Response Risk Communication Tools for Dispersants and Oil Spills

A Final Report Submitted to

The Coastal Response Research Center

Submitted by

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Abstract

The current regulatory framework for oil spill response does not easily allow for integration of public and stakeholder participation and information sharing, nor does this framework consider risk perception as a significant factor in response efforts. With social media and more immediate exchange of information being used during crisis situations such as oil spills, it is important to consider these factors, since information from a variety of sources, including members of the public, can influence decision making and oil spill response outcomes. As evidenced in the Deepwater Horizon (DWH) incident, use of social media and rapid information sharing was an influence in the response, possibly impacting decision making. In particular, the use of dispersants as an oil spill countermeasure caused an outcry of concern amongst the public, when both information and misinformation spread through social media and some academic channels, which led to heightened fears about this response option.

One logical way to address some of these issues is to better understand public concerns and beliefs regarding oil spills and response options, so that responders can better communicate about risks and share information in ways that people will understand. Likewise, engaging a broad range of stakeholders including members of the public, especially early during the pre-spill stage, a dialogue can be started and relationships formed that may enable improved collaboration and informed decision making in an actual spill situation.

Led by co-PIs, Ann Hayward Walker of SEA Consulting Group and Ann Bostrom from the University of Washington (UW), the SEA/UW team was comprised of investigators with extensive public, private, and academic research experience with oil spills and risk communication. The investigators surveyed members of the public at large and analyzed Twitter data collected during DWH oil spill, assessed the use of scenarios, and summarized current issues regarding communicating uncertainty in oil spill planning and response. The survey research and social media analyses exploit new technology and analytical capabilities in both domains, and build on data from prior oil spill workshops as well as DWH. Quality assurance was provided through a peer-review workshop structured to comment on five draft white papers and discuss preliminary findings from the project's research results. Products from this project can be applied immediately by NOAA, other federal, state and local, as well as industry, end users to promote effective response communications about dispersants and oil spills. Findings can also provide direct input to a strategic risk communications plan for oil spills and response options, including the use of dispersants, controlled burning, and mechanical clean-up.

This project led to the development of preparedness recommendations and response tools to address public and stakeholder information needs and risk perceptions about dispersants and oil spills. The approach is original and integrative: building on a mental models approach for risk communications, the research team conducted original survey research, analyzed social media data, leveraged other current survey research and decision analysis, and integrated relevant social and natural science research findings to design effective and useful communications strategies for dispersant use at oil spills for use in future preparedness and response planning.

Keywords: Oil Spill, Response, Dispersants, Mental Models, Risk Communication, Stakeholder Engagement, Social Media, Twitter, Scenario(s)

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1.0 Introduction

Experience with stakeholders and the public on oil spills and dispersant issues from 1980 through the Deepwater Horizon (DWH) oil spill in 2010 has shown that communicating about dispersants has long been and remains a problem across the country (Walker 2012, 2011a, 2011b, 2011c, 2010, 2001a, 2001b, 1999, 1997; Bostrom et al 1995 and 1997; Pavia 1984, 1985). Further, high quality information to support decision making is one of the perceived goals of oil spill response (Tuler et al 2008). The project presented here represents a collaborative social science and natural science research designed to address public, media and political concerns and develop preparedness recommendations and response tools to facilitate well-balanced decisions under the uncertain conditions of risk that spills represent. Natural science communications can benefit from data-driven social science research, and collaborations between the two can lead to new breakthroughs (Schaal, 2012).

The project has three subsidiary objectives: (1) identify key information needs and areas of confusion and misunderstanding, (2) explore the role of social media in effective risk communication, and (3) identify better methods to communicate scientific uncertainty and complexity with respect to response alternatives.

As a result of the DWH incident, many people hold correct and sophisticated beliefs regarding dispersant and oil spill processes and recognize the relevant scientific uncertainties. However findings from a workshop held in 2012 (Walker, 2012),which was supported as part of joint industry effort on dispersant communication tools, show that some individuals' mental models omit key elements, and may focus unduly on elements that contribute relatively little to potential risk. A mental model is someone's understanding of how something works in the real world. Mental models of processes associated with the lifecycle of an oil spill and dispersants can influence risk perceptions and public health (CRRC 2012). To assess mental models, information needs, and risk perceptions of lay stakeholders, the project, and in particular the survey research task, was informed by prior mental models risk communication research. This research reflects the social, natural and engineering sciences of how risks are created and controlled, as well as the social and behavioral sciences of how people comprehend and respond to such risks (Morgan et al 2002). The prior research included developing a decision-focused expert (i.e., science based) model of dispersant and oil spill processes, to aid in identifying correct beliefs as well as misperceptions that might influence oil spill response decisions. Comparing mental models with this decision model can provide insights about information gaps and misunderstanding, which in turn identifies knowledge areas to address and supports more effective communications. The approach applied in this project was a relatively new and innovative way to approach survey research, analysis of social media data, and integration of relevant social and natural science research findings.

Results from survey research and analysis of DWH Twitter data inform the team's approach for characterizing constituencies and their communication needs as they relate to dispersants and oil spills. The results are intended to be immediately applicable to promote effective response communications about dispersants and oil spills. Project end users include Unified Command (Federal and State On-scene Coordinators and spillers known as Responsible Parties), dispersant decision makers from coastal Regional Response Teams (RRTs), and academia. Many of these

key stakeholders are looked to by elected officials/politicians and the public for assurance about oil spill response options.

2.0 Objectives

The principal objective of this project was to provide end users with research-based risk communications knowledge and guidance to improve dispersant and oil spill communications going forward. This project aimed to meet a range of needs, through cross-disciplinary exploration of the human dimensions of risk communication and spill response by conducting work in the following ways.

Identify key information needs and areas of confusion and misunderstanding. This project leveraged the investigators' ongoing survey development and social media assessment research, extending it to address additional constituent groups and members of the general public. The team analyzed previously collected DWH tweets, and elicited responses representative of coastal residents nationally, using a novel research design strategy and Google Consumer Insights survey tools.

Specifically, the social media and survey results enabled the team to identify common beliefs, preferences, information needs, gaps and misunderstandings in coastal subpopulations, and compare these with interest group results from workshops, to inform improved communication approaches. This allows communication approaches to be informed by the needs of recipients, rather than treating public audiences as a monolithic whole. Work by the Pew Internet & American Life Project for example highlights differences among groups in trusted information sources and methods for accessing information (Rainie et al 2012; also Maibach et al 2011).

Our method is to develop strategies for engaging communities and individuals in discussions about spill issues, in addition to relying on the perhaps more common one-way communication model of briefings and talking points. Engagement (two-way interaction) allows responders to adaptively manage communication activities based on feedback from those with stakes in oil spill management actions (Health Canada 2006; Tuler and Webler 2008; Tuler et al 2008). Through engagement, government and industry managers responsible for spill preparedness and response will gain a better appreciation of public and stakeholder knowledge gaps and information needs in relation to practitioner and expert understanding. Scenario thinking is one tool for engaging and motivating people to rehearse a range of possibilities and to enable action by asking "What if?" What-if scenarios were part of the interview strategy used in the earlier mental models research conducted by the team (Bostrom et al 1995). The project explored the use of this form of interactive inquiry to more fully address perceived risks and benefits (tradeoffs) among ecological, human health, and seafood safety issues in oil spill response.

In addition, our team explored the role of social media in effective risk communication. Social media platforms (e.g., Facebook and Twitter) can be used to foster engagement and develop two-way communication between response agencies and the general public as well as other stakeholder groups that operate outside of the realm of oil spill preparedness and response, e.g., fishermen. Social media updates by these latter groups, which provide a complex snapshot of public opinion at a place in time, may also be a valuable information source for decision makers

and risk communicators. The team considered this effort essential for four reasons. Social media are:

- Looked to during crises as a source of real-time emergency information.
- An important and, in some cases, primary component of people's daily information consumption patterns.
- A democratic approach for determining influential voices and establishing credibility for information sources to which the public turns during crises.
- A unique venue for engaging with the public in a direct and ongoing way.

Identify better methods to communicate scientific uncertainty and complexity with respect to response alternatives. There is a rich literature in communicating scientific uncertainty and complexity in environmental decision-making (e.g., Bostrom et al 2008; Drew et al 2004; Johnson 2003; Webler et al 2011). Some of that literature addresses oil spills response, but much can be drawn from research into other environmental management challenges. Recently, there has been a focus on integrating human-dimensions and natural scientific research to understand the role of the environment in quality-of-life (e.g., Chan et al 2012; USEPA 2009). This range of literature was mined to identify different approaches appropriate for communicating the complexity and uncertainty of response actions and the tradeoffs associated with alternative responses to oil spill management. Using a fast-track peer review strategy focused on key issues identified in the survey research and social media analyses, the team assessed the evidence for and develop guidance on "best practice" information development, exchange and evaluation paths that include content creation, means of publication and dissemination, audience targeting, and mechanisms for analytics and feedback that could be incorporated into a strategic communications plan for future oil spills.

In order to meet the above listed objectives, the research team completed the following tasks:

1. **National Public Survey**
   The team developed and conducted a public survey of coastal areas nationally in order to characterize public knowledge, concerns, desire for information, and information gaps, and to provide insight into values for future science and policy investments related to oil spills.

2. **Social Media/Twitter Analysis**
   The team assessed social media use during oil spill response in an effort to improve communication strategies by increasing our understanding of how crisis-related information diffuses through a social media platform and how influential users shape this movement. In addition to improving future communication around dispersant use, these findings could inform real-time computational tools that enable response agencies to identify and address information gaps during an event.

3. **White Papers, Peer Review Workshop, and Guidance Tools**
   The team identified empirically-tested, practical approaches to content creation, audience targeting, means of information exchange and dissemination, and mechanisms for analytics and feedback and incorporated these findings along with research findings into

five topical white papers and related guidance to be used in oil spill preparation and response communications. In addition, the team conducted a peer-review workshop in July 2013, and invited experts in both social and natural sciences to participate in a review and discussion of findings. The white papers were revised accordingly.

3.0 Methods

3.1 National Public Survey and Interview Methodology

3.1.1 Expert decision model

Members of the research team developed a qualitative decision model for dispersant use in oil spill response through expert elicitation workshops. The initial model for dispersants was developed in the late 1990s (Bostrom et al 1997); this initial model was updated and expanded in a second workshop in 2012 (Walker and Bostrom 2014), which was supported as part of the API JITF (Joint Industry Task Force) D-1 effort on dispersant communication tools.

. Both workshops elicited knowledge from those in the nation most expert in the sciences of oil spill response, and also recruited their assistance directly in constructing the decision model. The decision model was developed to support communications designed for stakeholders in oil spill response, and in particular for those facing response decisions. Because it was designed for response decisions and not necessarily to address those decisions faced by coastal residents, the model is only partly relevant for public survey samples. The decision model reflects the overall structure of the hazardous process, from exposure (sources, pathways, and influences on these), through effects (ecological, economic, as well as human health in the later model) and mitigation of risk (see Appendix C). The key pieces in the model are: Initial oil (dispersibility), time, physical and environmental conditions, fate and transport processes, logistics, response options (best practices), and impacts of both the spill and the response.

3.1.2 Survey item selection

The initial questions for the project derive from mental models research with oil spill responders and stakeholders in the late 1990s (e.g., Bostrom et al 1996; Pond et al 1997). These were revised during survey toolkit development in 2012, through three workshops (Bostrom et al in preparation; Bostrom et al 2014; Walker and Bostrom 2014). The initial intent was to refine these questions in a small sample of cognitive interviews (i.e., "read-alouds"; see Ericsson and Simon 1993; Sudman et al 1996) with spill-interested non-experts on the Gulf coast or in Alaska.

A principal components analysis of 2012 workshop responses to earlier versions of the candidate survey questions was used to select initial sets of items whose content and structure (including within set correlations) would be of interest. The decision model developed in the August 2012 SEA workshop was used to guide the selection of additional survey questions. Interview recruitment emails were sent a sample of Alaska CRRC workshop participants and Mississippi Sea Grant contacts (n=100 total), with the anticipation of conducting at least a dozen cognitive interviews by telephone. Fewer than this responded, and to compensate for the small number of cognitive interviews, a sample of questions debriefing the interpretation of each item (question) was added to the survey data collection.

The team worked with Google Insights, with the aim to apply a novel multiple matrix survey design (e.g., Thomas et al 2006; Gonzalez and Eltinge 2007) in order to elicit perceptions, beliefs and preferences that are representative of coastal residents nationally using the above-mentioned survey items. Google Insights is now alpha testing fielding more than two questions per person but as of July 2013 could still only guarantee timely responses with no more than two questions per respondent (pairs). Thus, our matrix design is based on pairwise questions. The design pairs questions with the intent of allowing inferred response sets for multiple questions by coastal region. Sample sizes and response rates allow comparisons by region for the entire set of questions (few were evident). Additional contingencies between responses to multiple questions and at more refined geographical scales remain to be analyzed. .

Using NOAA's designation of coastal counties for the Statistical Abstract, the FIPS for all U.S. coastal counties excepting those in the Great Lakes region were extracted and converted to zip codes. Google can target population down to the zip code level, but would not stratify the sample to the state level, due to current market limitations. Google uses algorithms to analyze IPs and other user features to infer demographics, and have validated their approach, demonstrating that response rates and sampling errors are comparable or better than those obtained with Internet panels or telephone surveys (McDonald et al 2012). However, not all responses can be weighted, and charges are incurred regardless of the availability of weights. In the analyses, some results are weighted but most not. In all cases the weights do not change the gist of the relative distributions, with the exception that they reduce the proportion of don't know responses by up to ten percent in some instances.

Given the two-question constraints, along with strict character limits on prompts, some questions were used to introduce a context for other questions, including a question regarding ocean ecosystem resilience, adapted Holling's 1979 myths of ecological stability (Holling 1979; Holling et al 2002; Schwarz and Thompson 1990; Thompson et al 1990; Steg and Sievers 2000; and Leiserowitz et al 2010), two open-ended questions—one free association with chemical dispersant use, and one about oil spill information wants and needs—and a question regarding anticipated economic impacts of a spill. The intention of these context-building questions is to introduce the topic at hand (marine oils spills and chemical dispersants) in a manner that is more accessible to a lay audience. These context-building questions are each then followed by another question, which is somewhat more technical and addresses an element of the expert decision model described above (e.g., fate and transport). Because of the two-question limitation, each debriefing question followed an individual survey item presented without a preceding context-setting question.

3.1.3 Survey Analysis

Interview and survey responses from pre-tests were coded and statistically analyzed using documented mental model and quality assurance protocols (Bostrom et al 1995, 1997; de Bruin and Bostrom 2013; Morgan et al 2002; Wood et al 2012).

3.2 Social Media and Twitter Analysis Methodology

This research examined online communication and interaction during the 2010 DWH oil spill. It consisted of an in-depth qualitative analysis complemented by descriptive network and

quantitative analyses, to examine information flow within social media as well as the broader information space of the surrounding Internet.

3.2.1 Data Collection

Twitter provides several Application Programming Interfaces (APIs) that allow anyone with a Twitter account to collect public Twitter data programmatically. The data analyzed in this study were collected using Twitter's Streaming API, which enables a forward-in-time search on a keyword or a set of keywords. We collected on the term #oilspill, a hashtag that had emerged to signal participation in the ongoing, public conversation around the event. For each tweet, we captured the timestamp, author, and tweet text, among other features.

The collection period spanned from May 9, 2010 (~3 weeks after the spill began) to August 4, 2010 (~3 weeks after the well was capped). The collection captured 693,409 tweets sent by 132,075 different Twitter users. The number of tweets per Twitter user has a heavy-tailed distribution typical of many social media metrics, and the majority of Twitter users contributed only one tweet to our set (83,035). Of those, the sole tweet of 50,299 of these accounts was a retweet, indicating relatively low engagement in the larger Oil Spill conversation. Only 8,464 users sent 10 or more #OilSpill tweets.

Within this set, 11,146 (1.6%) tweets contain one of the following dispersant-related keywords that we identified in the data: *dispersant*, *Corexit*, and the misspelling *dispersant*, and these were sent by 3,283 different Twitter users. This larger data set is referred to in this report as the *Total #OilSpill Tweet Collection*, and several parts of the analysis refer back to this set, including the network diagrams.

3.2.2 Sampling

To complete an in-depth qualitative analysis of the Twitter activity, we identified a small sample from the larger data set using a tweet-based selection method (as opposed to a Twitter user-based one). We randomly selected 250 tweets from the *Total #OilSpill Tweet Collection* and 250 tweets from the 11,146 that contained a dispersant-related term. These 500 tweets become the *50-50 Random-Dispersant Sample*.

As a result of the tweet-based selection method, Twitter users who sent more #OilSpill-related tweets and more dispersant-related tweets are more likely to be represented in our data sample. This sample is therefore both representative of overall tweet content and biased towards high volume Twitter users and those who tweeted about dispersants. This means that though descriptive statistics at the tweet level can be extrapolated across the larger sample, characterizations made about Twitter users (e.g. how many are local, how many accounts belonged to members of the media, etc.) are only true for this sample.

Data Set	**# of Tweets**	**# of Dispersant-Related Tweets**	**# of Distinct Twitter users**
Total #OilSpill Tweet Collection	693,409	11,146	132,075
50-50 Random-Dispersant Sample	500	254*	387

Table 1. Descriptions of the Two Data Sets

* Consistent with the relative percentages in the set, 4 of the 250 random tweets also contained dispersant-related terms.

3.2.3 Method of Analysis

The analysis took place in four stages: exploratory analysis, qualitative coding of tweets, qualitative coding of articles linked-to by tweets, and mixed-method analysis of results.

3.2.3.1 Exploratory Analysis

Tracing information flow using retweets, replies and URLs. The connections that exist between accounts within a social media site as well as the connections between social media and other online sites are important for understanding information flow. As discussed above, retweets and URL links within tweets play important roles in information flow within Twitter and across the broader information space of the Internet. We explored connections between different Twitter users in the #OilSpill network using network graphs.

Qualitative Exploration. A second part of the exploratory analysis was qualitative as we sampled randomly from the data, reading tweets and assessing Twitter accounts. Using a grounded theory approach, we identified possible key themes, developed coding categories based on those themes, attempted to code tweets and Twitter users using these categories, and then revised our coding scheme in an iterative process. We derived the tweet themes and emotion categories during the exploratory analysis. We also shared preliminary categories with the members of our larger research team, comparing and integrating emerging categories from the social media analysis with categories derived from parallel research on oil spill stakeholders' mental models (discussed in other sections of this report). When we were satisfied that our coding categories reflected the themes present in the data, we selected our final *50-50 Random-Dispersant Sample* to code.

3.2.3.2 Qualitative Coding

Using the final coding scheme, we coded the *50-50 Random-Dispersant Sample* data across two separate dimensions: tweet content and Twitter account characteristic. We also coded all URL links present in the sample.

Tweet Content. For each tweet in the *50-50 Random-Dispersant Sample,* we coded for tweet theme (allowing one or two selections); emotion conveyed in the tweet; whether the tweet contained scientific content; whether the tweet contained a mention of dispersants and whether that mention was negative; and whether the tweet contained a conspiracy theory. For tweet coding, we had three coders code 200 tweets each, with an overlap of 100 tweets for assessing inter-rater reliability.

Twitter Accounts. Each Twitter account that contributed one or more tweets in our *50-50 Random-Dispersant Sample* was coded for Location relative to the event (Remote, Peripheral, Local, Unknown) as well as for role and organizational affiliation (Individual, Informal Group, Formal Organization, Other). Location was determined through a combination of reading through the #OilSpill tweets and assessing information available on the account owner's current profile (in June 2013), including their 3000 most-recent tweets. We classified as "local" anyone for whom we had evidence that they were in the area at any time during the event. Peripheral

users lived in or visited affected states, but not affected areas of those states—e.g. the east coast of Florida or northern Louisiana. Since many inland individuals had fear of oil and dispersant impacts through airborne transmission and other environmental effects, we applied a liberal lens in coding areas within about 100 miles of the Gulf Coast as "local." Unfortunately, we did not have access to what the user profiles looked like at the time of the event, and additionally, many account owners do not broadcast their account location, so we were unable to determine the location for 39 accounts. Table 2 shows the number of Twitter users in each location category and Table 3 shows the coding across Organizational Affiliation. For accounts that were organizations and for individuals with an organizational affiliation, we also coded the organizational type and sector. For Twitter user coding, we divided the 387 accounts evenly across three coders, then used a secondary round of consensus coding to bring results into alignment.

Location	# Twitter Accounts
Local	41
Peripheral	30
Remote	276
Unknown	30

Table 2. Location Distribution of Accounts

Org Affiliation	# Twitter Accounts
Individual	333
Formal Org	21
Other Group/Entity	20
Unknown	13

Table 3. Affiliation Distribution

3.2.3.3 Web-Link Analysis

A large portion of tweets in the *Total #OilSpill Collection* (69%) contain an embedded web link. To capture a picture of the larger information space surrounding Twitter, and the flow of information between Twitter and other sites, we explored the content of embedded links in our sample.

Of the 500 tweets in the *50-50 Random-Dispersant Sample*, 354 contained a web link. Text in the tweet helped to confirm or deny if a web page and its content were correct. When links were unavailable or if we suspected that the content had changed, we then attempted to use the Internet Archive to locate the content. In a few cases, we were able to trace back to an original link by using machine algorithms to compare content of similar Tweets in the collection. Through these combined means, we were able to locate the original content of 81.5% of the links nearly three years after the event.

We were particularly interested in the range of sources that were mentioned in different cited articles. We coded individuals and entities mentioned in the articles linked-to through tweets across multiple dimensions, including role and organizational affiliation. We also captured title, author, domain, and media type (e.g. news article, video, blog, petition). Specific to characterizing the nature of dispersant related tweets, we noted when a link's content appeared to be geared toward a professional scientific or technical audience. For longer audio and video pieces we only coded the first ten minutes of content.

This analysis allowed us to see the kinds of external sources that different Twitter users brought into the #OilSpill conversation.

3.2.3.4 Mixed-Method Analysis

Finally, we analyzed the results of the coding, integrating descriptive statistics of the codes with further qualitative analysis of tweet content, Twitter user behaviors, and network connections between users. This mixed method approach provides a rich set of findings, described below.

3.2.4 Data Limitations

Consistent with other studies on social media data (Boyd & Crawford, 2011), this data represents only a subset of the broader Twitter conversation about the DWH Oil Spill and has specific biases related to its collection and sampling. Most significantly, only tweets where the account owner purposefully used the #OilSpill hashtag in their tweets were collected, which means that account owners who were not aware of the hashtag are not represented in this analysis. However, the presence of certain accounts, including several high-volume, local Twitter users and the official account of Unified Command (@Oil_Spill_2010), suggests that some portion of the relevant Oil Spill conversation was indeed organized around the use of this hashtag. Additionally, our sampling technique favored high-volume Twitter users who tweeted about dispersants, so the presented statistics do not characterize all accounts that tweeted about the Oil Spill. We are careful in the reporting to account for these limitations, but recommend that readers keep them in mind when referring to these findings out of the context of this paper.

3.3 White Papers, Peer Review Workshop, and Guidance Tools Methodology

Five white papers were drafted to consolidate the interdisciplinary project research and literature reviews were drafted around issues identified in the RFP. The five white papers are:

1) Stakeholder and public mental models of and economic, environmental and health concerns about dispersant and oil spill processes (*leads Ann Bostrom and Ann Hayward Walker, with Tyler Scott, Robert Pavia, Tom Leschine, and Kate Starbird*);
2) Engaging the stakeholder community in oil spill preparedness and response (*leads Ann Hayward Walker and Robert Pavia, with Ann Bostrom, Tom Leschine, and Kate Starbird*);
3) What-if scenario modeling to support oil spill preparedness and response decision making (*leads Tom Leschine, with Ann Hayward Walker, Robert Pavia, Ann Bostrom, and Kate Starbird*);
4) Sensemaking through Twitter after the 2010 Gulf Oil Spill (*lead Kate Starbird, with Dharma Dailey, Ann Hayward Walker, Tom Leschine, Robert Pavia and Ann Bostrom*);
5) Methods for communicating the complexity and uncertainty of response actions and the tradeoffs associated with various response options (*lead Ann Bostrom, with Susan Joslyn, Robert Pavia, Ann Hayward Walker, Kate Starbird, and Tom Leschine*).

The white papers are being delivered to CRRC as an unpublished deliverable; they will be the basis for developing submissions to peer-review journals and conferences. Particularly because of the integrative, interdisciplinary nature of this project, the team wanted to have a peer-review of the white papers prior to submission to CRRC, journals and conferences.

On July 24-25, 2013, the team conducted a workshop at the University of Washington with social science peer-reviewers who have worked with oil spills, decision making under uncertainty, and science communications. The workshop allowed the project team to fast-track peer review and revise the white papers based on participant expert consensus, and to produce a

summary assessment of current perceptions, communications and engagement practices, and recommendations for oil spill preparation and response communications and engagement practices going forward. Participants were identified to provide relevant expertise for each of the white papers. The team assigned a lead reviewer for each paper based on their area of expertise. Lead reviewers presented an overview of the paper and their comments during the workshop. However, participant discussion and comments were invited on all the white papers. The agenda for the workshop is presented in Appendix A.

In addition to all project team members, workshop participants included Dr. Amy Merten, Co-Director of CRRC and the following peer reviewers:

White Paper	Final Peer-review and Workshop Participants
Stakeholder and public mental models of and concerns about dispersant and oil spill processes	• *Seth Tuler-, Research Fellow, Social & Environmental Research Institute, previous research on human dimensions of oil spills
Suggested practices for community and stakeholder engagement in oil spill preparedness and response	• *Bob Pond, USCG HQ Senior Oil Spill Advisor (retired), National Research Council member Committee on Understanding Oil Spill Dispersants: Efficacy and Effects (also worked with AHW and AB on 1990s dispersant mental models project) • Debbie Scholz, SEA Consulting, Environmental Specialist – support to Regional Response Team and US EPA, Aerial Dispersants in Deepwater Horizon, author of dispersant fact sheets for Joint Industry Project to improve dispersant communications and 1990s papers
What-if scenario modeling to support oil spill preparedness and response decision making	• *Glen Watabayashi , Supervisory Scientist, Emergency Response Division, NOAA's Office of Response and Restoration • **Jeffrey Wickliffe, Assistant Professor, Tulane University, Dept. of Global Environmental Health Sciences, School of Public Health and Tropical Medicine, Department of Global Environmental Health Sciences
The role of social media and emerging information and communication technology in oil spill response communications strategies	• *Jeannette Sutton, Senior Research Scientist, Trauma, Health and Hazard Center, University of Colorado at Colorado Springs • Emma Spiro, incoming Assistant Professor, Information School, University of Washington • Keeley Belva and Vickie Loe, NOAA Communications and External Affairs, National Ocean Service
Methods for communicating the complexity and uncertainty of response actions and the tradeoffs associated with various response options	• *Susan Joslyn, Assistant Professor, Dept. of Psychology, University of Washington (*Decision Making in Applied Settings)* • Richard Sheehe, Former NBC national news correspondent, adjunct professor and public affairs executive at George Washington University and he is a lecturer for Tulane University's doctoral program in crisis communication (designated by Barbara Reynolds, Director, CDC Public Communications)
*** Lead Reviewers**	****Provided additional comments on role of human health information and communication**

Table 4. Workshop Participants and Peer-Reviewers

Results from the survey and analysis of DWH Twitter data informed the team's approach for characterizing communication needs as they relate to dispersants and oil spills. The team partitioned communication needs into multiple time horizons including: during preparedness activities (between spills); during spills when dispersant use is being planned or executed; and during spills post-dispersant use (monitoring phase). The team utilized empirical findings (from stakeholder workshops conducted in 2012 by members of the team and from the project research) to identify constituencies (including stakeholder groups).

4.0 Results

4.1 National Public Survey and Interview Results

4.1.1 Cognitive interviews

The response to our interviewee recruitment emails for the cognitive interviews to the Alaska workshop and Mississippi Sea Grant lists was extremely low. Further, even though we screened out a significant proportion of those on the lists whose emails or other contact information showed them to be NOAA employees (NOAA email addresses) or academic researchers (.edu email addresses), those who did respond to our request for participants tended to be heavily invested stakeholders with significant experience rather than representing the public at large. We conducted nine cognitive interviews via Skype or telephone, five of which were with a non-expert convenience sample from Seattle. The interviews ranged from about 17 minutes to almost an hour.

Cognitive interview results and associated comments supported switching back from a Likert-type response scale to a True-False response scale for the knowledge questions, eliminating the question about when it was appropriate to consider source control (all respondents said always), and several minor wording changes. Non-expert respondents struggled with words like biodegrade and photo-oxidation, which we addressed by adding context or definitions. While we did receive a few additional responses from Alaska regarding potential interviews, those respondents were unable to schedule/complete the interviews within a week of the initial recruitment email. In order to complete data collection before the workshop conducted at the end of July, 2013, we abbreviated the cognitive interview collection to conduct the survey.

The first question we asked participants was open-ended:

"Briefly, what information do you think should be included in a summary reference booklet on oil spill response options—including mechanical on water and shoreline strategies, controlled burning, chemical dispersants, and source control—for it to be most useful to concerned members of the public?"

Responses specified wanting to know the "what and how" of dispersant use, their pros and cons, and contextual information and history and experience of use, as two responses illustrate:

- "Response booklet should include explanation of how dispersants work, summary of rules for their use (shallow v deep water, application rate, specific variety used and why), timeline of use history - so we had a set of rules in place at DHOS that guided use of

dispersants... how did the set of rules change as a result of DHOS use of dispersants and their impacts on the gulf ecosystem? "

- "A description of the control methods, prior experience with each in other oil spills from various sources, the advantages and disadvantages of each."

The first respondent above describes her experience with oil spills as follows: "I am a geologist, but I know minimal detailed info about oil geology. I began learning about oil spill response on April 20, 2010 and implemented a [grant-type omitted to protect confidentiality] grant in MS related to DHOS in fall 2010 then in spring 2013 led a group of citizen scientists through a literature review DHOS to learn about the process of science and its role in emergency response."

The second reports his experience with oil spills as follows: "Experience with BP oil spill. I have an oyster farm at [location omitted to preserve confidentiality] AL, on the MS sound. There is a chain of offshore islands 12 miles offshore. The water between each island was boomed. The entrance to the bay where I am located was boomed. We had no evidence of any oil at any time after the spill as determined by periodic sampling of sediment, water and oyster meat. I would say the spill response methods were effective in preventing oil from reaching my site."

It swiftly became apparent that given their investment and experience these respondents have the expertise to interpret questions about oil spill response somewhat differently than most coastal residents.

Analyses of the cognitive interviews were conducted iteratively, and the survey items revised throughout the process, as initially planned. One salient result of this process was that the True-False response scale was easier for interviewees to interpret and use for the candidate survey questions than was the Strongly Agree-Strongly Disagree response scale, for which reason we switched to that scale, despite questions raised about the True-False scale by a survey expert at the August meeting. Including midpoints in response scales for attitudes has been shown to improve reliability of responses, whereas including no-opinion options does not improve the reliability of responses (Krosnick & Presser, 2010; Krosnick et al 2002). Including an explicit "don't know" option increases the frequency of don't know responses, without improving the quality of the data, these authors argue. Given that uncertainty and lack of knowledge are of interest to us as well, however, we nevertheless deemed it appropriate to include an explicit don't know response category.

4.1.2 Survey results

Overall, we received 36,978 responses to pairs of questions, and several thousand additional responses from individuals who did not answer the second question in the pair they were presented or who were asked debriefing questions instead. Response numbers are provided with each question analyzed. The analyses include those responses to initial (context-setting) or secondary questions that represent unique pairs or individual answers. Google Consumer Insights calculates response rates based on the percentages of "impressions" (people who see the initial question) who answer it. Response rates calculated this way varied widely, from under 10% for

some of the initial questions (the first in a pair), to over 70% for some follow-up questions (the second in a pair, seen after the respondent answered the first question).

Preliminary analyses of the debriefing questions suggest that item wording was fairly robust though minor wording changes did trigger some minor shifts in response distributions. This may have been because while over half of coastal residents held specific beliefs about oil spills and oil spill response based in part on their experiences with past oil spills such as Deepwater, most—including a plurality of those with specific beliefs—expressed considerable uncertainty.

Initial results suggest that people see ocean ecosystems as somewhat resilient but potentially vulnerable to the cumulative effects of major oil spills (see Figure 1). A plurality (33% overall) selected the threshold view of how ocean ecosystems work ("*Oceans are stable within limits. With a few oil spills, the oceans will return to a stable balance. Major oil spills will lead to dangerous effects*"). Next most prevalent (27.3%) was the view that ocean ecosystems are fragile ("*Oceans are delicately balanced. A few major oil spills will have catastrophic effects*."), which women were significantly more likely to choose than men. Least frequently selected was the view that ocean ecosystems are very stable, and that major oil spills will have little to no effects. The response options were displayed in random order. In Figure 1, results are weighted by age. The median response time for this question was 34 seconds, which is relatively slow in relation to other questions posed in our survey.

Two open-ended questions were also included as context-setting questions in our survey. For the open-ended questions, respondents tend to write only a word or two, response times are on the order of 15-22 seconds), shorter if the question appears after another question, longer if first.

The first open-ended question was: "*What key information do you think should be in a booklet on oil spill response options, for it to be useful to you?"* Similar to the results from the cognitive interviews, responses to this open-ended question do include mention of pros (clean up) and cons (costs) (see Figure 2). However, the dominant response is "don't know," and the general picture that emerges is a focus on actions—what to do, how to prevent harm, how to clean up—with a secondary emphasis on damage and costs.

Figure 2 is a graphical representation of open-ended responses received from respondents who first answered the ocean ecosystem resilience question. Individual words and phrases are scaled in accordance to their relative prevalence across responses. The 'word cloud' in Figure 2 does not include those few responses that were either numerical, strings of random letters, or obviously nonresponsive.

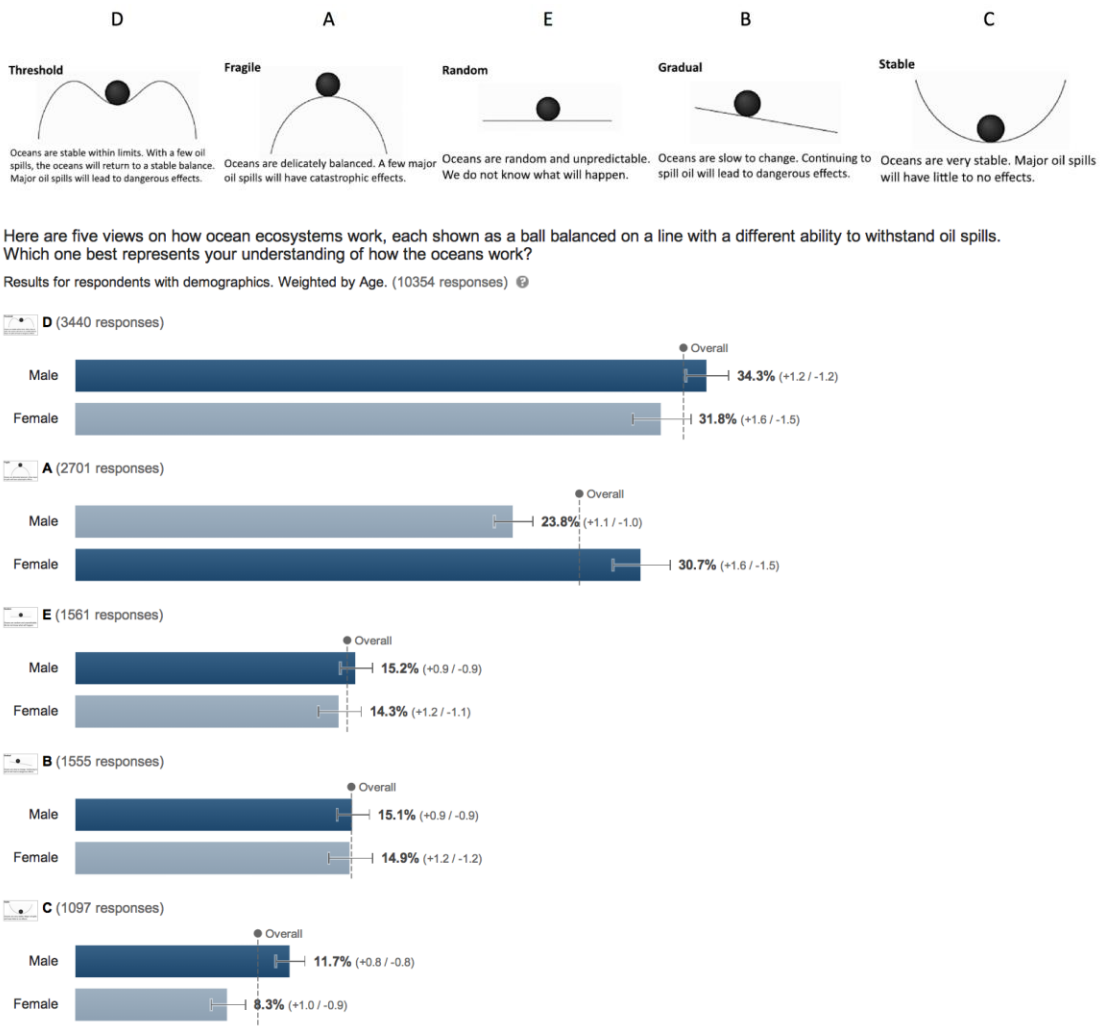

Figure 1. Ocean ecosystem resilience. From the 175,683 internet impressions of the question in NOAA-designated coastal counties (excluding the Great Lakes coastal counties), 14,308 internet users responded (8.4%). Weighted results are shown, which when weighted by age to resemble Current Population Survey demographics correspond to N=10,354.

Figure 2. Open-ended responses to "What key information do you think should be in a booklet on oil spill response options, for it to be useful to you?" administered following resilience question (N=500).

Responses to "What comes to mind first when you think of using chemical dispersants to respond to marine oil spills?" paint a general picture of a response technology that people dislike and equate with pollution, characterizing dispersants as equally polluting or worse than spilled oil. These responses are from individuals who first received the ocean ecosystem resilience context-building question (see Bostrom et al 2014). When grouped by sentiment, neutrals (don't know) dominate, but negatives sentiments greatly outweigh positive sentiments.

4.1.3 Summary of Interview and Survey Results

Most respondents do not feel they know whether there is scientific agreement on the effectiveness or toxicity of chemical dispersants, but a majority of those responding to date have a tendency to think of dispersants as persistent (detectable in fish after a year), and toxic (toxicities due to dispersant rather than oil).

Preliminary results suggest that coastal respondents have limited knowledge and interest in oil spill response, but a plurality think a major oil spill in their region would have major effects on the economic well-being of their household, and are negatively disposed toward dispersant use on oil spills. In all questions related to the perceptions lay respondents hold with regards to the toxicological effects of chemical dispersants, the modal response is "Don't Know." However, respondents who express a negatively oriented view towards dispersant toxicology outweighed those who express a positive orientation in every case. Coastal respondents also express doubt regarding the degree of expert consensus about the effects of dispersants. Aside from those who chose "Don't Know," the next most common response regarding whether scientists agree about the efficacy or toxicity of dispersants is "False." Viewed in conjunction, these results speak to a hearty skepticism amongst coastal respondents towards chemical dispersants generally. This is

interesting in light of the fact that the questions for which "Don't Know" is chosen most frequently are those addressing the mechanisms and means by which dispersants work; thus, negative opinions about the effects of chemical dispersants are disproportionate to respondents who believe (whether accurately or not) that they have knowledge about how dispersants work or what they do.

Common sense models of the shortcomings of technological responses may be driving some of the judgments exhibited in these data (i.e., respondents are skeptical of claims made regarding the efficacy and risks of unfamiliar technology). Unsurprisingly, the data also speak to a general unfamiliarity with regards to the technical aspects of oil spills and chemical dispersants. However, the pattern of missing knowledge and conceptions of fate and transport processes suggests an opening for developing a deeper appreciation of the tradeoffs made in oil spill response decisions. Part of the challenge appears to be that respondents (understandably) seem to view all things oil-spill related in a negative light.

This makes it difficult for respondents to address counterfactuals, since more often than not they view both oil spills and chemical dispersants with negative sentiment. Table 5 represents a greatly simplified contingency table of decision-making with regards to the use of chemical dispersants:

	No Marine Oil Spill	Marine Oil Spill
No Response	Scenario A	Scenario B
Dispersant Use	Scenario C	Scenario D
Mechanical Clean-Up	Scenario E	Scenario F

Table 5. Contingency Table of Dispersant Use and Marine Oil Spills

The overall pattern of responses indicates that lay respondents tend to conceptualize their answers in terms of a comparison between: (1) Scenario A and B; and (2) between Scenario A and C. However, Scenario A and Scenario C are irrelevant, since dispersants would of course not be applied in the absence of a marine oil spill and the questions in the survey take spilled oil to be a given (obviating Scenario A). More effectively framing this issue as a comparison between Scenario B and Scenario D might provide a more accurate conception of this issue and foster a wider understanding of oil spill response policy (more generally) and chemical dispersant use (more specifically) as rooted in tradeoffs. Similarly, respondents appear to struggle to weight response alternatives against one another. In particular, instead of comparing Scenario D and Scenario F, respondents tend to compare each response scenario to the baseline of either no response (Scenario B) or no spill (Scenario A).

Empirically, elevating understanding and discourse in this regard could have significant social and environmental benefits. No matter how heightened public understanding becomes, it is expected that the use of chemical dispersants will remain somewhat controversial. However, focusing on the tradeoffs associated with dispersant use (i.e., between Scenario B and Scenario D) can potentially foster a more productive discourse amongst the public, politicians, and policy makers. Given the time demands of oil spill response and the detrimental impact of a major spill, any improvements to the decision-making process (whether said process results in the application of chemical dispersants or not) would be beneficial.

4.2 Social Media and Twitter Analysis Results

Findings on information recommendation, influential accounts, and the information-sharing behaviors of highly-engaged Oil Spill tweeters, including locals, provide insight into the broader patterns of information flow through Twitter during the Oil Spill. These findings characterize a complex information space—a social media platform tightly integrated into the surrounding Internet.

4.2.1 Tweet Themes within the #OilSpill Conversation

Table 6 shows the distribution of tweets from the *50-50 Random-Dispersant Sample* according to the themes that presented. Each tweet was assigned up to two themes from the list. More than half of the tweets (both dispersant and non-dispersant) related to some aspect of the *response*. About one third referred to *impacts* of the hazard. The *state* of the hazard and *drivers* of the event made up a smaller portion of the tweets, and differed in proportion for dispersant and non-dispersant tweets.

Theme	Dispersant-Related		Not Dispersant-Related	
Response: Clean Up Strategy, Including Efficacy of Dispersants	188	76%	21	9%
Impact: Environmental Impact	36	15%	35	15%
Impact: Health Impact	32	13%	4	2%
State: Clean Up or Spill Status	19	8%	43	18%
Response: Who is in charge?	15	6%	5	2%
Response: Call to Action	11	4%	25	10%
Impact: General/Other Impact	10	4%	18	8%
Response: Communications/Cover Up	9	4%	24	10%
Response: Monitoring	9	4%	4	2%
Response: Responsibility/Liability	8	3%	29	12%
Response: Community Response	6	2%	14	6%
Response: Environmental Policy	6	2%	5	2%
Driver: Corruption	4	2%	7	3%
Impact: Political Impact	4	2%	18	8%
Driver: Environmental/ Commercial Policy	3	1%	24	10%
Response: General/Other	3	1%	8	3%
Other	2	1%	19	8%
Unknown, Unclear or Off topic	2	1%	19	8%
Response: Recovery-Assistance	1	<1%	3	1%
Response: Wildlife Response	1	<1%	8	3%
Impact: Economic Impact	0	0	2	1%
Impact: Mental Health Impact	0	0	0	0
Response: Evacuation/Safety Regulation	0	0	3	1%

Table 6. Distribution of Tweets across Identified Themes

Tweets that were not related to dispersants contained a wide range of themes (see Table 6, pink highlighting for some salient categories). 18% of these tweets were simply about the state of the spill. 15% dealt with environmental impact. 12% focused on liability issues, with many of these suggesting that BP be held accountable. About 10% were calls to action, including requests to sign petitions or join in volunteer activities. Commentary on how the oil spill was being communicated by official sources, including accusations of a cover-up, constituted about 10% of tweets in the broader conversation. Another 10% of tweets contained remarks on drivers of the event, including environmental and commercial policy. Political impact was a primary theme in 7.5% of non-dispersant tweets.

Dispersant-related tweets focused around a smaller set of themes. 76% related to the clean-up strategy, including aspects of the risks and benefits of dispersant use. 15% dealt with environmental impacts and 13% were focused around health impacts. Significantly, dispersant-related tweets were much more likely to refer to human health impacts than tweets that did not mention dispersants (13% to 2%, see Table 6, row 3, orange highlighting). This suggests that while the social media crowd talked about the oil itself as an environmental disaster, **dispersant use brought up more concerns around human health effects**.

An interesting theme that emerged during preliminary analysis involved tweet content that questioned who was in charge of response efforts, often with criticism of the U.S. Government and Coast Guard for not exerting control over BP. 6.5% of dispersant-related tweets contained this theme.

> **@suesalinger** (2010-05-23 03:55:13): http://tinyurl.com/3xfje4h Obama Fail: Month After Oil Gusher, Why is BP Still In Charge? #OilSpill
>
> **@GulfCoastSpill** (May 22 00:07): BP: Screw you EPA: #BP is sticking with its dispersant choice. http://bit.ly/aOz71O #gulf #OilSpill

This theme was also significantly more likely to appear in dispersant-related tweets, like @GulfCoastSpill's tweet above, than in others (Chi-Square, $p<0.04$).

Missing Themes: Mental Health & Economic Impacts

Though we identified mental health impacts as a potential theme, the tweet coding did not show Twitter users talking explicitly about them in the public #OilSpill conversation. Also surprising, economic impacts were rarely a primary theme of tweets in our sample.

4.2.2 Most Retweeted/Recommended Accounts

Analyzing retweet patterns allows us to see what voices were being heard within the set. Retweets can also be seen as a form of recommendation (Starbird and Palen 2010), lending insight to what voices were valued as well. We approach the analysis of the most retweeted accounts from two perspectives: by examining retweets across the entire set (Table 7) and by looking at retweets from Twitter users in our *50-50 Random-Dispersant Sample* who were coded as Local to the event (Table 8). From a high level view, we see that Non-Governmental Organizations (NGOs) were influential in the space, along with a few individuals who were tweeting from affected areas. Celebrities make the top-retweeted list across the larger set, but are not as influential among local, high-volume #OilSpill tweeters. Significantly, @Oil_Spill_2010, the official account of Unified Command, is highly retweeted both in the larger set and among locals in the sample.

	Twitter User	# of RTs	Affiliation Type	Affiliation Sector	Description
1	NWF	7677	NGO	Environment- Wildlife	National Wildlife Federation
2	IBRRC	7327	NGO	Environment- Wildlife	International Bird Rescue
3	WhoDat35	5261	Individual		Local individual
4	Oil_Spill_2010	4738	Government	Response	Account of Unified Command
5	GulfOilCleanup	4538	Informal Group	Media, Community Response	Informal group of collaborating media partners for Oil Spill relief
6	Alyssa_Milano	3507	Individual	Actress, Celebrity	Early adopter of Twitter, celebrity
7	MacMcClelland	3474	Individual	Journalist	Mother Jones journalist in NOLA
8	sami_shamieh	3259	Individual	Political Commenter	Remote individual
9	TheOilDrum	3225	NGO	Media, Energy	Online news about energy
10	Jason_Pollock	3093	Individual	Entertainment	Filmmaker, writer, activist

Table 7. Top 10 Most Retweeted Accounts in the *Total #OilSpill Tweet Collection*

	Twitter User	# of RTs	Affiliation Type	Affiliation Sector	Description
1	WhoDat35	675	Individual		Local individual
2	Oil_Spill_2010	601	Government	Response	Account of Unified Command
3	GOHSEP	567	Government	Response	Local response organization
4	IBRRC	403	NGO	Environment- Wildlife	International Bird Rescue
5	SaveTheGulf	342	Informal Group	Community Response	Local action group
6	GulfOilCleanup	318	Informal Group	Media, Community Response	Informal group of collaborating media partners for Oil Spill relief
7	TheNewsBlotter	310	Individual	Blogger	Local blogger
8	BPGulfLeak	198	Individual		Individual as a cause
9	TheOilDrum	165	NGO	Media, Energy	Online news about energy
10	NolaNews	157	Organization	Media	Local news outlet

Table 8. Top 10 Most Retweeted Accounts by Locals in *50-50 Random-Dispersant Sample*

4.2.3 Sense-making and scientists

Previous research has reported that many people utilize social media platforms after crisis events for collective sense-making activities (Vieweg et al 2008; Qu et al 2009; Heverin and Zach 2012). This research supports those claims, as the #OilSpill tweets show many people, including some locals, coming together through Twitter to try to make sense of the event. Weick (1995) describes sense-making as an attempt to make meaning out of experience, and connects it to a need to reduce uncertainty. People are not comfortable with uncertainty, and in times of uncertainly they often fear the worst. Researchers in the area of health psychology have theorized that "fearing the worst" is a coping mechanism—i.e. if one prepares for the worst, then they are better able to accept the facts when their worst fears are realized (Sweeny and Cavanaugh 2012).

During the DWH oil spill, some people turned to social media platforms to seek information that would help reduce their uncertainty, and to collectively process that information. We want to

emphasize here that **Twitter users OFTEN sought out and later tweeted/retweeted scientific information and other highly technical resources**. These individuals (and groups) were actively searching the information space looking for trustworthy information, and making calculated decisions about what and whom they could trust. Users in our sample shared similar information, including links to media articles and blogs citing scientific "experts" and technical reports on the efficacy of different dispersants. When the scientific information they found was conflicting or when it acknowledged uncertainty in its claims, Twitter users often returned to a place of fearing the worst. For an unprecedented event where the impacts could not be known, and where scientists with different kinds of expertise shared conflicting views, crisis communicators were forced to walk a thin line between aggravating the public's fears and being less than forthright about the situation.

4.2.4 Implications for Design and Practice

Emergency response professionals and other crisis responders are beginning to experiment with social media, and in some cases these platforms are being formally integrated into response plans. Many realize that social media are interactional media, and clearly Unified Command and others understood this already in the spring of 2010, when they deployed their communications response plan.

This research supports the claim (American Red Cross 2010; Hughes and Palen 2012) that social media users will attempt to contact response agencies through their social media accounts, and they will expect replies, often at a pace that may strain a response agency's capacity. In many cases, these back and forth communications will be visible to others in the space, and can be an integral part of developing trust with an affected community. Responders can also use social media to detect rumors, misinformation, and concerns among the crowd. It may also be possible for responders to use these new tools to engage in ways that build trust in response efforts, though this potential was largely unrealized during the DWH Oil Spill.

This research reveals several implications for oil spill responders who choose to use social media to interact with the crowd:

1. Engagement: Social media is interactional media. Responders should **engage - if they can do it well.** Establishing a social media account in the response space opens up a new communication channel that people will assume they can use. If their messages to responders go ignored, or if they feel disrespected by the responders, then the work to engage could be counterproductive. The operator of the account will be expected (by other users) to interact in near real-time, and therefore, if an organization chooses to use a social media account, the operators of that account will need the capacity to interact with other users in a real-time, around-the-clock manner. Problematically, the constraints and expectations of this work may require account operators to have the expertise and authority to improvise content, including responses to questions from the public. These practices may conflict with existing procedures for outgoing crisis communication, designed for a different mode of media.
2. Social media is a long-term commitment: Responders who do choose to engage should carefully consider how they structure that engagement in terms of tools, accounts, and websites. In assessing their capacity for establishing event-specific accounts and

websites, they should consider whether they have the resources to keep these alive when the event has ended. In this event, after the well had been capped, Unified Command cancelled their @Oil_Spill_2010 account, and at some point after that another account took over that name and began tweeting information that was critical of both BP and the government response. Unified Command also shut down their websites, which led to claims by some that they were covering up information about the response.

3. Identifying influencers: It is possible and growing increasingly easy through the availability of online tools to **generate network graphs** of social media conversations to **identify influencers**. Though these graphs can be useful for understanding information flow during an event, investigators may need to keep in mind that how they define that network may shape what they see. For instance, a graph created by following relationships for everyone who participated in the #OilSpill conversation would look far different than one created from retweets of highly retweeted accounts.
4. Connecting with local users and other influencers**.** The social media crowd after a crisis event is a global one, but this research suggests that local voices are extremely important in shaping the conversation. This research shows many locals to be both eager to engage and to have their voices heard. One recommendation is to spend some time searching for local and otherwise influential accounts—finding the most highly retweeted accounts is one way to do this—and then engage with these accounts in a way that demonstrates respect both for their fears and for their drive to be informed.
5. Integrating online volunteers: Tweet evidence supports a view that many **people** who are affected by a crisis **want to contribute in a productive way** to responding to the event. This phenomenon extends from the long recognized phenomenon of spontaneous volunteerism, and these crowd contributions can manifest in various ways—e.g. as citizen reports of impacts, as ad-hoc clean-up expeditions, and as activism designed to affect change in policies and response efforts. It may be possible to use social media and other ICT to help shape volunteer contributions through coordinated efforts that bridge responders, influential and trusted NGOs and media, and affected citizens. This research suggests a **re-positioning of the crowd as participatory** (they are), and the intentional **structuring of "official" volunteer opportunities** to be both safe and productive and **to align with the motivations, goals, and values of the public**. In particular, finding a way to support citizen reporting may be a way of building trust and engagement between responders and the local crowd.
6. Communicating scientific complexity: Citizens in the era of connected, online media have access to information like never before, and they are developing new skill sets and expectations around this access. These findings demonstrate that **the social media crowd values academic credentials and scientific information.** During the oil spill, in their information seeking and through their social media interactions, members of the public were actively trying to make sense of the situation and to reduce their uncertainty. They often cited sources that make explicit mention of the viewpoints of scientists, and some even brought highly technical documents like published scientific studies and Material Safety Data Sheets into the conversation. This sophisticated sensemaking behavior may have design implications for future communication strategies around oil spills and oil dispersants.

5.0 Discussion and Importance to Oil Spill Response/Restoration

5.1 Some Recommended Practices for Oil Spill Response/Restoration Based on Project Research Results

Research conducted on this project including national public survey analysis and social media analysis is providing insights into gaps in understanding about oil spills and dispersants. In addition, team researchers prepared the white papers to suggest areas of new practice that are relevant to oil spill preparedness and response. This section highlights suggested future practices as examples for applying these findings. The example applications focus on approaches that build resilience within the planning and response system through community engagement as new ways to communicate. These practices are believed to enable and support adaptive responses to unanticipated situations. They include recommendations for analytics and feedback that can empower consultation and participation as part of community engagement and in this manner connect activities of the incident management team (IMT) to external stakeholders, such as affected communities, academia, and the public at large. These five recommended practices are:

1. Structured Dialogues to Help Communities Understand Complex Science and Uncertainty
2. Adapting Scenarios to Strengthen Oil Spill Preparedness and Response
3. Outreach for Communicating Oil Fate and Transport Forecasts
4. Listening and Understanding Communities Through the Internet and Social Media
5. Participating With Digital Volunteers to Monitor Oil

Community engagement and communication practices for dispersants should accommodate multiple time scales. The time scales below incorporate response and post-response activities.

Time Scales

- Learning and adapting (research, lessons learned)
- Preparedness (education, contingency planning, training, and exercising)
- Response (in progress and planned)
- Recovery (natural resources, community infrastructure)

Preparedness activities (procedures, training, incorporating procedures changes in plans, engagement, and exercises) need to occur in order for the recommended practices to be successfully implemented during response. Each example practice is presented as a strategy, anticipated benefit, problem statement, relevant white papers used to guide the practice, as well as approaches to implementing and obstacles (policy procedures, technical and scientific) to implementation.

5.1.1 Structured Dialogues to Help Communities Understand Complex Science and Uncertainty

Strategy

Engage scientists and technical experts outside of the Incident Command System to evaluate and discuss issues among themselves and with the public and responders via structured dialogues.

Anticipated Benefit

Communicate complex technical information and uncertainty affecting spill response decisions of high public interest to responders, stakeholders, and communities. Enhance understanding by the public and stakeholders of the basis for and credibility of response decisions.

Relevant Project White Papers

1. Sense-making through Twitter during the 2010 Gulf Oil Spill.
2. Stakeholder and Public Mental Models of and Concerns About Dispersant and Oil Spill Processes.
3. What-If Scenario Modeling to Support Oil Spill Preparedness and Response Decision Making.

5.1.2 Adapting Scenarios to Strengthen Oil Spill Preparedness and Response

Strategy

Use scenarios in new ways to consider a full range of "what if" possibilities which will (1) engage stakeholders at all levels (community, local, state/regional, national) to actively address possible ecological, socio-economic, political, cultural and psychosocial aspects of oil spills, (2) facilitate learning more about non-responder mental models of oil spills, and (3) identify ways to address and mitigate the range of spill causes, possible impacts, and new opportunities for improving oil spill preparedness response plans, training and exercises.

Anticipated Benefit

The anticipated benefits from this recommended practice will result from engaging with stakeholders to learn about risk perceptions and concerns through practical dialogue about oil spills risks (risk communication). Adapting the way scenarios are developed and used will strengthen current procedures, cultivate relationships, and build trust among stakeholders at all levels. Implementing this recommended practice will enable participants in the National Response System to adapt and strengthen current preparedness and response practices and procedures.

Relevant Project White Papers

1. What-if Scenario Modeling to Support Oil Spill Preparedness and Response Decision Making.
2. Stakeholder and Public Mental Models of and Concerns about Dispersant and Oil Spill Processes.

5.1.3 Outreach for Communicating Oil Fate and Transport Forecasts

Strategy

Distribute interpreted oil fate and transport forecasts to the public and responders via interactive Internet publication.

Anticipated Benefit

Communicate actionable knowledge for responders, stakeholders, and communities about the dynamic information space, deep uncertainty, and complex scientific content supporting oil fate and trajectory forecasts.

Relevant Project White Papers

1. Methods for Communicating the Complexity and Uncertainty of Response Actions,
2. Sense-making through Twitter during the 2010 Gulf Oil Spill
3. What-If Scenario Modeling to Support Oil Spill Preparedness and Response Decision Making

5.1.4 Listening to and Understanding Community Risk Perceptions through the Internet and Social Media

Strategy
Use social media analytics and surveys to understand community concerns, priorities, and perceptions.

Anticipated Benefit
Data-driven methods can provide information to the response that helps to identify key public information needs and influential information sources through analysis of Internet sources. This information will enhance the response community's ability for developing comprehensive, understandable communication and engagement practices.

Relevant Project White Papers

1. Sense-making through Twitter during the 2010 Gulf Oil Spill.
2. Stakeholder and Public Mental Models of and Concerns about Dispersant and Oil Spill Processes.

5.1.5 Participating With Digital Volunteers to Monitor Oil

Strategy
Engage digital volunteers to verify citizen reports about the location of oil on the water and shorelines for use by the Incident Command.

Anticipated Benefit
Community volunteer response data collection can expand information for use in response decision-making and enhance community confidence in information used for response decision-making. Integrating volunteer data with response data has the potential to contribute to community support of response actions.

Relevant Project White Papers

1. Sense-making through Twitter during the 2010 Gulf Oil Spill.
2. Stakeholder and Public Mental Models of and Concerns about Dispersant and Oil Spill Processes.

6.0 Technology Transfer

The findings of this project are being disseminated through a range of methods and for a varied audience. Project team members are presenting findings at academic conferences that cross several disciplines. Team members are utilizing research findings and white papers to produce articles that will be submitted in the upcoming year to peer-reviewed journals. The team is preparing to submit 5 papers from this project to the journal, Ecology and Society (http://www.ecologyandsociety.org/), to produce a special feature. In addition, the information and findings are being shared with the oil spill response community.

Ann Hayward Walker gave a presentation on this project, *Oil Spill and Dispersant Risk Communication*, at the 2014 Gulf of Mexico Oil Spill and Ecosystem Science Conference in Mobile, AL on January 26, 2014 in Session 001: Education and Outreach: Setting the Record Straight: Debunking Myths and Misconceptions about Oil in the Gulf and Promoting Ocean Literacy.

Several project team members submitted papers, incorporating some aspects of this project that will be presented at the upcoming International Oil Spill Conference (IOSC) to be held in Savannah, Georgia on May 5-8, 2014.

- *Stakeholder Engagement and Survey Tools for Oil Spill Response Options*, Ann Hayward Walker and Ann Bostrom
- *Human Dimension Impacts of Oil Spills and Social Responsibility: Evolving Needs*, Ann Hayward Walker
- *Integrating Engagement at the Local Level for Oil Spill Preparedness and Response*, Ann Hayward Walker, Debbie Scholz and Gary Ott

Kate Starbird and Dharma Dailey anticipate presenting a paper for the upcoming conference, Computer Supported Cooperative Work (CSCW).

Ann Bostrom recently gave a presentation on "Opportunities for conveying scientific certainties and uncertainties in risk communication: an applied example" at the scientific symposium - *Communicating risks and uncertainties concerning environmental hazards* in Amsterdam on December 13, 2013.

Ann Hayward Walker has presented and discussed findings at the USCG On-scene Coordinator Crisis Management Course, Marine Safety Schools, USCG Training Center, and Yorktown, VA in October and December 2013.

Feedback from the project's NOAA Liaison and CRRC, both during the peer-review workshop and status conference calls, further clarified the need for improving information in relation to oil spill preparedness and response procedures. Specifically-identified end users of the project tools are NOAA personnel in the Emergency Response Division (ERD), e.g., Scientific Support Coordinators (SSCs) and Communications Team, as well as the US Coast Guard personnel, e.g., Federal On-scene Coordinators (FOSC), Regional Response Team (RRT) co-chairs, Public Information Assist Team (PIAT). These end users have responsibility under the US National Response System for (a) decision making about response options including dispersants, (b) obtaining technical consensus, and (c) explaining and communicating the scientific basis for

decisions to stakeholders, the public, and elected officials. These end users have preparedness responsibilities in Area Contingency Plans (ACPs), Regional Contingency Plans (RCPs), and receive training for various response positions in accordance with the Incident Command System (ICS).

The NOAA Liaison has asked for communications guidance which can be implemented:

- *About dispersants*, both before decisions are made by the RRT during preparedness, as well as after dispersants are authorized by the FOSC during response.
- In preparedness, *enhance the training* of FOSCs, SSCs, PIAT and NOAA Communications staff so they can learn how to incorporate project findings.
- In preparedness, enhance ACPs and RCPs to enable effective oil spill communications for example, *develop communication materials, new social media strategies, and new ways to use scenario analysis* which can be implemented by the RRTs, NOAA Communications, and PIAT.
- During a response which is managed using ICS, *suggest ways to assess and address risk perceptions, implement oil spill communication strategies, and ways of communicating uncertainty* at the FOSC, RRT, and national communications levels, that is through Unified Command, the RRT and National Incident Command if it is activated.

Derived from this project, the project team will deliver a 60-minute, self-guided training module to provide guidance for NOAA, US Coast Guard, and other agency personnel in implementing the findings from this project. In addition, the team will deliver a 1-page set of briefing points on the project guidance for agency executives.

The guidance will address the following four topics:

1. Research on the general public's understanding of oil spill response goals and strategies, including response options, tradeoff decision-making, environmental impacts, dispersant information needs and expectations, and recommendations for future preparedness and response planning.
2. Survey to identify key information gaps and areas of confusion and misunderstandings.
3. Methods to effectively communicate and educate stakeholder groups and the general public of dispersants and oil spills.
4. Better methods to communicate scientific uncertainty and complexity with respect to response alternatives.

Models of the type of product the team aims to produce in this task are the chapters in the risk communication guidance developed for FDA by Fischhoff et al (2011), which provides practical, empirically-informed guidance on key risk communication processes, including content creation, audience targeting, information exchange and dissemination, and methods for evaluating communications products and programs.

Because the pre-spill and response processes and procedures vary among the end users, information needs vary. Therefore, the guidance will be organized around preparedness and response activities for the following identified end users:

NOAA

1. SSC
2. ERD – Scientific Support Team
3. Communications

USCG

1. FOSC
2. RRT Co-Chairs
3. USCG HQ
4. PIAT and External/Public Affairs

The guidance will also propose mechanisms for evaluating the effectiveness of the above enhancements, to facilitate and inform continuing improvement in oil spill and dispersant risk communication.

Finally, the data collected by the team was extensive and only part of the data was analyzed and presented in the project white papers and this final report. The team submitted a proposal, which is pending, to NOAA OR&R in early 2014 to conduct additional analyses in two areas:

Mental models survey analysis:

- Further analysis of correspondence between belief sets (how beliefs tend to correlate or cluster), and closer examination of regional differences in these, building on the descriptive results that have already been completed.
- Further comparison of these survey findings with our previous and other researchers' findings, to provide additional guidance for dispersant and oil spill communications.

Social media analysis:

- Further analysis of the Twitter data that we've already coded
- More high level analysis of our findings with regard to political aspects.

7.0 Achievement and Dissemination

7.1 Workshops, Conferences, and Outreach

Papers to be presented at the International Oil Spill Conference (IOSC), Savannah, Georgia on May 5-8, 2014.

- *Stakeholder Engagement and Survey Tools for Oil Spill Response Options*, Ann Hayward Walker and Ann Bostrom
- *Human Dimension Impacts of Oil Spills and Social Responsibility: Evolving Needs*, Ann Hayward Walker

- *Integrating Engagement at the Local Level for Oil Spill Preparedness and Response*, Ann Hayward Walker, Debbie Scholz and Gary Ott

Presentation on Oil Spill and Dispersant Risk Communication at the 2014 Gulf of Mexico Oil Spill and Ecosystem Science Conference in Mobile, AL on January 26, 2014 in Session 001: Education and Outreach: Setting the Record Straight: Debunking Myths and Misconceptions about Oil in the Gulf and Promoting Ocean Literacy, Ann Hayward Walker.

Scientific Symposium on Communicating risks and uncertainties concerning environmental hazards, Amsterdam, December 13, 2013

- *Opportunities for conveying scientific certainties and uncertainties in risk communication: an applied example***,** Ann Bostrom

Ann Hayward Walker has presented and discussed findings at the USCG On-scene Coordinator Crisis Management Course, Marine Safety Schools, USCG Training Center, and Yorktown, VA in October and December 2013.

7.2 Graduate Students

The following graduate students assisted with the project:

- Tyler Scott, Doctoral Student, Daniel J. Evans School of Public Affairs, University of Washington
- Dharma Dailey, Doctoral Student, Human Centered Design & Engineering, University of Washington

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Appendices

Appendix A – Response Risk Communication Tools Peer-Review Workshop Agenda

CRRC Project - Task III
Response Risk Communication Tools Peer-Review Workshop
Date: July 24-25, 2013
Location: Seattle - UW campus
Petersen Room, Allen Library, (4th floor, room 485)
Shuttle from the Silver Cloud Hotel will depart 0800 both days for UW campus.

Wednesday July 24th, 2013

8:30-9am coffee (informal) [coffee, tea, quiche, fruit and croissants provided]

9am-9:30am Introductions, aims of workshop

9:30-9:50am Stakeholder and public mental models and concerns about dispersant and oil spill processes -- presented with constructive commentary and/or suggestions for improvement by Seth Tuler

9:50-10:20am Response by authors and discussion

10:20-10:35 Break [coffee and pastries]

10:35-10:55 The role of social media and emerging information and communication technology in oil spill response communications strategies -- presented with constructive commentary and/or suggestions for improvement by Jeannette Sutton

10:55-11:05 Response by authors

11:05-11:35 Discussion

11:35-11:55 Methods for communicating the complexity and uncertainty of response actions and the tradeoffs associated with various response options -- presented with constructive commentary and/or suggestions for improvement by Susan Joslyn

11:55 -12:05 Response by authors

12:05-12:35 Discussion

12:35-1:30 Working lunch – discussion of morning papers [catered lunch]

1:30-1:50 What-if scenario modeling to support oil spill preparedness and response decision making – presented with constructive commentary and/or suggestions for improvement by Glen Watabayashi

1:50 -2:00 Response by authors

2:00-2:30 Discussion

2:30-3pm Break [beverages, fruit and cookies]

3:00-3:20pm Best practices for community and stakeholder engagement in oil spill preparedness and response-- presented with constructive commentary and/or suggestions for improvement by Bob Pond

3:20-3:30pm Response by authors

3:30-4pm – Role of human health information and communication in oil spill response and white papers – Jeff Wickliffe

4:30pm-5pm Synthesis and commentary on white papers – Group

5:00-5:15pm Discussion

5:15pm Wrap-up, homework and logistics for evening

5:30 Authors and Peer-reviewers (optional beer tasting* followed by dinner at ~7pm) UW Club on campus

Thursday July 25, 2013

8:30-9am Coffee and discussion [coffee, tea, quiche, fruit, croissants]

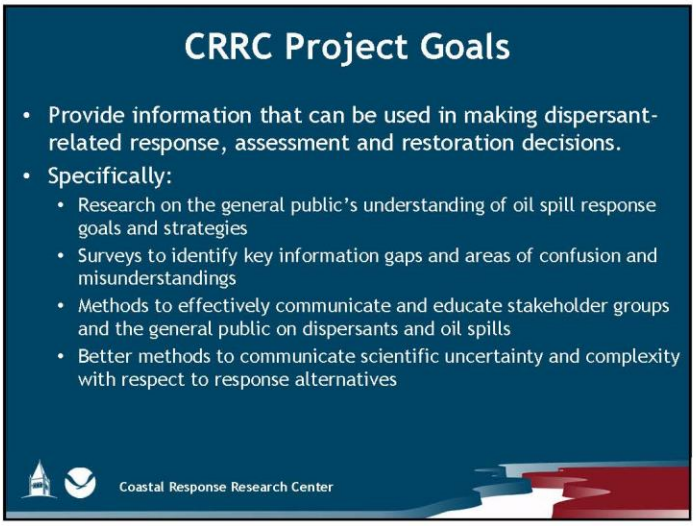
9:00am to 10:30am introduction and discussion of best practices table and examples – Bob Pavia

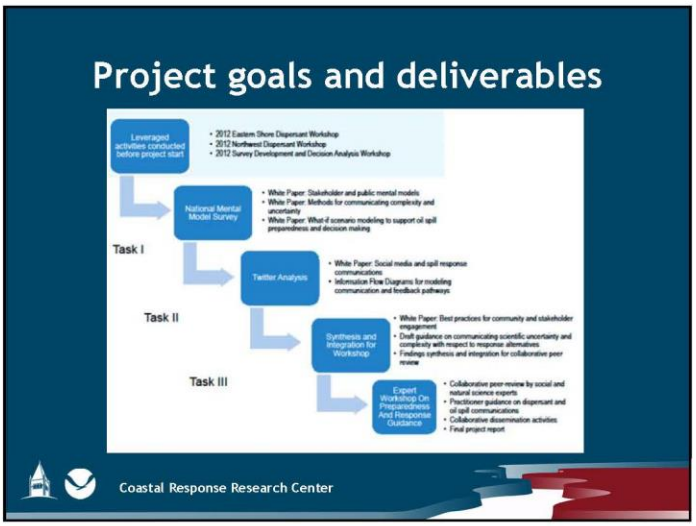
10:30am-10:45am break [coffee and fruit]

10:45am to Noon – Summary and discussion of next steps

Adjourn [join the group for an informal lunch at Agua Verde if your schedule permits]

Appendix B – Response Risk Communication Tools Peer-Review Workshop Introduction





Workshop Goals

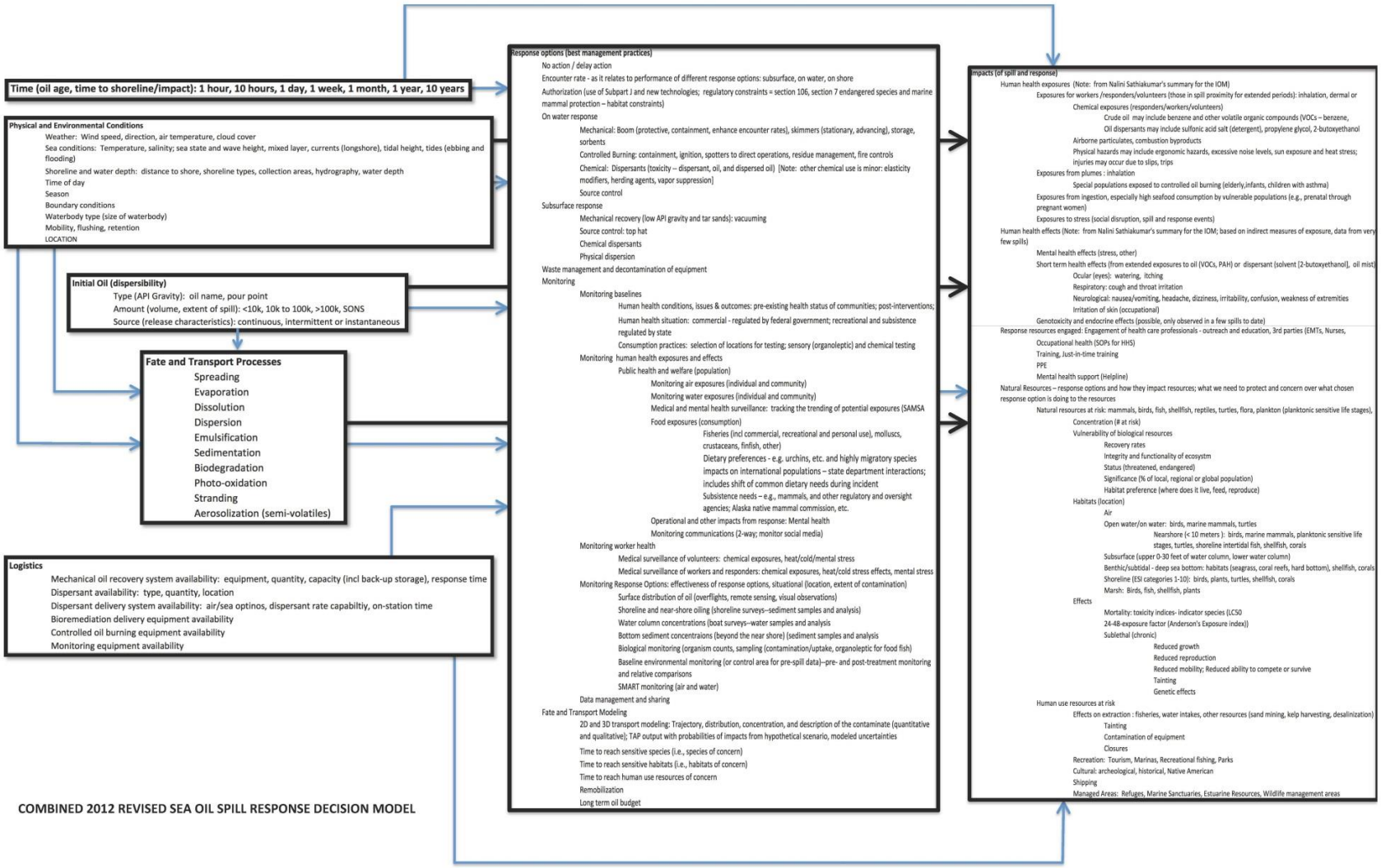
- Incorporate your research and insights in the white papers
- Identify in each paper:
  - What's important?
  - What could be improved?
  - What's missing?
- What are common threads and differences?
- Key points and future actions?

Coastal Response Research Center

Invited Peer-Reviewers

- Keeley Belva, NOAA Communications and External Affairs
- Susan Joslyn, Dept. of Psychology, University of Washington
- Bob Pond, USCG HQ Senior Oil Spill Advisor (just retired)
- Debbie Scholz, SEA Consulting Group
- Richard Sheehe, CDC Crisis and Emergency Response Communications
- Emma Spiro, Information School, University of Washington
- Jeannette Sutton, Trauma, Health and Hazard Center, University of Colorado at Colorado Springs
- Seth Tuler, Social & Environmental Research Institute
- Glenn Watabayashi, Scientific and Technical Support Branch Chief, NOAA ERD
- Jeffrey Wickliffe, Tulane University, School of Public Health and Tropical Medicine

Coastal Response Research Center

Project Team
• Ann Hayward Walker, President of SEA Consulting Group
• Ann Bostrom, Professor, Evans School of Public Affairs, University of Washington (UW)
• Thomas M. Leschine Rabinowitz Professor of Human Dimensions of the Environment, UW Director School of Marine and Environmental Affairs
• Robert Pavia, Affiliate Associate Professor, UW School of Marine and Environmental Affairs
• Kate Starbird, Assistant Professor, UW Department of Human Centered Design and Engineering.
Coastal Response Research Center

Appendix C – 2012 Revised SEA Oil Spill Response Decision Model