] The area shown
- [ ] Categories used
- [ ] Other (please specify): Other

Q29. What is your perception of this product with respect to the following qualities or characteristics?

	Very negative	Somewhat negative	Neutral	Somewhat positive	Very positive	Don't know
Information included	○	○	○	○	○	○
Format	○	○	○	○	○	○
Understandability	○	○	○	○	○	○
Graphics/Symbols	○	○	○	○	○	○
Text	○	○	○	○	○	○
Use of color	○	○	○	○	○	○

Q30. How would each of the categories shown below affect what you would do?

	Avoid that location	Still go but stay out of the water	Still go but check with a lifeguard before going in the water	Still go but check what other people are doing before going in the water	Nothing different than originally planned
High	○	○	○	○	○
Moderate	○	○	○	○	○
Low	○	○	○	○	○

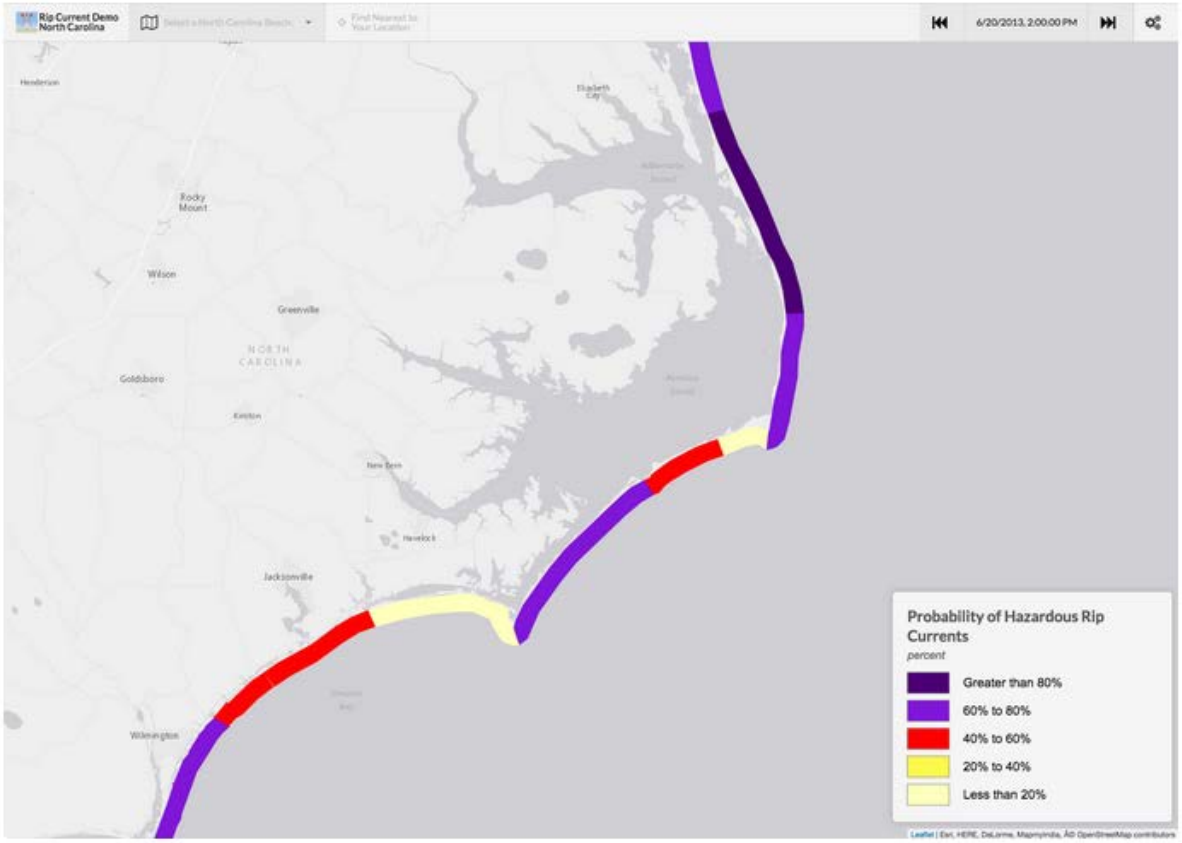
Q31. Considering all of the information shown above, how likely

	Very likely	Somewhat likely	Undecided	Somewhat unlikely	Very unlikely	Don't know
Would this product affect your decision to go to the beach?	○	○	○	○	○	○
Would this product affect your decision on which beach to go to?	○	○	○	○	○	○
Would this product affect your decision to go in the water if you were already at the beach?	○	○	○	○	○	○
Would this product affect your decision to swim in an area with lifeguards?	○	○	○	○	○	○
Is it that you would use this product in the future to understand rip current risk?	○	○	○	○	○	○
Would this product lead you to learn more about rip currents and what to do if caught in one?	○	○	○	○	○	○

Q32. If you were to use this product, when would you look at it?

- ○ Prior to going to the beach
- ○ While at the beach
- ○ Both
- ○ I wouldn't use it

Graphic D



Q33. What does this product tell you?

- How strong the rip current is
- How strong the rip current is likely to be
- The likelihood of a hazardous rip current
- Not sure

Q34. What element or elements of this product are most useful in understanding the rip current risk forecast? (Please check all that apply)

- [ ] Locational information
- [ ] Use of color
- [ ] Text explanations
- [ ] The area shown
- [ ] Categories used
- [ ] Other (please specify): Other

Q35. What is your perception of this product with respect to the following qualities or characteristics?

	Very negative	Somewhat negative	Neutral	Somewhat positive	Very positive	Don't know
Information included	○	○	○	○	○	○
Format	○	○	○	○	○	○
Understandability	○	○	○	○	○	○
Graphics/Symbols	○	○	○	○	○	○
Text	○	○	○	○	○	○
Use of color	○	○	○	○	○	○

Q36. How would each of the categories below affect what you would do?

	Avoid that location	Still go but stay out of the water	Still go but check with a lifeguard before going in the water	Still go but check what other people are doing before going in the water	Nothing different than originally planned
Greater than 80%	○	○	○	○	○
40-60%	○	○	○	○	○
Less than 20%	○	○	○	○	○

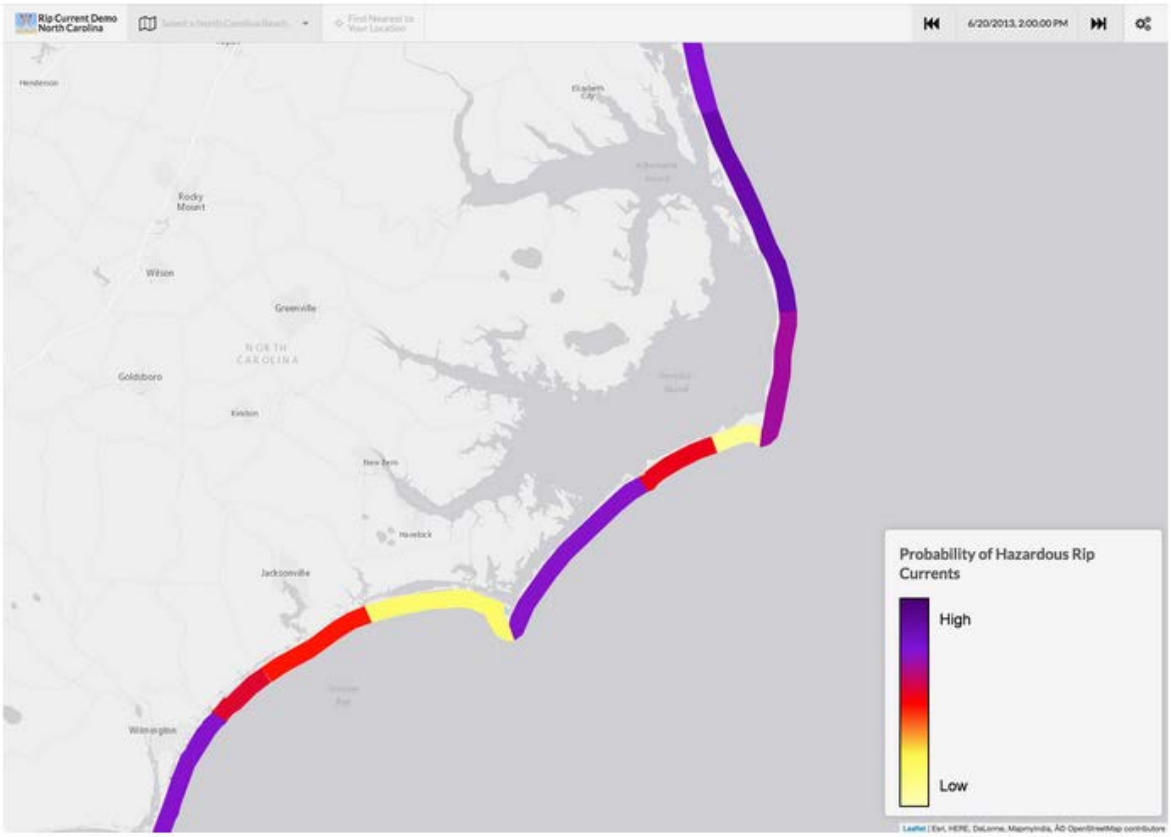
Q37. Considering all of the information shown above, how likely

	Very likely	Somewhat likely	Undecided	Somewhat unlikely	Very unlikely	Don't know
Would this product affect your decision to go to the beach?	○	○	○	○	○	○
Would this product affect your decision on which beach to go to?	○	○	○	○	○	○
Would this product affect your decision to go in the water if you were already at the beach?	○	○	○	○	○	○
Would this product affect your decision to swim in an area with lifeguards?	○	○	○	○	○	○
Is it that you would use this product in the future to understand rip current risk?	○	○	○	○	○	○
Would this product lead you to learn more about rip currents and what to do if caught in one?	○	○	○	○	○	○

Q38. If you were to use this product, when would you look at it?

- ○ Prior to going to the beach
- ○ While at the beach
- ○ Both
- ○ I wouldn't use it

Graphic E



Q39. What does this product tell you?

- How strong the rip current is
- How strong the rip current is likely to be
- The likelihood of a hazardous rip current
- Not sure

Q40. What element or elements of this product are most useful in understanding the rip current risk forecast? (Please check all that apply)

- [ ] Locational information
- [ ] Use of color
- [ ] Text explanations
- [ ] The area shown
- [ ] Categories used
- [ ] Other (please specify): Other

Q41. What is your perception of this product with respect to the following qualities or characteristics?

	Very negative	Somewhat negative	Neutral	Somewhat positive	Very positive	Don't know
Information included	○	○	○	○	○	○
Format	○	○	○	○	○	○
Understandability	○	○	○	○	○	○
Graphics/Symbols	○	○	○	○	○	○
Text	○	○	○	○	○	○
Use of color	○	○	○	○	○	○

Q42. How would each of the categories shown below affect what you would do?

	Avoid that location	Still go but stay out of the water	Still go but check with a lifeguard before going in the water	Still go but check what other people are doing before going in the water	Nothing different than originally planned
High	○	○	○	○	○
Low	○	○	○	○	○

Q43. Considering all of the information shown above, how likely

	Very likely	Somewhat likely	Undecided	Somewhat unlikely	Very unlikely	Don't know
Would this product affect your decision to go to the beach?	○	○	○	○	○	○
Would this product affect your decision on which beach to go to?	○	○	○	○	○	○
Would this product affect your decision to go in the water if you were already at the beach?	○	○	○	○	○	○
Would this product affect your decision to swim in an area with lifeguards?	○	○	○	○	○	○
Is it that you would use this product in the future to understand rip current risk?	○	○	○	○	○	○
Would this product lead you to learn more about rip currents and what to do if caught in one?	○	○	○	○	○	○

Q44. If you were to use this product, when would you look at it?

- ○ Prior to going to the beach
- ○ While at the beach
- ○ Both
- ○ I wouldn't use it

Graphic A

Graphic B

Graphic C

Graphic D

Graphic E

Q45. Which of the five graphics do you think is MOST effective?

- ○ A
- ○ B
- ○ C
- ○ D
- ○ E
- ○ None

Q46. Why? (Please check all that apply)

- [ ] The categories make sense to me
- [ ] The colors make sense to me
- [ ] The symbols make sense to me
- [ ] It is easy to find the situation at a particular beach
- [ ] I can see what the risk is at a number of places
- [ ] It is easy to interpret
- [ ] Other (please specify): Other

Q47. Which of the graphics do you think is LEAST effective?

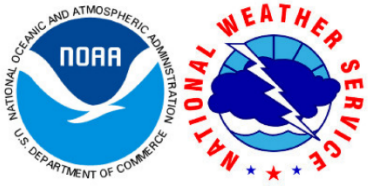
- ○ A
- ○ B
- ○ C
- ○ D
- ○ E
- ○ None

Q48. Why? (Please check all that apply)

- [ ] The categories used do not help me understand the risk
- [ ] The colors used are not helpful
- [ ] The symbols do not make sense to me
- [ ] It is difficult to find the situation at a particular beach
- [ ] It is difficult to distinguish risk at one location from another
- [ ] It is difficult to interpret
- [ ] Other (please specify): Other

Q49. Please provide any additional comments about any of the products or other information you would like concerning rip currents.

Aadditional comments you have



Rip Current Graphics

What is your position?

A. Lifeguard
B. Water Safety Professional
C. Emergency Manager
D. Other Emergency Support Function
E. Media
F. Other

Into what age group do you fall?

A. Under 20
B. 20-29
C. 30-39
D. 40-49
E. 50-59
F. 60-69
G. 70 or older

What is your gender?

A. Female

B. Male

How long have you been in your current position?

A. Less than 5 years
B. 5-10 years
C. 11-15 years
D. More than 15 years

Have you had to rescue swimmers from rip currents?

A. Yes

B. No

To what extent do you think the public pays attention to current rip current warnings that are posted?

A. Not at all
B. Somewhat
C. To a great extent

How would you characterize the public's understanding of rip currents?

A. No understanding
B. Very little understanding
C. Some understanding
D. Great understanding

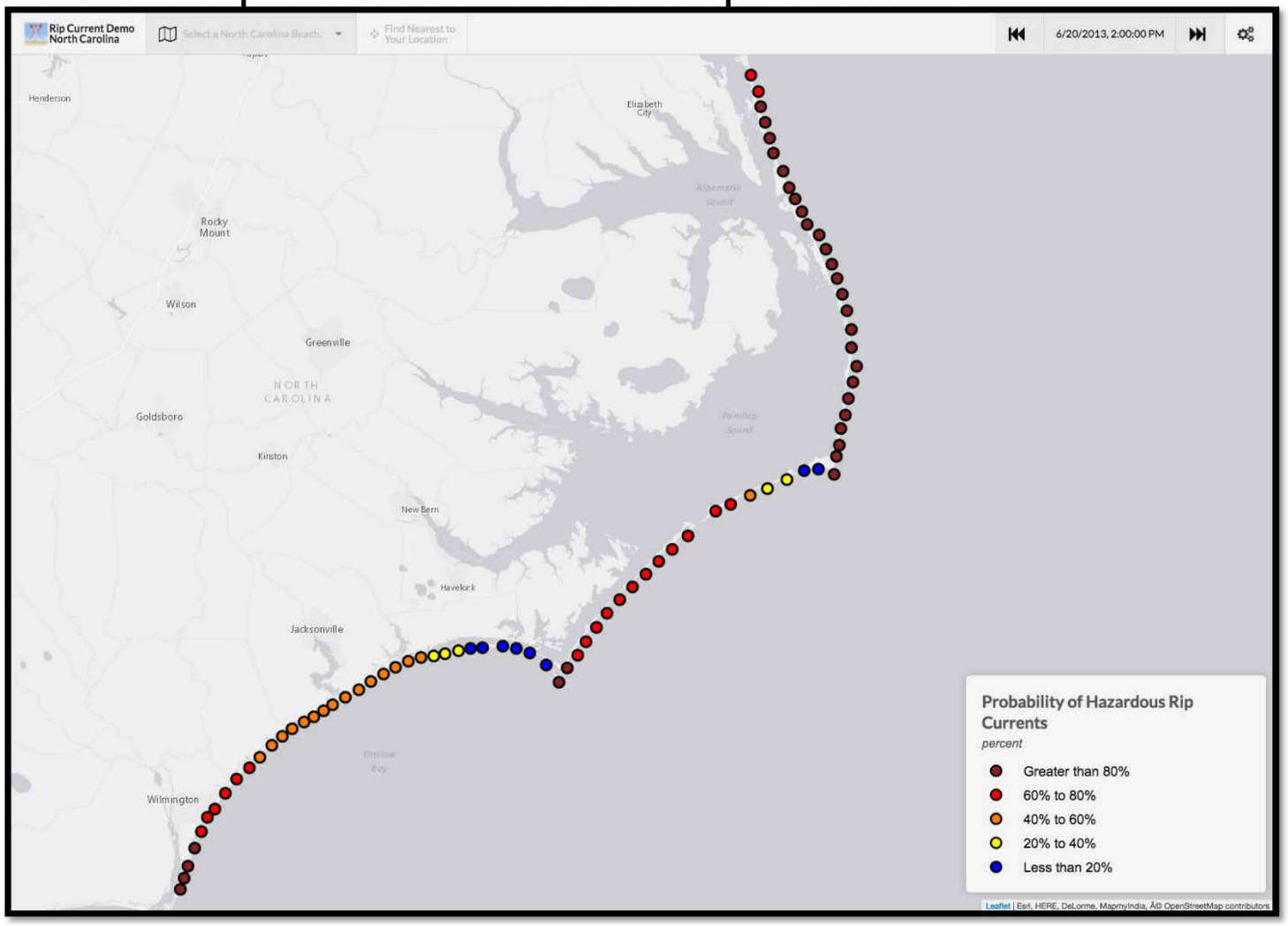
Which of the following do you think the public ***least*** understands?

A. What a rip current is
B. How dangerous a rip current can be
C. Their ability to get out of the rip current's pull
D. How to spot a rip current

Which of the following do you think the public ***most*** understands?

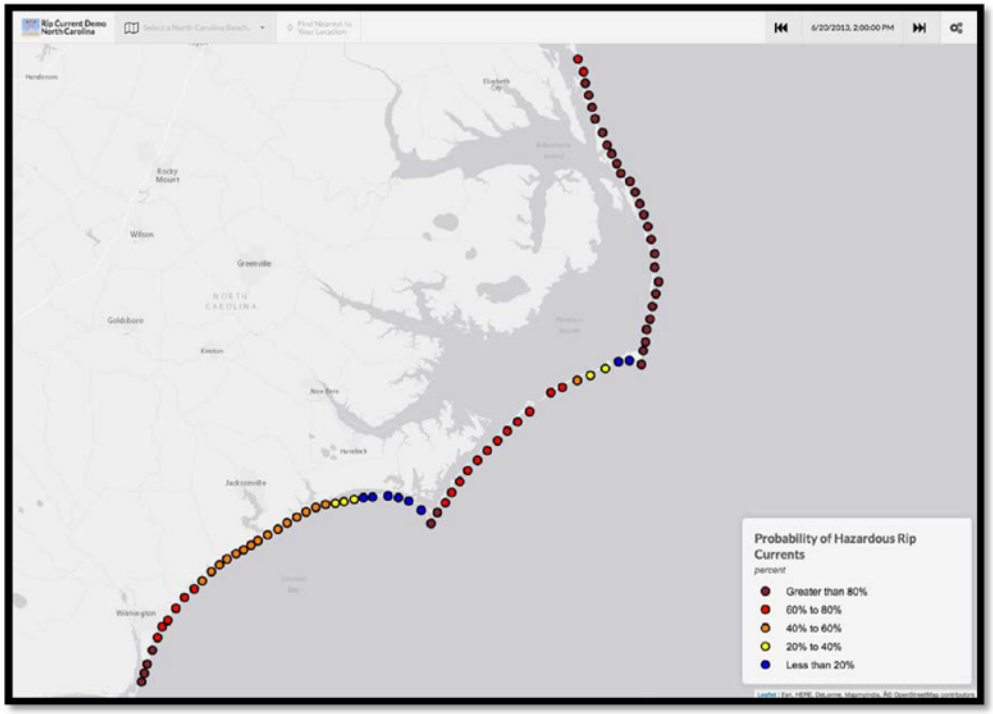
A. What a rip current is
B. How dangerous a rip current can be
C. Their ability to get out of the rip current's pull
D. How to spot a rip current

For this graphic, What is your perception of this product with respect to…



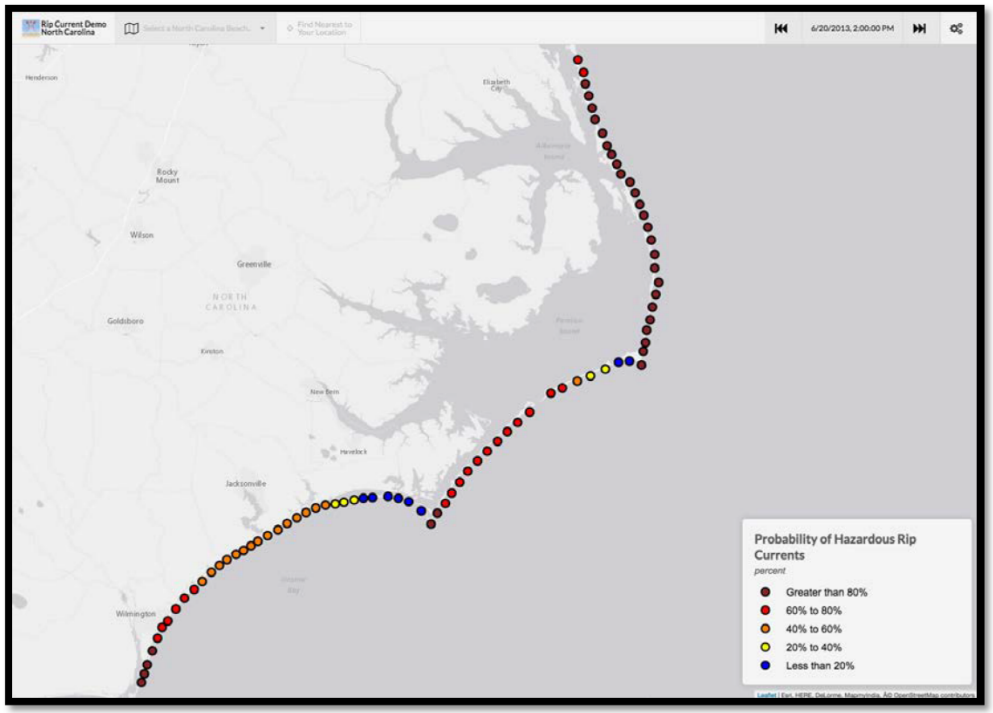
...the information included

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



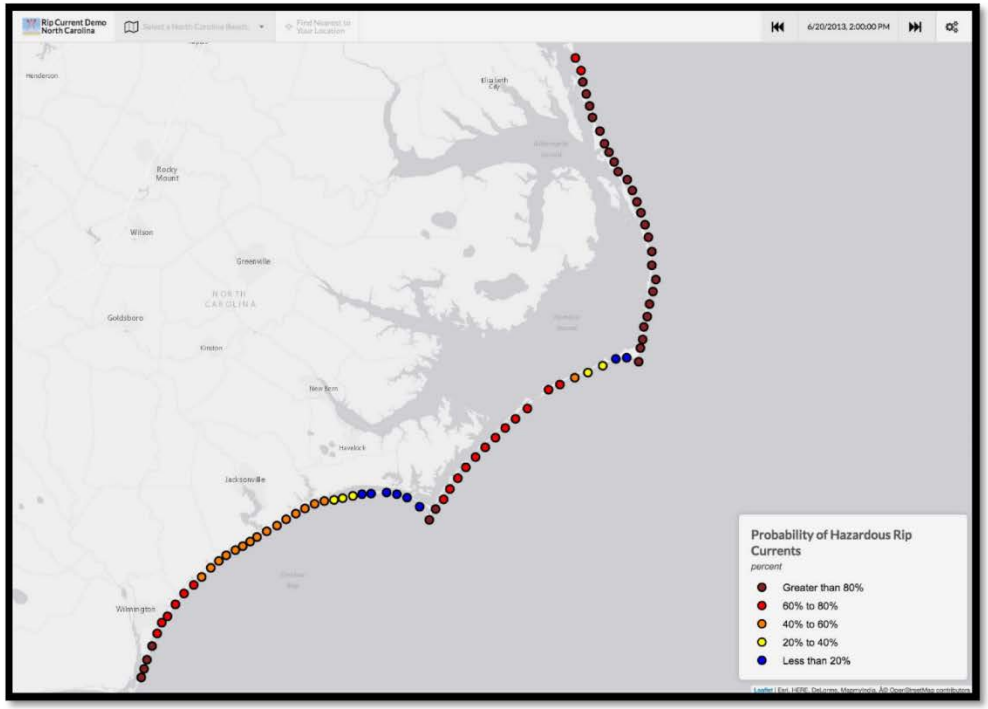
…format

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



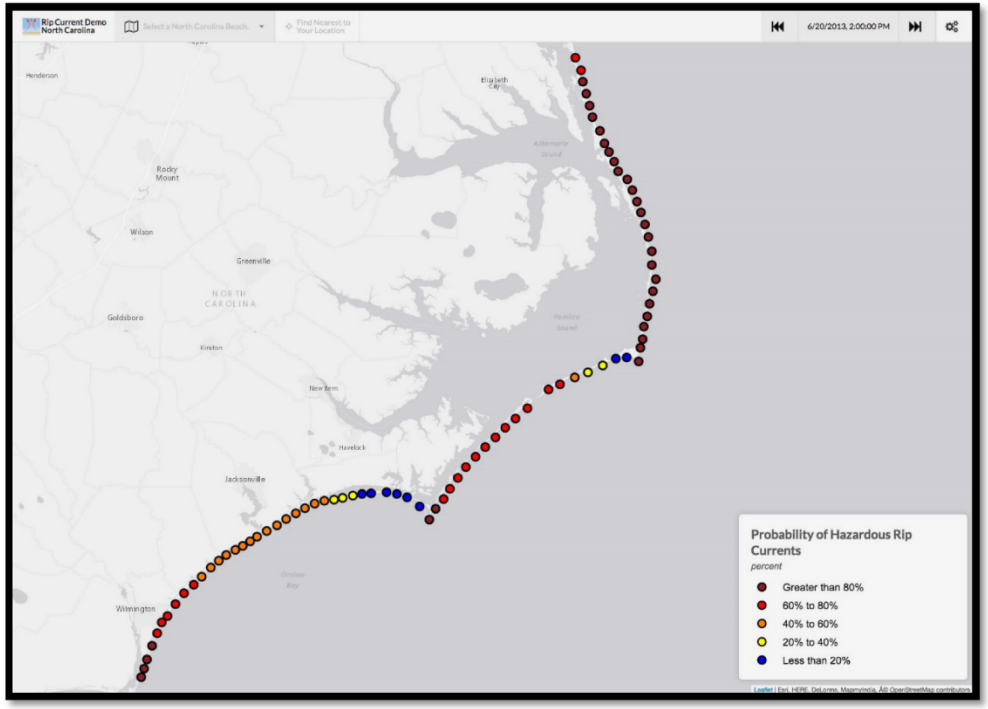
…understandability

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



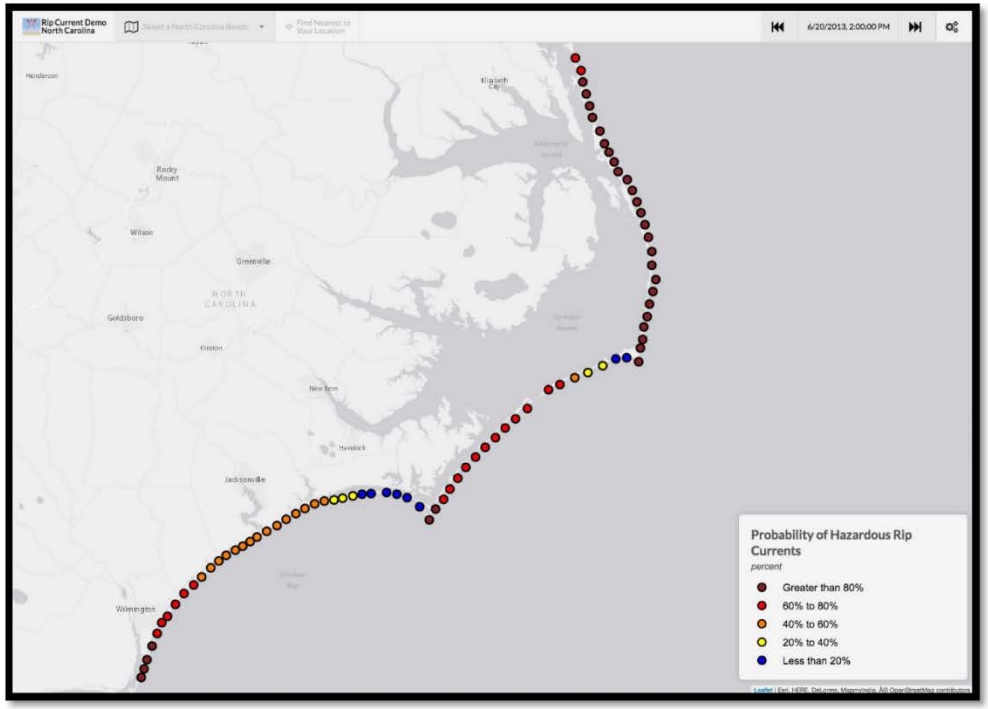
…graphics/symbols

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



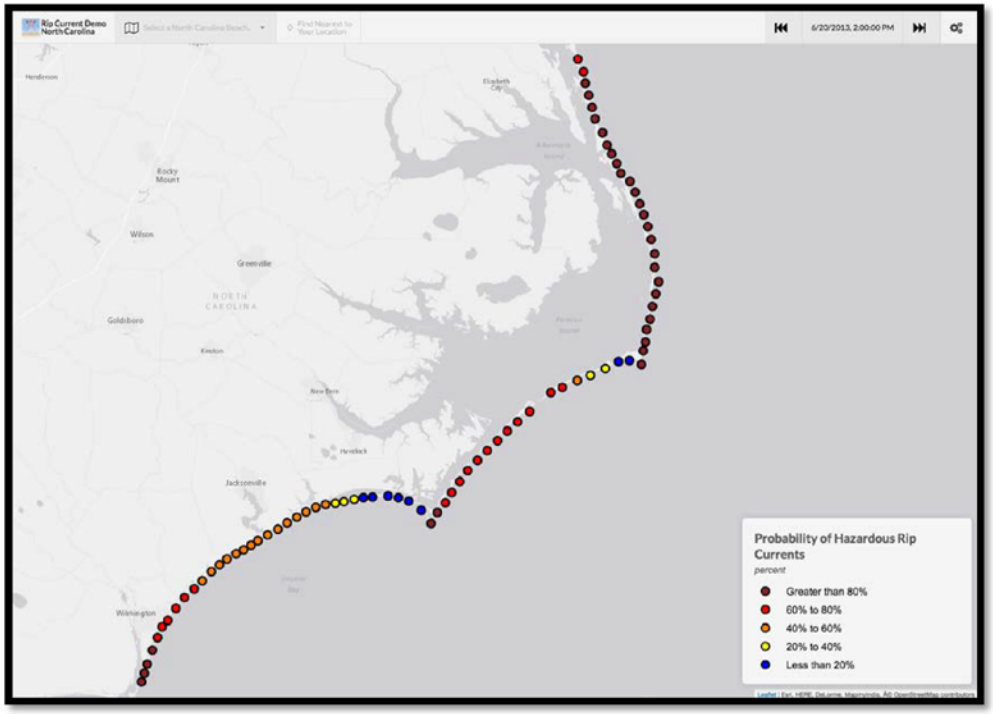
…text

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



…use of color

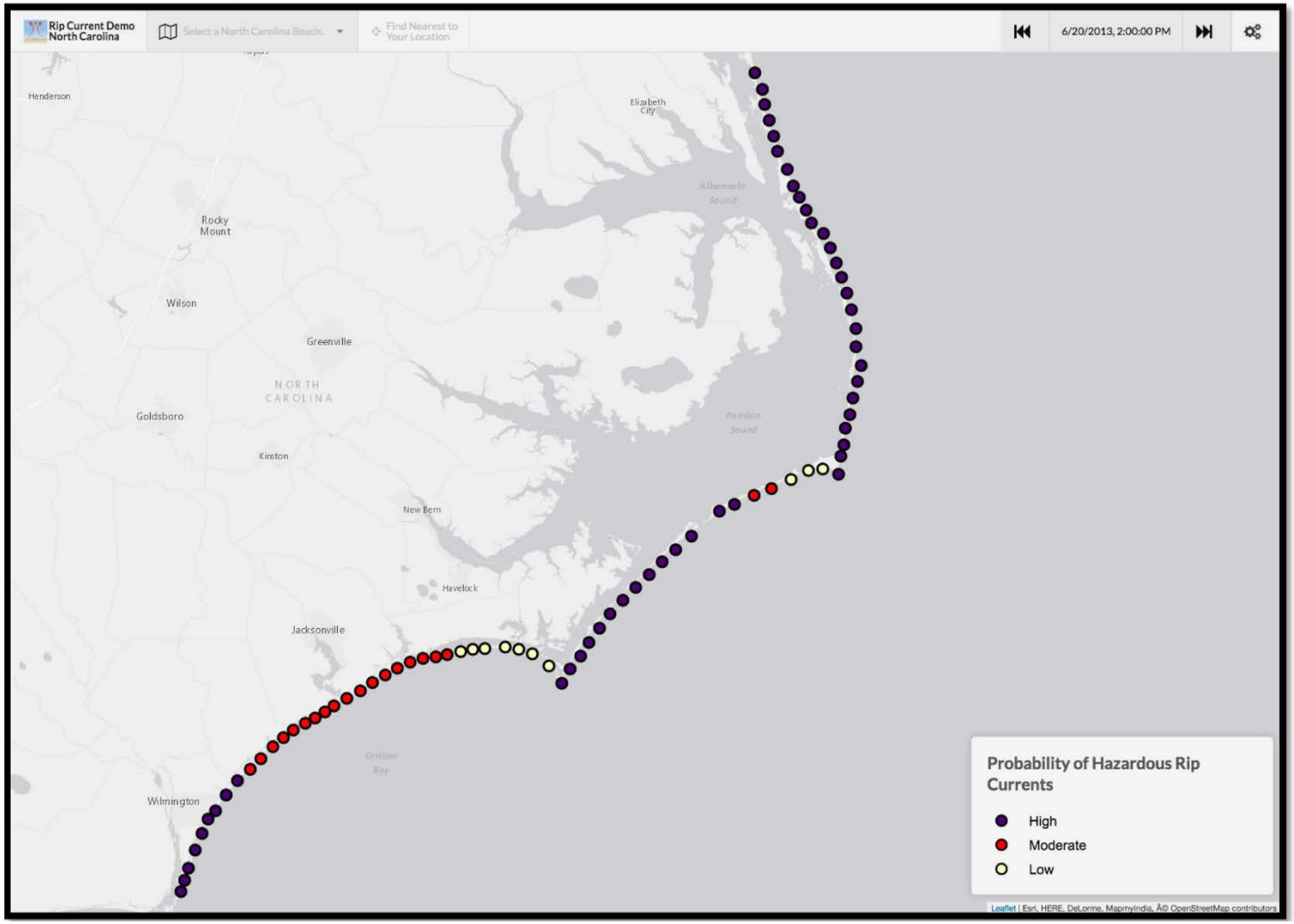
A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



How helpful is this product for your day-to-day operations?

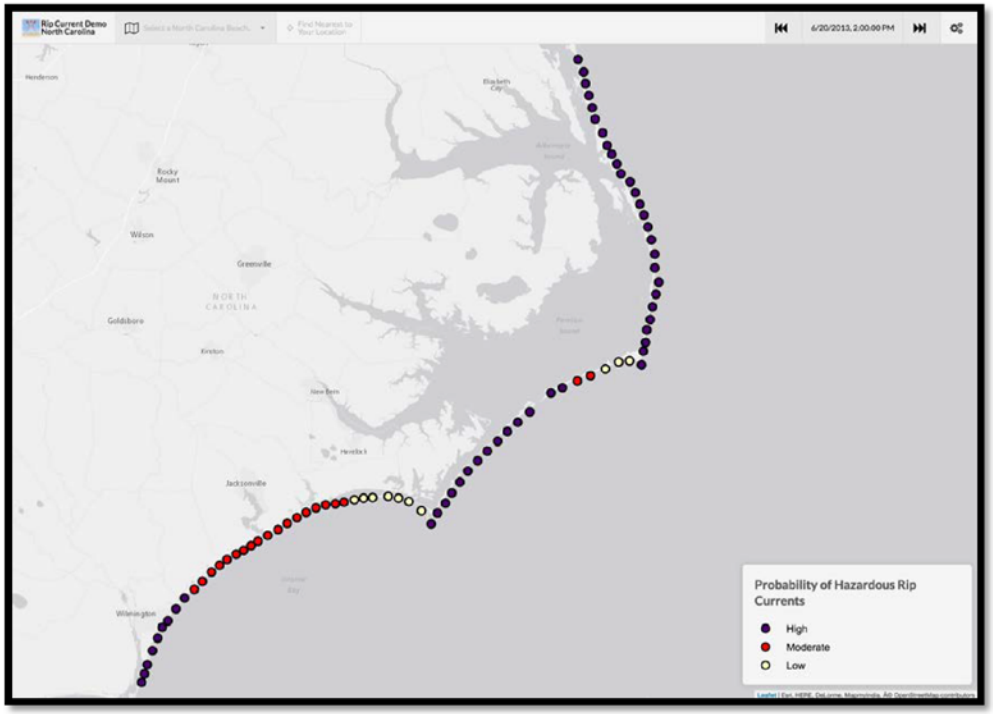
A. Entirely unhelpful
B. Somewhat unhelpful
C. Neither helpful nor unhelpful
D. Somewhat helpful
E. Very helpful

For this graphic, What is your perception of this product with respect to…



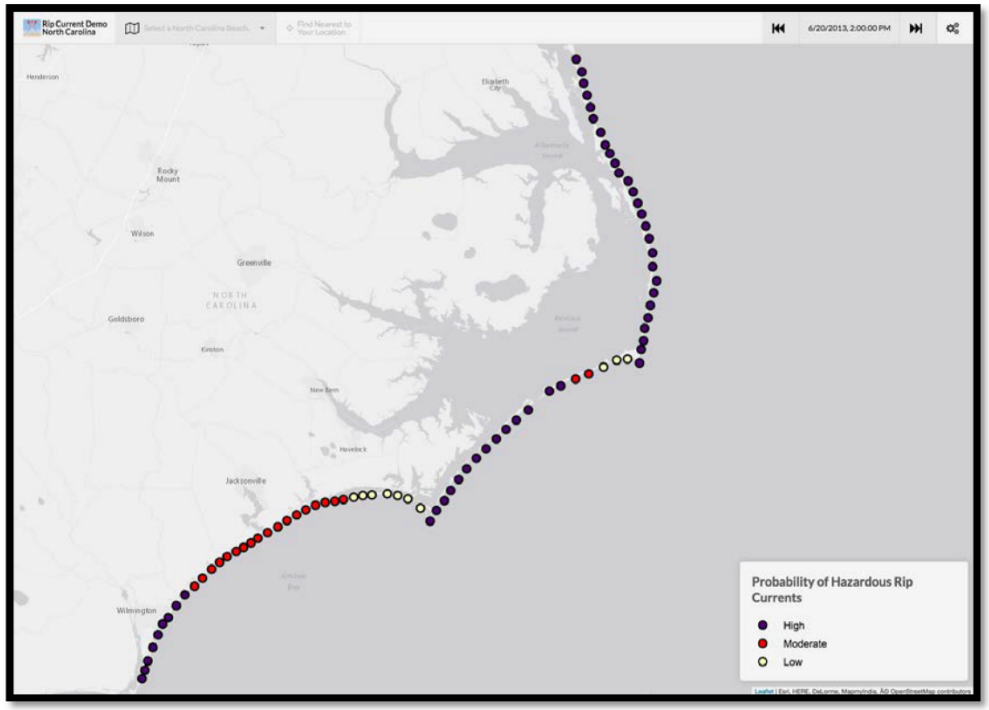
...the information included

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



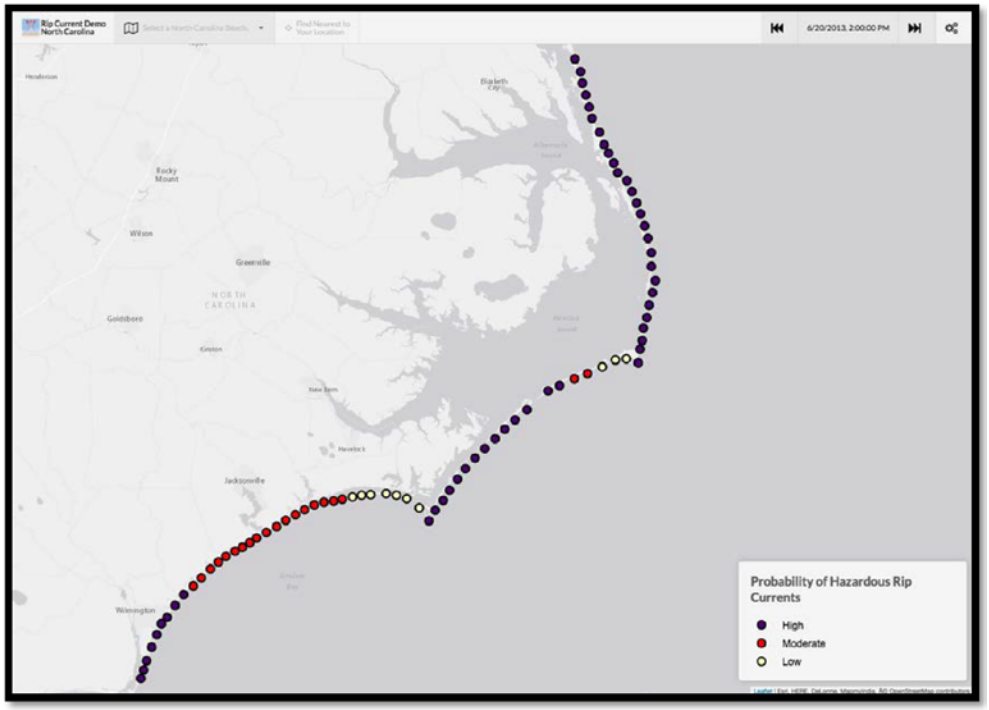
…format

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



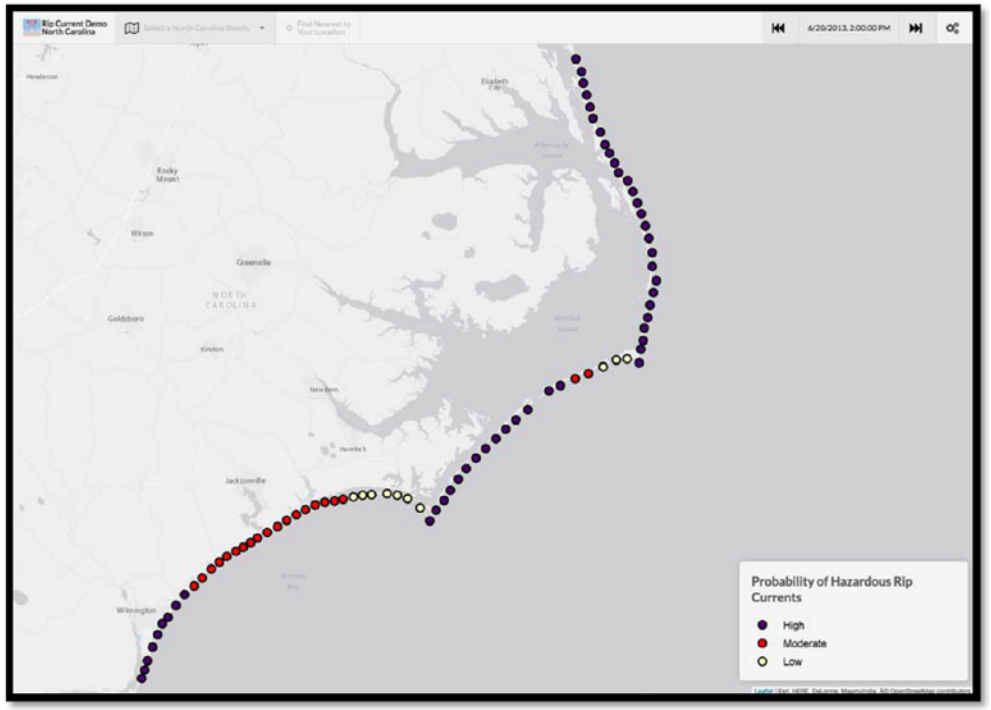
…understandability

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



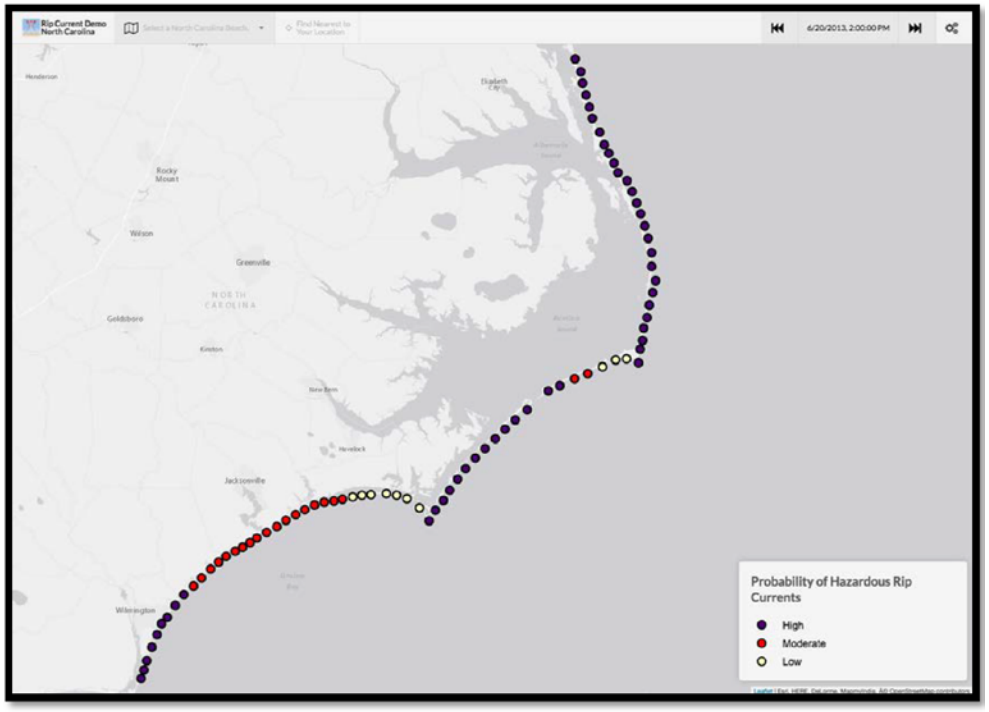
...graphics/symbols

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



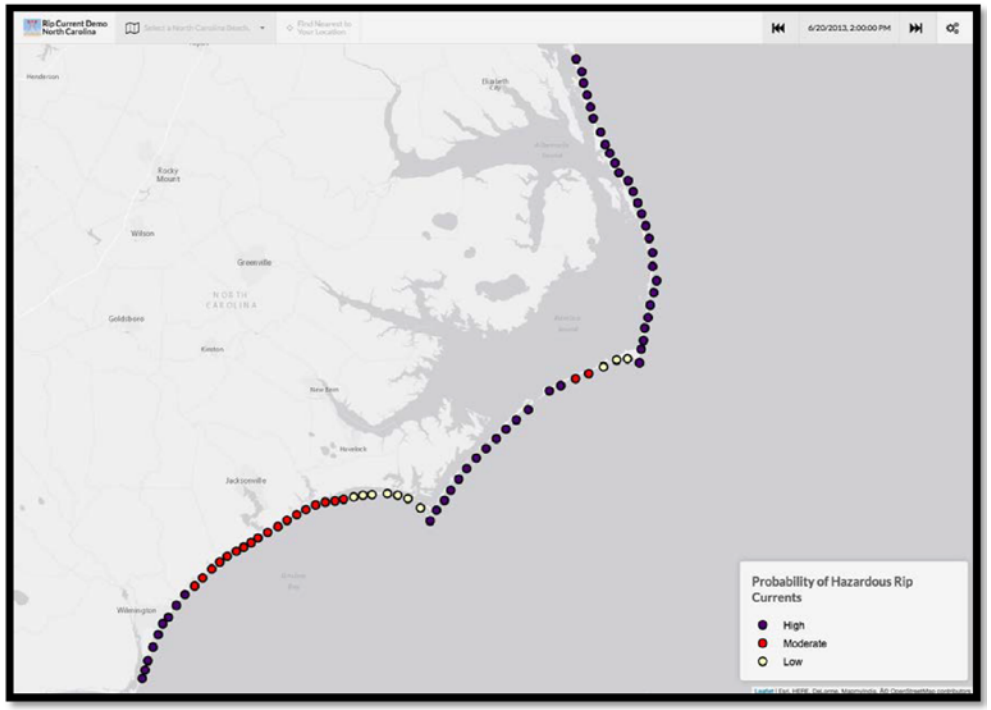
...text

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



...use of color

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



How helpful is this product for your day-to-day operations?

A. Entirely unhelpful
B. Somewhat unhelpful
C. Neither helpful nor unhelpful
D. Somewhat helpful
E. Very helpful

For this graphic, What is your perception of this product with respect to…

…the information included

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know

...format

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know

…understandability

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know

…graphics/symbols

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know

...text

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know

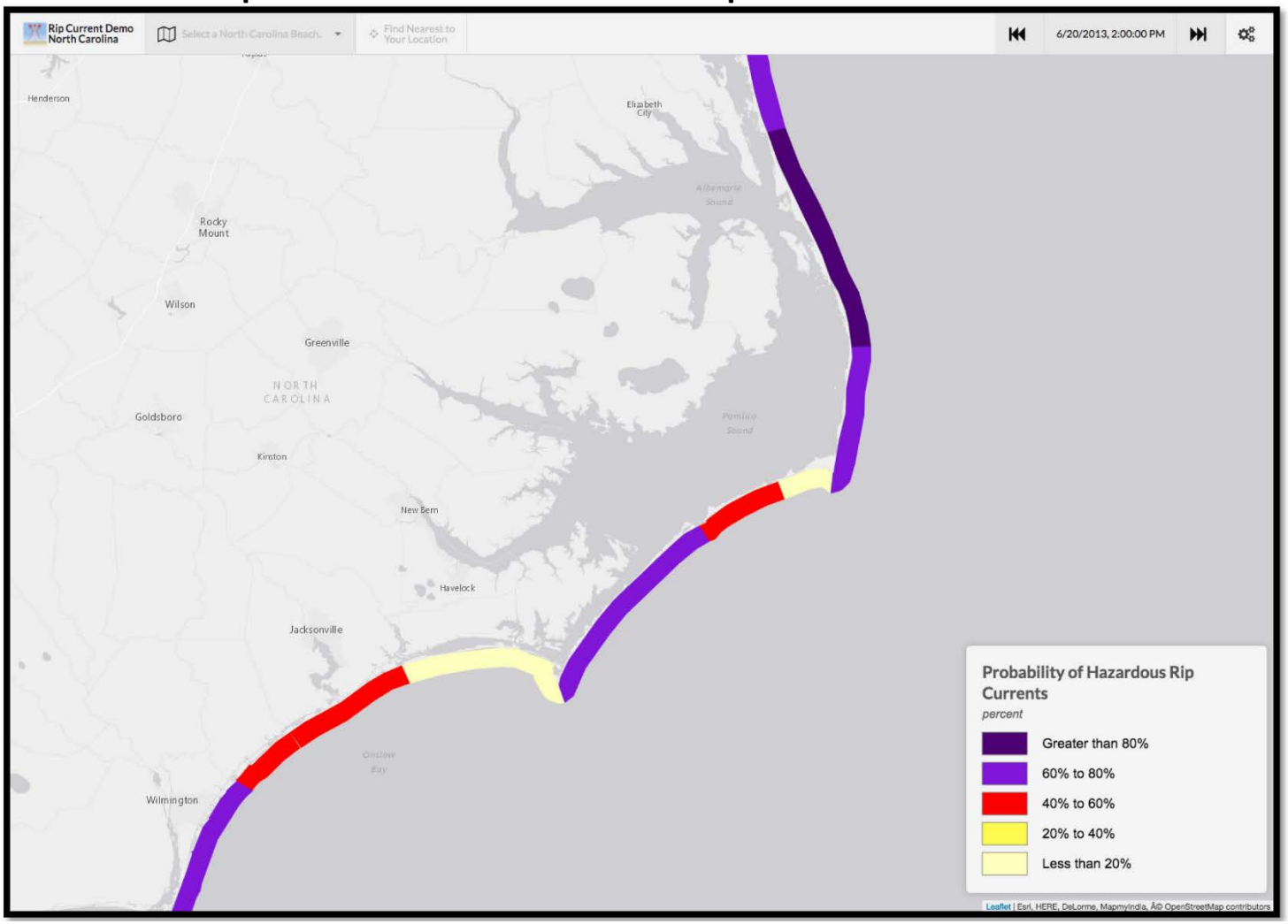
…use of color

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know

How helpful is this product for your day-to-day operations?

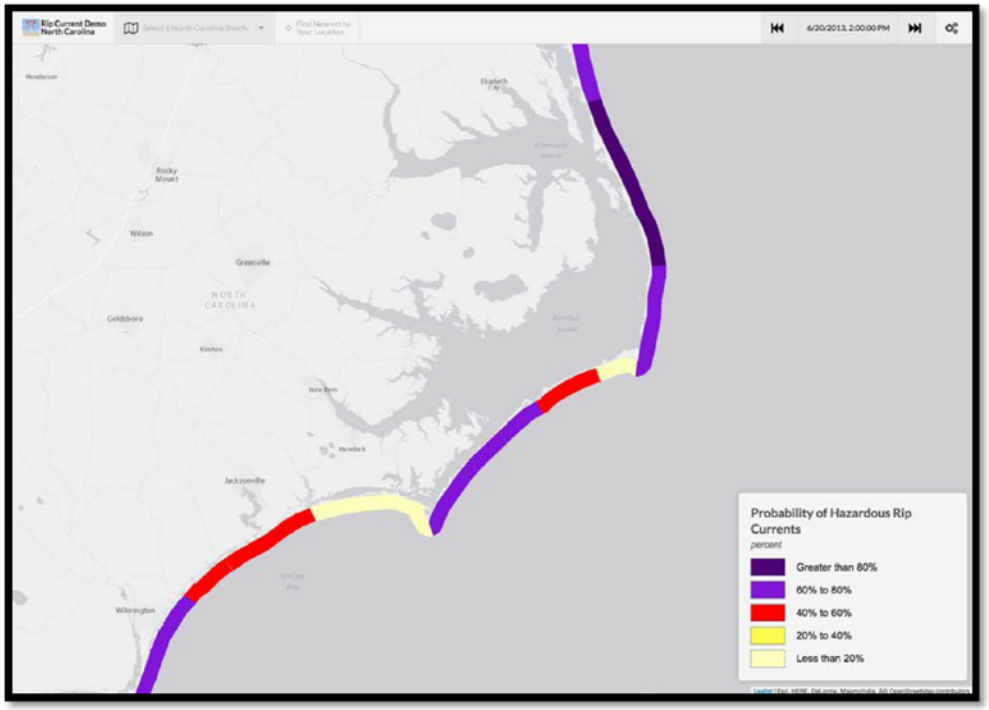
A. Entirely unhelpful
B. Somewhat unhelpful
C. Neither helpful nor unhelpful
D. Somewhat helpful
E. Very helpful

For this graphic, What is your perception of this product with respect to…



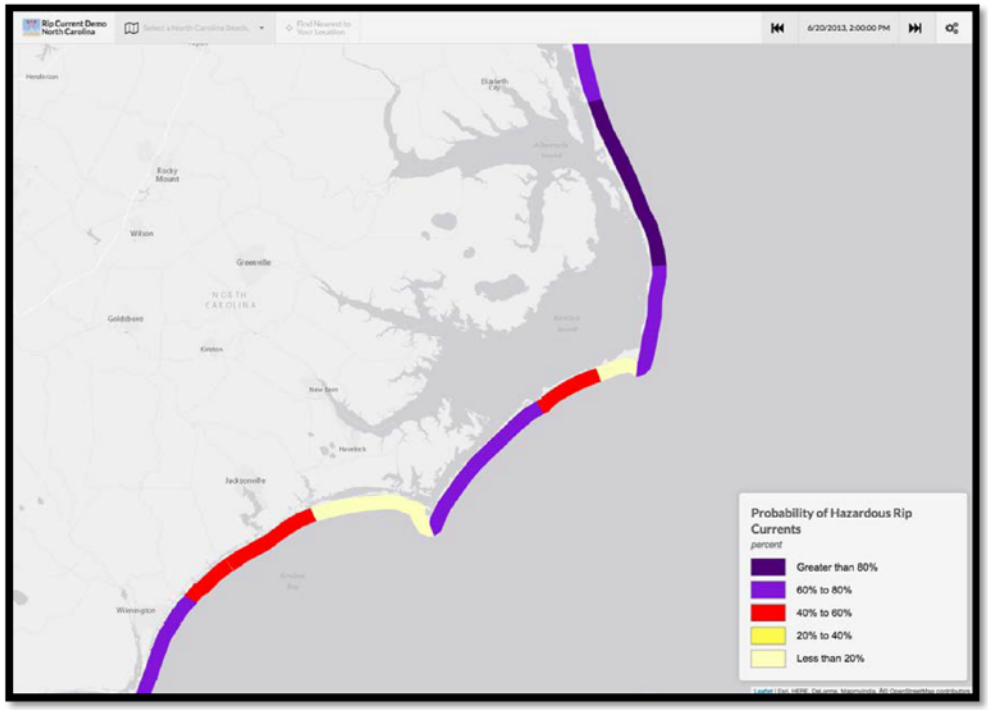
...the information included

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



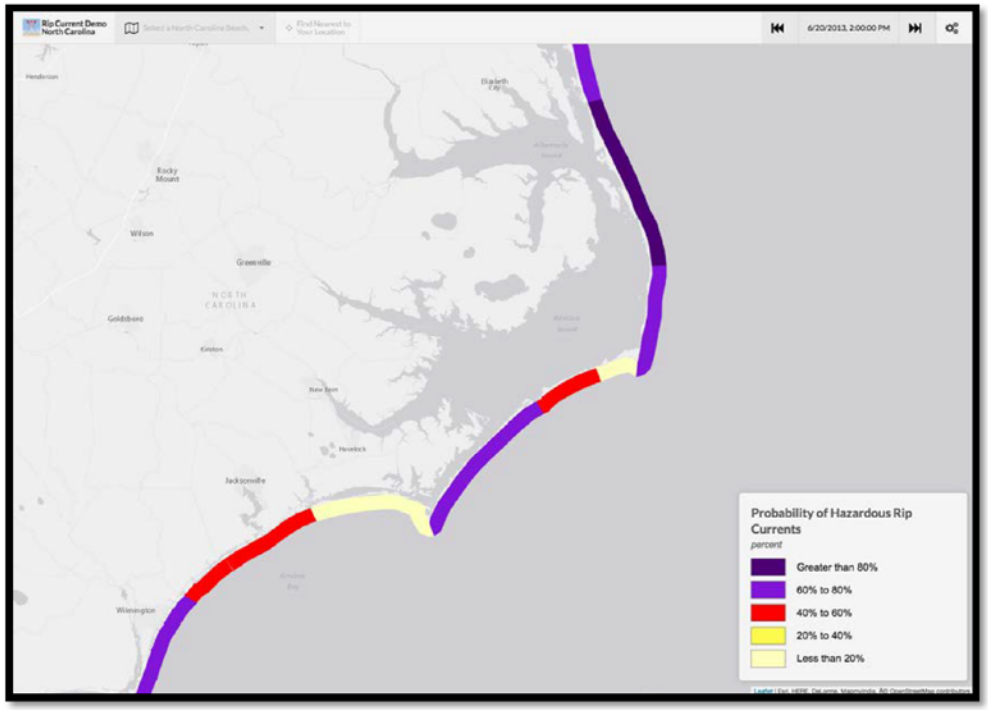
...format

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



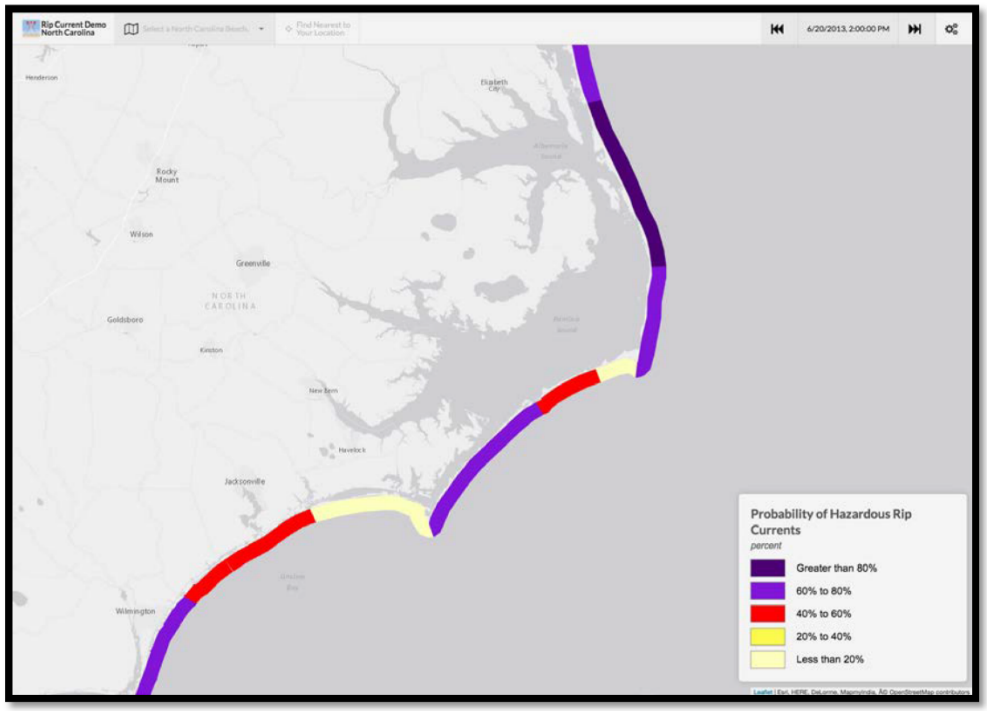
…understandability

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



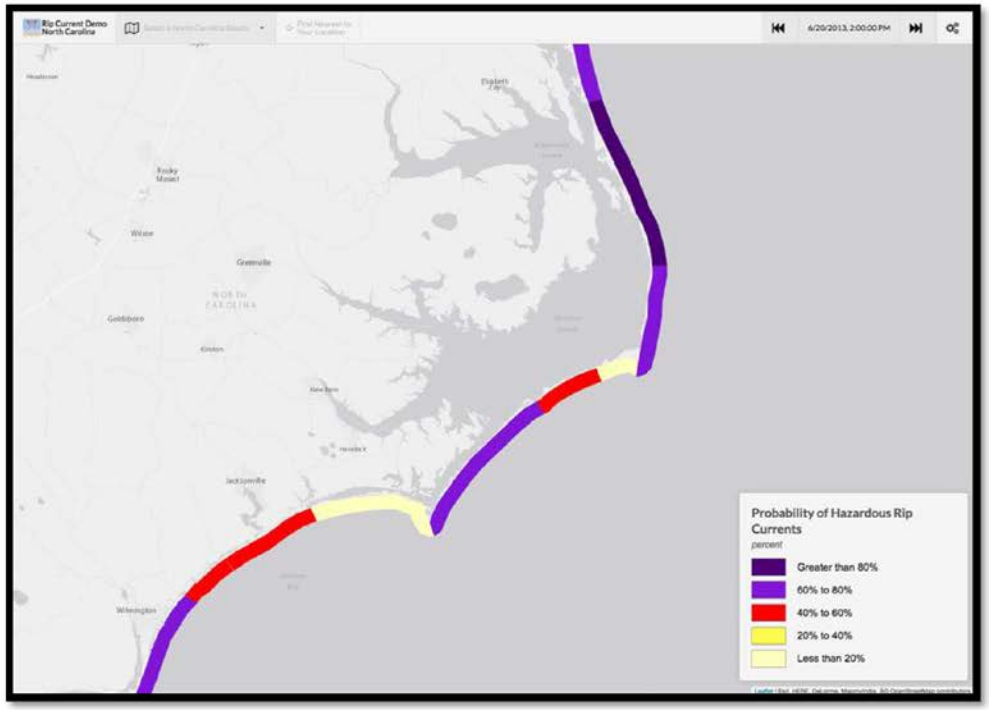
…graphics/symbols

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



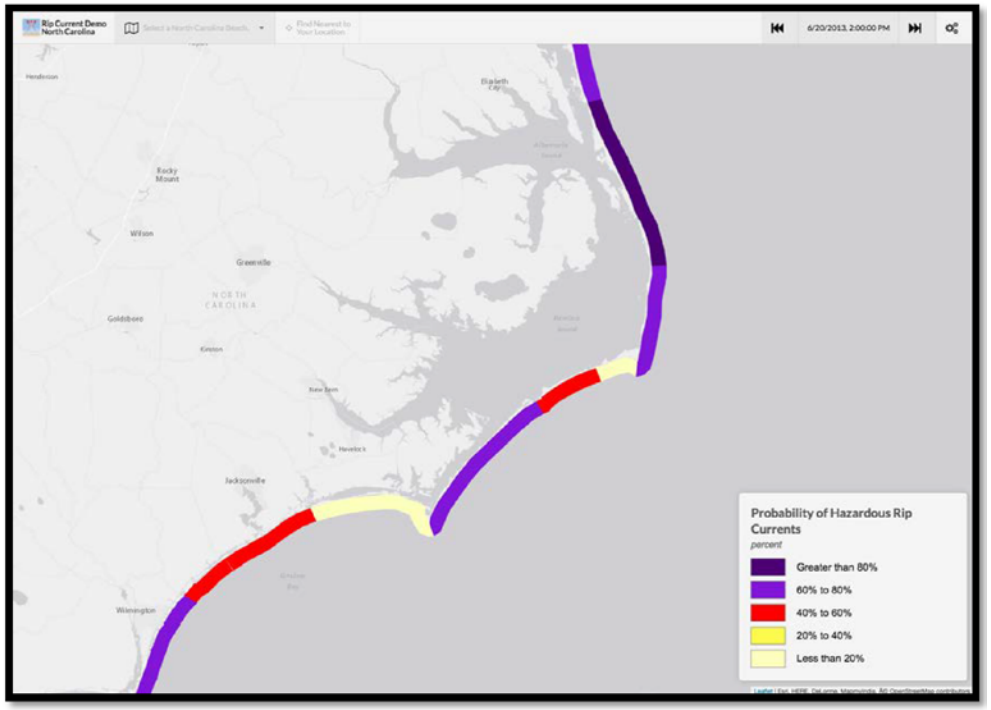
...text

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



…use of color

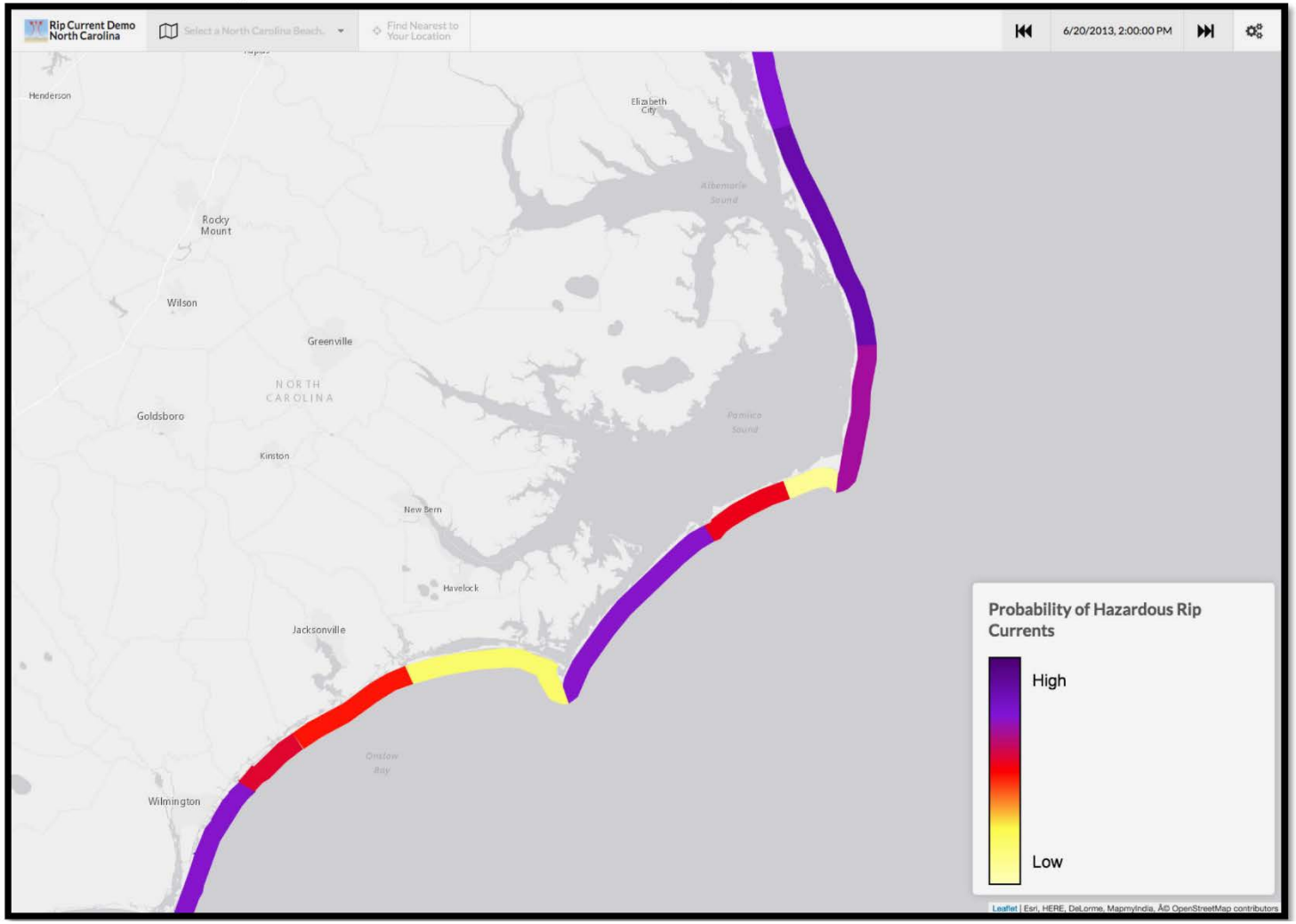
A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



How helpful is this product for your day-to-day operations?

A. Entirely unhelpful
B. Somewhat unhelpful
C. Neither helpful nor unhelpful
D. Somewhat helpful
E. Very helpful

For this graphic, What is your perception of this product with respect to…



…the information included

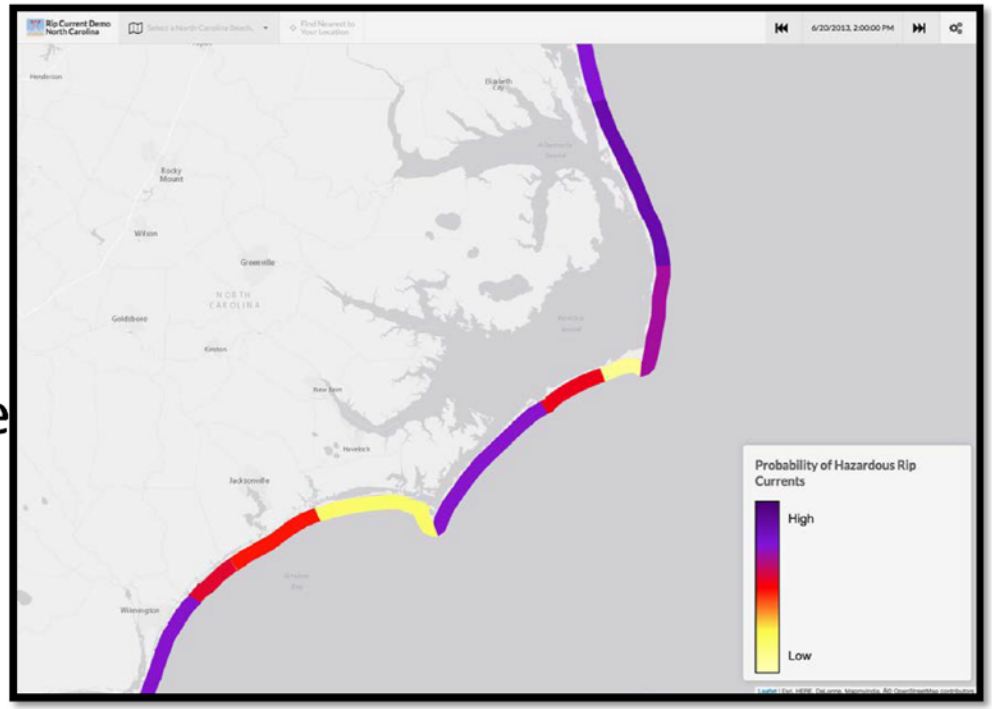
A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know

...format

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know

…understandability

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know

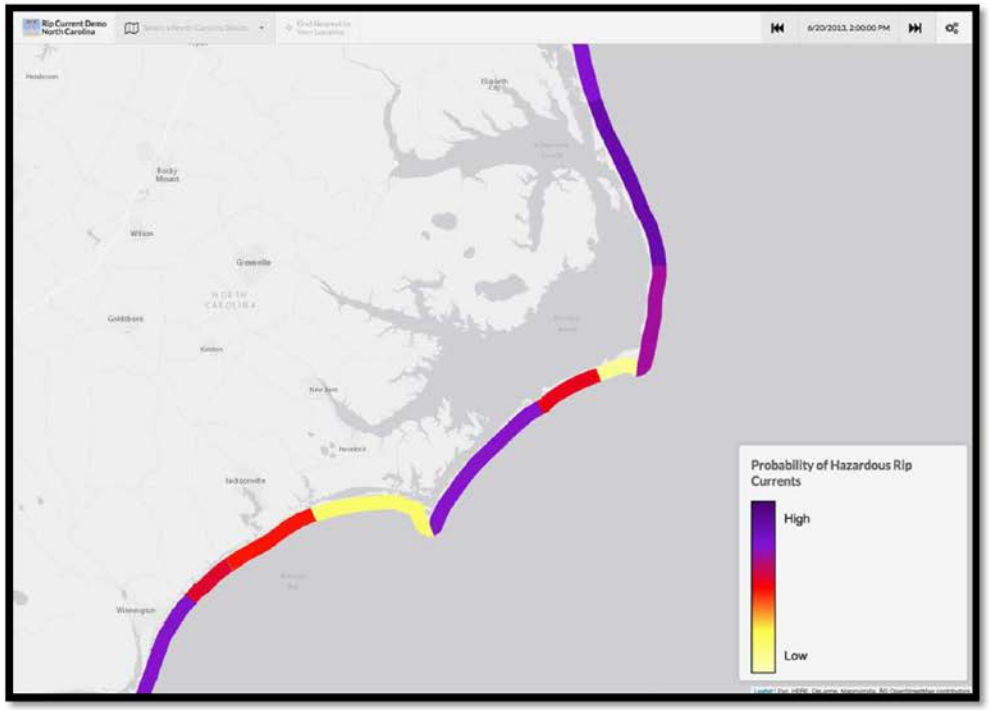


...graphics/symbols

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know

...text

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know



…use of color

A. Very negative
B. Somewhat negative
C. Neutral
D. Somewhat positive
E. Very positive
F. Don't know

How helpful is this product for your day-to-day operations?

A. Entirely unhelpful
B. Somewhat unhelpful
C. Neither helpful nor unhelpful
D. Somewhat helpful
E. Very helpful

Which graphic do you like best?

A. 1

B. 2

C. 3

D. 4

E. 5

Which graphic do you like least?

A. 1

B. 2

C. 3

D. 4

E. 5