Opportunities for the Gulf Research Program: Community Resilience and Health: Summary of a Workshop

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LeighAnne Olsen and Steve Olson, Rapporteurs; Gulf Research Program; National Academy of Sciences; National Academy of Engineering; Institute of Medicine; National Research Council

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GULF RESEARCH PROGRAM

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ABOUT THE GULF RESEARCH PROGRAM

In 2010 the *Deepwater Horizon* explosion and fire in the Gulf of Mexico caused the largest offshore oil spill in U.S. history, resulting in significant impacts on the region's environment and residents. Legal settlements with the companies held responsible led the federal government to ask the National Academy of Sciences to form and administer a 30-year program to enhance oil system safety, human health, and environmental resources in the Gulf of Mexico and other U.S. continental shelf areas where offshore oil and gas exploration and production occur or are under consideration. The new Gulf Research Program will receive $500 million to support activities using three broad approaches: research and development, education and training, and environmental monitoring.

To inform program planning, the Gulf Research Program held three Opportunity Analysis Workshops in 2014: Middle-Skilled Workforce Needs, Monitoring Ecosystem Restoration and Deep Water Environments, and Community Resilience and Health. These workshops are part of an ongoing effort to elicit input from experts, practitioners, and community members on key opportunities to translate the Program's strategic vision into activities that will benefit communities in the Gulf region and beyond. The workshops are expected to lead to the development of additional Program activities and opportunities for the research and education communities.

For more information on the Gulf Research Program and to access the additional Opportunity Analysis workshop reports, see www.nas.edu/gulf.

PLANNING COMMITTEE FOR THE WORKSHOP ON OPPORTUNITIES FOR THE GULF RESEARCH PROGRAM: COMMUNITY RESILIENCE AND HEALTH[1]

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[1] The planning committee's role was limited to planning the workshop. The workshop summary has been prepared by the rapporteurs as a factual account of what occurred at the workshop. Statements, recommendations, and opinions expressed are those of individual presenters and participants and are not necessarily endorsed or verified by the Institute of Medicine or the National Research Council. They should not be construed as reflecting any group consensus.

GULF RESEARCH PROGRAM
Advisory Group

Staff

REVIEWERS

This workshop summary has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the process. We wish to thank the following individuals for their review of this report:

Maureen Lichtveld, Tulane University
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Richard Powers, University of Alabama at Birmingham
Liesel A. Ritchie, University of Colorado Natural Hazards Center
Paul A. Sandifer, University of Charleston, South Carolina
Leanne Truehart, National Alliance on Mental Illness

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the content of the workshop summary, nor did they see the final draft of the workshop summary before its release. The review of this workshop summary was overseen by **Jonathan M. Samet**, Keck School of Medicine at the University of Southern California. Appointed by the Institute of Medicine, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the rapporteurs and the institution.

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Introduction

On September 22–23, 2014, the Gulf Research Program of the National Academies held a workshop in New Orleans, Louisiana, to examine opportunities to improve the health, well-being, and resilience of communities in the Gulf of Mexico region. Approximately 50 individuals with diverse expertise and experience participated in discussions about perceived needs, challenges, and opportunities that are aligned with the Program's mission and goals. Box 1-1 provides information about the Gulf Research Program, its mission and goals, and the series of opportunity analysis workshops held in 2014.

Six members of the Gulf Research Program's Advisory Group planned the workshop agenda, selected presentations, and facilitated discussion during the meeting to accomplish the following:

- Explore needs, challenges, and potential opportunities to improve the health and resilience of Gulf communities.
- Identify potential opportunities to improve how Gulf communities anticipate, prepare for, and recover from disasters and environmental change.

BOX 1-1 The Gulf Research Program: Origins, Strategic Vision, and Workshop Series

Origins: In 2010 the *Deepwater Horizon* explosion and fire in the Gulf of Mexico caused the largest offshore oil spill in U.S. history, resulting in significant impacts on the region's environment and residents. Plea agreements with the companies held responsible led the Department of Justice to ask the National Academy of Sciences (NAS) to use a portion of the funds to form and administer a 30-year program to enhance oil system safety, human health, and environmental resources in the Gulf of Mexico and other U.S. continental shelf areas where offshore oil and gas exploration and production occur.

The NAS will receive $500 million between 2013 and 2018 for the Gulf Research Program, which will be placed in an endowment and expended within 30 years. The Gulf Research Program is expected to use these funds to support activities in three broad categories: research and development, education and training, and environmental monitoring.

Strategic Vision: On September 15, 2014, the Gulf Research Program released its strategic vision document, which provides a framework to guide conversations, over the Program's 30 year duration, about Program priorities and the development of an expanding portfolio of activities. The strategic vision document is the result of year-long deliberations by the Program's Advisory Group, composed of 25 NAS-appointed volunteers with extensive expertise and familiarity with the Gulf region. Key elements of the Program's strategic vision are summarized below:

Mission: Over its 30-year duration, the Gulf Research Program will work to enhance oil system safety and the protection of human health and the environment in the Gulf of Mexico and other U.S. outer continental shelf areas by seeking to improve understanding of the region's interconnecting human, environmental, and energy systems and fostering application of these insights to benefit Gulf communities, ecosystems, and the Nation.

Goals:

1. Foster innovative improvements to safety technologies, safety culture, and environmental protection systems associated with offshore oil and gas development.
2. Improve understanding of the connections between human health and the environment to support the development of healthy and resilient Gulf communities.
3. Advance understanding of the Gulf of Mexico region as a dynamic system with complex, interconnecting human and environmental systems, functions, and processes to inform the protection and restoration of ecosystem services.

Opportunity Analysis Workshops: From June through September 2014, the Program held three opportunity analysis workshops to elicit input from participants on ways to advance specific aspects of the Program's strategic vision. The first workshop examined education and training to meet middle-skilled workforce needs in the Gulf region; the second explored environmental monitoring to support ecosystem restoration and to advance understanding of deep sea ecosystems; and the third, which is summarized in this report, investigated opportunities to improve the health and resilience of communities in the Gulf region.

- Identify potential opportunities to improve detection, assessment, management, and communication about environmental health risks.
- Explore how the Gulf Research Program can encourage innovation and collaboration and ensure that its activities engage and benefit communities.

DEVELOPING HEALTHY AND RESILIENT GULF COMMUNITIES

Discussion at the workshop focused on topics relevant to the Gulf Research Program's goal: *To improve understanding of the connections between human health and the environment to support the development of healthy and resilient Gulf communities.*

To provide a starting point for discussion, workshop participants were provided with the following text from the Gulf Research Program's strategic vision, which included working definitions of key concepts (Gulf Research Program, 2014).

> Health is more than a lack of illness. Human health, for the Program's purposes, is defined as a "state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." The environments in which people live, work, and play are connected to health and well-being in a variety of ways, as exemplified by a wealth of ecosystem services[1] in the Gulf region. Coastal wetlands, for example, regulate water quality, reduce the severity of storm impacts, and provide food and recreational opportunities. Other ecosystem services provide highly valued resources such as fish, oil, and natural gas that are extracted by major employers in the region and provide an economic base critical to community and individual well-being. These are just some of the many connections between human communities and their surrounding environments that influence health.
>
> The impacts of the *Deepwater Horizon* oil spill on communities and ecosystems in the Gulf region illustrated the need to better understand these connections. Closure of fishing grounds, for example, threatened the livelihoods of individuals and caused disruptions in entire communities associated with the seafood industry (particularly those also involved in subsistence fishing). More broadly, uncertainty about exposure to and the health and environmental impacts of spill-related contaminants continues to drive public concern about the long-term effects of the spill. Mental and behavioral health effects are of particular concern, with lessons from the *Exxon Valdez* spill and other disasters suggesting the potential for long-lasting impacts on community recovery.
>
> Over the next 30 years, natural and man-made disasters, climate change impacts, and other environmental stressors will present similar, complex challenges to the physical, mental, and social well-being of communities in the Gulf and other continental shelf areas. Understanding the interrelationships among health, ecological, and economic impacts of disasters and other environmental stressors will be crucial to addressing these challenges.
>
> Resilience is a concept used by a variety of disciplines—from engineering to sociology—to describe the capacity of a system to absorb and recover from a disturbance. In the Gulf and other coastal regions, resilience is heavily influenced by interactions between human communities and their natural environment, yet these linkages are often not well understood. Understanding of factors that influence the vulnerability, recovery, and resilience of ecosystems and communities will require research across disciplines, including the physical, biological, social, and health sciences. Integrative research to examine these factors—including feedbacks between human systems (health, social, and economic dimensions, among others) and ecosystems—will help communities to better anticipate, respond to, and recover from disasters and other environmental stressors.
>
> The Gulf Research Program's focus on linkages between the environment and human health will include efforts to improve capacity to detect, assess, and communicate about environmental health risks in ways that support the development of healthy and resilient communities. National, state, and local efforts to improve community resilience have focused on preparedness for, response to, and recovery from all hazards. The Program will seek to provide information that can guide decisions by the public and policy makers and to advance scientific understanding. Additionally, the Program will work to support the development of health, scientific, community, and policy leaders that can address complex issues at the intersection between human and ecosystem health.

ABOUT THE WORKSHOP SUMMARY

This workshop summary has been prepared to inform the discussions of the Gulf Research Program's

[1] Ecosystem services are the benefits that people obtain from ecosystems, including provisioning services such as the supply of food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth (GRP, 2014).

Advisory Board about the Program's priorities for 2015–2020 and the development of an expanding portfolio of activities. The summary should not be seen as reflecting a consensus of workshop participants. Rather, it captures the comments made by presenters and the points made by participants in the open discussion sessions. To provide a high level summary of the discussion, points highlighted by the rapporteurs can be found the beginning of each chapter.

Chapter 1 provides an introduction to the Gulf Research Program and context for the workshop discussion. Chapter 2 provides an overview of many of the concepts and issues discussed at the meeting. Chapters 3, 4, and 5 highlight the ways in which health, social, economic, and environmental factors affect the resilience of communities, and they identify some of the perceived needs, existing approaches, and opportunities for improving the health and resilience of communities in the Gulf region. Chapter 6 explores needs and opportunities for improving capacities to detect, assess, manage, and communicate about environmental health risks. Chapter 7 summarizes discussions about opportunities that take best advantage of the Program's 30-year duration. Chapter 8 provides a summary of opportunities to create lasting benefit. This workshop is a first step by the Gulf Research Program to explore the many needs, challenges, and opportunities to improve community resilience and health in the Gulf region. All facets of this very complicated topic could not be covered in a single workshop and many relevant and worthy topics were not explored in depth or addressed at the workshop.

On both days of the workshop, participants broke into four groups to examine specific questions posed by the workshop organizers. Summaries of the breakout groups' suggestions can be found at the end of chapters on related topics. They should not be seen as the consensus recommendations of the workshop participants; nor are they necessarily actions that the Gulf Research Program should undertake. Rather, they represent a suite of possible future activities with which the Program could be involved.

The material presented during the workshop has been somewhat reorganized to combine discussions of related issues. The workshop agenda, statement of task, speaker biographies, and workshop attendees can be found in Appendices A, B, C, and D, respectively. Appendix E includes an overview of related funding programs.

2

Human Health, Public Health Practice, and Community Resilience

BOX 2-1 Important Points Highlighted by the Keynote Speaker

- Environmental health management approaches increasingly will emphasize resilience and sustainability to address complex environmental health issues.
- To guide policy development and planning, researchers should develop and use metrics for resilience that include factors related to health, socioeconomics, the environment, and community structure.
- The scientific literature remains inadequate to answer many of the questions clinicians and members of the public have about the health effects of the *Deepwater Horizon* (*DWH*) oil spill or the risks of future oil spills.
- Psychosocial impacts may be the most important negative outcomes of an oil spill. Research is needed to understand the factors that contribute to and mitigate these impacts.
- Activities initiated after the *DWH* disaster have led to the development of research cohorts, academic–community partnerships, and programs to build health capacity that the Gulf Research Program can learn from and build upon.
- Research opportunities for the Gulf Research Program include advancing the science of community resilience, oil spill toxicology, individual exposure assessment, and cumulative risk assessment.
- The public health community needs to make sure they are at the table during the response to an oil spill and demonstrate that it can play a valuable role.

In his keynote presentation, Bernard Goldstein, emeritus professor of environmental and occupational health and former dean of the University of Pittsburgh School of Public Health, provided an overview of the major concepts and issues to be discussed at the workshop, including the relationship between public health and resilience and lessons learned from the *DWH* oil spill and other disasters. He also discussed some possible areas of research that could support the strategic vision of the Gulf Research Program.

HEALTH, RESILIENCE, AND SUSTAINABILITY

Goldstein began by noting the difficulty of addressing today's environmental health management challenges using standard approaches of "command and control" and "risk assessment and management."[1] While these approaches will remain useful, he said, the field also needs new ways to think about the many existing—and emerging—complex environmental health challenges. He predicted that over the Gulf Research Program's 30-year duration, environmental health management approaches will increasingly emphasize the concepts of resilience and sustainability.

To ground discussion at the workshop, Goldstein characterized the concepts of resilience, health, and sustainability. The Gulf Research Program, in its strategic plan, characterizes resilient communities as human

[1] According to Goldstein, *command and control* refers to the prescriptive approaches derived from the first wave of environmental laws passed by Congress and signed by President Richard Nixon that accompanied the formation of the Environmental Protection Agency (EPA) in 1970. As measurements of pollutants and their effects became more sophisticated, and the value of pollutant control more evident, additional focus was placed on assessing the widely ranging risks of individual agents and mixtures. *The risk assessment and risk management* paradigm began to be codified through a framework provided by a 1983 NRC report (NRC, 1983). More recently, the EPA has moved toward incorporating sustainability considerations while continuing to employ command and control and risk assessment and risk management.

communities that "anticipate risk, limit impacts, recover quickly, and successfully adapt when faced with adverse events and change" (Gulf Research Program, 2014). The Gulf Research Program also uses the definition of *health* developed by the World Health Organization: "Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO, 1946). With regard to sustainability, Goldstein referenced the classic definition of sustainable development established by the Brundtland Commission of the United Nations: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987). Quoting Howard Frumkin (Dean of the University of Washington School of Public Health), Goldstein noted an important distinction among these definitions related to time. Definitions of resilience and sustainability acknowledge what could happen in the future whereas the same concept of time is not built in to the definition of health, although it is implicit in the focus on maternal and child health. The involvement of public health in the multigenerational aspects of maternal and child health issues highlight the importance of sustainability and of resilience.

The concept of resilience has helped researchers understand a variety of complex systems, from companies and ecosystems to the human body. Common characteristics of resilient systems can be summarized by the following basic principles developed by Joseph Fiksel at Ohio State University:

- Resilience is an intrinsic characteristic of all complex, self-organizing systems.
- A system is influenced by cycles of change at multiple temporal and spatial scales.
- Resilient systems respond to shocks or stresses by absorbing, adapting, or transforming.
- Resilient systems have feedback loops that help to maintain a dynamic equilibrium.
- A system may cross a threshold and shift to a different equilibrium state, or "regime."

As an example of a threshold, Goldstein pointed to the extra energy in Hurricane Katrina that caused levees to be overtopped or breeched. "A little bit of a shift can make an enormous difference," he said.

Goldstein also referenced key concepts of resilience identified by Bruneau and Reinhorn (2007) from their analysis of seismic resilience for acute care facilities:

- Robustness: The ability to withstand a given level of stress or demand without suffering loss of function
- Redundancy: The extent to which systems are substitutable
- Resourcefulness: The capacity to identify problems, establish priorities, and mobilize resources when conditions exist that threaten to disrupt
- Rapidity: The capacity to meet priorities and achieve goals in a timely manner in order to contain losses, recover functionality, and avoid future disruption

One way to think about the relationship between sustainability and resilience is to consider the classic question of whether the glass is half full or half empty, Goldstein said. For sustainability, the glass is twice as large as it needs to be and capacity needs to be "right-sized" because more effort is too costly. For resilience, the glass needs to be larger than half size because contending with unanticipated disruptions and change will require extra capacity. The question, asked Goldstein, is, "How much larger does it have to be?" Definitions are only important if they have an impact on actions, and planning is the mediator between definitions and actions.

MEASURING RESILIENCE

In a complex and turbulent world, resilience may be a prerequisite for achieving sustainability. Indeed, resiliency plays an important role in achieving certain sustainability targets, Goldstein said. For terrestrial biomes,[2] the key determinant of resilience is human activities—with more and more people competing for fewer and fewer resources. Human activities have decreased the resilience of many biomes, with potentially negative implications for sustainability. However, this trajectory can be reversed if the appropriate actions are undertaken. For communities, the key determinant of resilience is social capital,[3] which can lead in many directions, both positive and negative. Social capital consists of many components, including community organizations, health, the economy, and the built environment (Figure 2-1). "Put all these different things together and you end up with a community that is more resilient," Goldstein said. For example, in Chicago during a heat wave, communities with more social structure tended to do better than those with less (Klinenberg, 2002). There are also data suggesting that increased social capital is correlated with lower suicide rates (Kunst et al., 2013).

Research on social capital and resilience is being conducted all over the world, but we need metrics to better understand how different factors influence resilience, he said. How can resilience be measured? It is easy to talk in generalities, but we need to get specific about resilience in a way that provides guidance for

[2] A biome is a major ecological community type, such as tropical rain forest, grassland, or desert.

[3] Social capital can be defined as the features of social organization—such as civic participation, norms of reciprocity, and trust in others—that facilitate cooperation for mutual benefit.

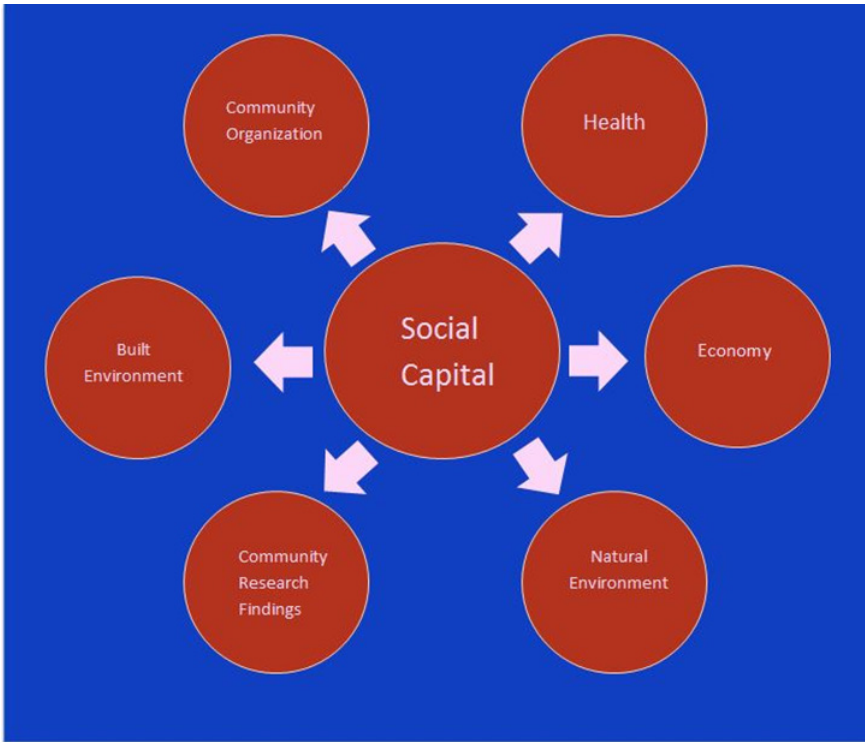

FIGURE 2-1 A variety of factors influence social capital, which is a key determinant of community resilience. SOURCE: Presented by Bernard Goldstein on September 23, 2014.

planning and practice. "If, at the end of 30 years, we are still talking about it and don't have something we can measure as having been accomplished, it is not going to be a meaningful exercise," he said.

Public health does many things well that are relevant to advancing the science of resilience. For example, understanding how environmental, health, economic, and social factors influence resilience is an interdisciplinary undertaking, an approach that is inherent to public health. Complex public health problems, Goldstein noted, can only be solved by collaboration among its component disciplines–behavioral and community health sciences, biostatistics, environmental health, epidemiology, and health care policy and management. Public health can be instrumental in developing models and metrics for understanding resilience, especially if it can effectively engage with a broader set of disciplines.

Some sources of variability or change for which resilience can improve outcomes are not controllable at the source by humans (e.g., sunspots, hurricanes, earthquakes), but others are. In "public health-speak," Goldstein said, "accidents are events that cannot be prevented, but incidents can." In the case of oil spills, public health should target prevention of incidents by working with engineers and others to promote a safety culture within the offshore oil industry. The *DWH* oil spill was an incident, he said, not an accident.

HEALTH AND RESILIENCE AFTER THE *DEEPWATER HORIZON* OIL SPILL

Understanding the context of the *DWH* oil spill is of overwhelming importance when thinking about its impacts, Goldstein said. For example, the Gulf States tend to rate very poorly when compared with the rest of the United States on major health indicators, such as the percentages of adults with poor or fair health, low-birth-weight babies, smoking rates, obesity, or insurance coverage. This background of poor health conditions, which is linked in part to socioeconomic status, does not create optimal conditions for response or recovery, he said. "If the same kind of oil spill occurred off the coast of Puget Sound and you had these very upscale communities or islands being affected, you would have a very different level of resilience."

Two months after the *DWH* oil spill the Institute of Medicine held a workshop to examine effects on human health. Take-home points from the workshop included (IOM, 2010):

- The *DWH* oil spill represented a failure of safety culture.
- Exposure assessment is central to linking chemical toxicity and effect.
- Psychosocial impacts may predominate.

- Lack of trust or transparency has psychosocial impacts.
- Risk communication must be tailored to community understanding.
- Seafood safety is a central short-term and long-term issue.

Goldstein noted that traditional toxicology and environmental health concerns are reflected in just two points (exposure assessment and seafood safety) and the other four points highlight broader cultural and psychosocial issues. The importance of these aspects of the disaster is underscored by the following observation made by the workshop summary authors, Goldstein said:

> In addition to the physical stressors, the *Deepwater Horizon* oil disaster has disrupted delicate social, economic, and psychological balances in communities across the Gulf region. Local fishermen and fisherwomen … are grappling with possibly permanent disruptions to their long-standing livelihoods … Communities question the safety of their most vulnerable populations and worry about the effects that the Gulf oil disaster will have on their immediate and long-term health. *The resulting uncertainty about physical, social, and economic health has profound implications for the psychological well-being of individuals in affected communities.* (IOM, 2010, *emphasis added*)

In Goldstein's view psychosocial impacts have predominated to date. As an example of factors that can contribute to psychological distress, Goldstein observed that a major component of a dispersant widely used in the Gulf was initially not disclosed because it was proprietary. This component turned out to be the most widely sold over-the-counter laxative in the United States. Goldstein said that, as a toxicologist, he was not worried about something that Americans consume in such large quantities. But keeping this information secret weighed heavily on the community.

The same effect can be seen in surveys done in communities affected by shale gas development, Goldstein noted. For example, Ferrar et al. (2013) found that the top six stressors in Pennsylvania residents who believe their health has been affected by shale gas activities are: being denied information or being provided with false information, corruption, having their concerns or complaints ignored, being taken advantage of, financial damages, and noise pollution. As this survey indicates, lack of familiarity and lack of trust can potentially amplify health impacts. In Texas, people are more familiar with oil and gas production than in Pennsylvania. Over time, familiarity may increase in Pennsylvania, said Goldstein, but trust may not. With oil spills, people will always be angry because of perceptions of what was done to them. "We can't ignore this social amplification of risk, and we need to know more about it," Goldstein said.

Goldstein also pointed to boomtown effects that are secondary to cleanup activities when an incident occurs. Boomtown effects are due to sudden influxes of mostly young males from outside of the community, who earn money and can bring with them problems of alcoholism, drug abuse, traffic incidents, violence, and sexually transmitted diseases. Some places are better able to deal with these problems than others, he said, depending on the extent to which a jurisdiction is willing to acknowledge, understand, and counter them.

OIL SPILL–RELATED RESEARCH

Goldstein highlighted several health-related studies and activities that have been initiated with funds related to the *DWH* oil spill (Table 2-1; see also Appendix E), including the Gulf Long-term Follow-up study (GuLF STUDY) funded by the National Institute of Environmental Health Sciences (NIEHS). He stated that this is a crucial activity that the Gulf Research Program should not duplicate. However, it may be possible to build upon this study by developing new protocols to gain additional information from the established cohorts.

Goldstein pointed out an important limitation of the GuLF STUDY: the lack of a system to quickly set up the study and to collect critical baseline data. As Lurie et al. (2013) pointed out, "Federal agencies and nongovernmental entities developed and rapidly established a roster of exposed workers and conducted important research, but there was no uniform, systematic collection of baseline data through surveys and biospecimen archives. Ultimately, the National Institutes of Health (NIH) supported a longitudinal study of exposed workers, but data collection did not begin until nearly 10 months after the spill." Some important biological markers for benzene exposure, Goldstein noted, would not be present 10 months after exposure. NIEHS is working on protocols to be set up before an event occurs so that relevant data can be collected immediately.

Goldstein also highlighted the work of four NIEHS-funded *Deepwater Horizon* Research Consortia grantees; these are based at the University of Texas Medical Branch at Galveston, Louisiana State University, Tulane University, and the University of Florida. These centers have formed partnerships with community organizations and are taking a transdisciplinary approach to answer community health concerns. The Tulane University Center for Gulf Coast Environmental Health, for example, encompasses community engagement, environmental health sciences, maternal and child health, psychosocial health, cultural anthropology, and physiology.

TABLE 2-1 Selected *DWH*-Related Programs with a Focus on Health and Resilience

Gulf Long-term Follow-up Study (GuLF STUDY)	NIEHS intramural program: prospective study of nearly 33,000 adults involved in oil spill cleanup or support. The study cohort was enrolled between March 2011 to March 2013 and received baseline interviews on cleanup jobs, symptoms, and health.
DWH Research Consortia	NIEHS extramural program ($25.2 million over 5 years): Four university–community partnerships working to determine if there are or were harmful contaminants in air, water, and seafood stemming from the oil spill and assessing their health impacts. • University of Texas Medical Branch at Galveston (PI: C. Elferink)—Gulf Coast Health Alliance: Health Risks Related to the Macondo Spill (GC-HARMS) • Louisiana State University (PI: E. Trapido)—Women and Their Children's Health study (WaTCH) • Tulane University (PI: Maureen Lichtveld)—Gulf Resilience on Women's Health (GRoWH) • University of Florida (PI: Glenn Morris)—Health Gulf, Healthy Communities
Gulf Region Health Outreach Program	A capacity-building program, funded through the Deepwater Horizon Medical Benefits Class Action Settlement at $105 million over 5 years, with the goal of creating more resilient communities through regional partnerships. **Primary Care Capacity Project:** Louisiana Public Health Institute (Eric Baumgartner) **Mental and Behavioral Health Capacity Project:** University of Southern Mississippi (Timothy A. Rehner) University of South Alabama (Jennifer Langhinrichsen-Rohling) University of West Florida (Glenn E. Rohrer) Louisiana State University (Howard J. Osofsky) **Environmental Health Capacity and Literacy Project:** Tulane University (Maureen Lichtveld) **Community Health Workers Training Project:** University of South Alabama (J. Steven Picou) **Community Engagement:** Alliance Institute (Stephen Bradberry)

SOURCE: Presented by Bernard Goldstein on September 23, 2014.

Goldstein also reviewed work that he has been involved with as part of the Gulf Region Health Outreach Program (GRHOP). GRHOP will use $105 million from the *Deepwater Horizon* Medical Benefits Class Action settlement to integrate primary care, mental and behavioral health, and environmental health, he said, with the goal of promoting health and resilience in the Gulf region. While GRHOP is not a research program, its activities are being evaluated. He noted that the findings from these evaluations may provide important guidance for the Gulf Research Program on how to build resilient communities.

Many of the scientists and public health professionals involved in GRHOP were also involved with the response to Hurricane Katrina. In essence, these earlier experiences have served as a baseline for the *DWH* responses, and "having these baselines are crucial if you are going to measure impact and see what works and what doesn't work."

The Gulf Research Program can also learn from other disaster centers across the country, such as those that conducted research in the aftermath of other disasters, for example, 9/11 and Hurricane Sandy in 2012.[4] In addition, relevant research is being conducted around the world, such as that of Kim et al. (2013) to determine the burden of disease attributable to the Hebei oil spill in Korea. The Gulf Research Program needs to take advantage of such efforts to understand the health effects of oil spills, he said, by working with and learning from this developing international community.

[4] "Sandy, as a hurricane and a posttropical cyclone, killed at least 117 people in the United States and 69 more in Canada and the Caribbean. Sandy ranks as the second-costliest storm on record at $68 billion. Hurricane Katrina of 2005 is the highest at $108 billion" (see http://oceantoday.noaa.gov/makingofasuperstorm).

POTENTIAL RESEARCH OPPORTUNITIES

Since the *DWH* oil spill, numerous publications have identified important research and capacity needs for improving the protection of human health related to oil spills. Goldstein began his discussion of research opportunities for the Gulf Research Program by reviewing findings from a selection of these publications. He concluded his presentation by discussing several broad areas of research that will benefit communities impacted by future oil spills.

Learning from the *DWH* Oil Spill

Goldstein highlighted several important considerations for future research that emerged from the IOM's 2010 workshop summary (IOM, 2010):

- Public health surveillance is essential.
- Worker health and community health are linked and must be considered together.
- Vulnerable populations should be the focus.
- Communities must be involved in research planning and execution, early and often.
- Public health research and evaluation must be disaster ready.
- Basic toxicological evaluation of weathered oil and dispersants is necessary.
- Exposure assessment should directly focus on the potentially exposed population.

Goldstein noted that the literature is still inadequate to respond to the many questions asked by clinicians and the public about the potential health impacts of the *DWH* oil spill. As summarized in an article he coauthored in 2011,

> several initiatives are urgently needed, before similar disasters occur in the future: rapid development and implementation of protocols for baseline clinical evaluations, including respiratory function; biospecimen banking; short- and longer-term medical surveillance and monitoring of workers; and development of psychosocial interventions … especially for vulnerable populations. (Goldstein et al., 2011)

"We simply do not have a good database that can help researchers and clinicians answer these important questions," he said. And, research is needed across four general categories of potential health effects of oil spills: (1) worker safety; (2) toxicologic effects in workers, visitors, and community members; (3) mental health effects from social and economic disruption; and (4) ecosystem effects that have consequences for human health (Goldstein et al., 2011). Understanding ecosystem effects, in particular, will require collaborative research with other disciplines, he observed.

As a specific example of the difficulties that can arise in implementing these recommendations, Goldstein pointed to several research needs related to health risk for pregnant women:

- What are the reproductive and developmental risks of exposure to crude oil, "weathered"[5] crude oil, dispersants, and mixtures?
- How do these compare with the risks of evacuating pregnant women from their community, including living elsewhere?
- Should pregnant women be advised against working on oil spill cleanups?

These questions are often more complex than they seem, he observed. For example, there may be a great deal of literature on the occupational health of workers in the crude oil industry, but not all spills are of crude oil, and crude oil workers are largely male. "We know next to nothing about the effects of weathered oil", he said, or, about the kinds of risks faced by populations that are evacuated to an unfamiliar location away from their usual health care supports. "We need to know more about these risks to make better decisions when responding to oil spills", he said.

Community Health and Resilience

Goldstein also pointed to requirements for research on determinants of community health and resilience related to responses to coastal oil spills. This research requires:

- Cross-cutting multidisciplinary approaches
- Community cooperation and involvement
- Public health agency cooperation and involvement
- Longer-term research support
- Interdependent projects
- Valid metrics of community resilience

Oil Spill Toxicology

Goldstein also pointed to major research needs related to understanding the toxicology of oil spills in gen-

[5] "Following an oil spill or any other event that releases crude oil or crude oil products into the marine environment, weathering processes begin immediately to transform the materials into substances with physical and chemical characteristics that differ from the original source material … Processes involved in the weathering of crude oil include evaporation, emulsification, and dissolution, whereas chemical processes focus on oxidation, particularly photo-oxidation. The principal biological process that affects crude oil in the marine environment is microbial oxidation" (NRC, 2003).

eral, particularly how these change over time. For *acute effects*, little is known about the acute human toxicology of "weathered" crude oil, dispersants, or mixtures. Research into *subacute effects* is also needed to inform better responses to concerns about whether seafood is safe for human consumption. And, very few studies have advanced understanding of the chronic effects of oil spills. For example, what are the long-term implications of exposure to weathered crude oil, Goldstein asked.

Cumulative Risk Assessment

Cumulative risk assessments attempt to integrate across all of the chemical risk factors to which an individual is exposed and through all of the pathways of exposure. Developing this capacity is seen as particularly relevant to environmental justice issues.[6] However, Goldstein noted, the field does not yet have the right tools and methods to do this well.

Recent research has shown that social and behavioral factors can moderate an individual's response to chemical exposures. For example, epigenetics—the study of heritable changes in gene expression caused by chemical modifications[7] of DNA—can mediate effects of chemical and nonchemical stressors. Goldstein noted that accumulating evidence suggests that both chemical (e.g., methylmercury, cigarette smoke, benzene, lead) and nonchemical (e.g., psychosocial stress, famine, exercise, nutrition) stressors can induce epigenetic changes.

Former NIEHS administrator and director of the EPA's National Center for Environmental Assessment Ken Olden has advanced the hypothesis that an individual's set of epigenetic changes (their epigenome) may serve as a biosensor to monitor cumulative effects of exposure to multiple chemical and non-chemical stressors over the life course, Goldstein said. And, epigenetic modifications have been associated with a variety of diseases and disorders, such as cancer, diabetes, neurodevelopmental disorders, and mental health disorders, among others (Olden et al., 2014).

This is an emerging area of research that may help future generations to understand some of the health issues that arise during an oil spill, Goldstein noted. As this field develops over the Gulf Research Program's 30-year duration, Goldstein said, it may contribute to capacity to conduct cumulative risk assessments and to a better understanding of important linkages between an individual's health and their environment.

Individual Exposure Assessment

Goldstein concluded his presentation by discussing "what we can be doing, should be doing, but aren't doing." The following five elements, he said, are part of a complete exposure pathway:

1. Source—How the material gets in the environment
2. Media—Soil, water, or air in which a material moves from its source
3. Exposure point—Where people contact the media
4. Exposure route—How the material enters the body (e.g., eating, drinking, breathing)
5. Receptor population—People who are exposed or potentially exposed

Environmental health researchers can predict what people are exposed to after an oil spill by looking at the first four elements, he observed, and while we do not really need to measure exposure in populations exposed or potentially exposed (receptor population), we should. The public is concerned and does not believe that researchers can take measurements made in the offshore environment and translate these measurements into exposure levels for individuals, based on wind or water currents or other factors, he said. "It doesn't work that way. You have to measure where people are, and you have to measure people."

Goldstein also emphasized the importance of consulting with the receptor population.

> A good industrial hygienist … will not just measure at a place where the model shows the highest level of exposure will be. That good industrial hygienist will go to the workers who are concerned and say, "Where do you think the exposure is greatest? Where is area you are most concerned about?" It is important that the measurement be made there if one is really going to address the issue.

Making the Case for Public Health

Finally, Goldstein commented on the role of public health in the response to the *DWH* oil spill. "We in public health have not done the job we need to do in making sure that we are at the table, in pushing into these areas, in paying attention to the broader range of activities that can occur," Goldstein said. With the *DWH*, insightful reviews have been done on the ways that science and engineering can contribute to the

[6] Environmental justice is achieved "when everyone enjoys the same degree of protection from environmental and health hazards and equal access to the decision-making process to have a healthy environment in which to live, learn, and work." (see, http://www.epa.gov/environmentaljustice/).

[7] Epigenetic changes include modifications to the cytosine residue of DNA (DNA methylation) and histone proteins associated with DNA (histone modification). These changes alter the expression of certain genes and are distinct from genetic mutations, which are chemical changes that alter the sequence of DNA.

response to the oil spill (Lubchenco et al., 2012; McNutt et al., 2012). But public health typically has not been represented in these studies. "This is a situation in which we have not made the case. We have not tried hard enough to be sure that we can be involved."

The Gulf Research Program, with its 30-year duration and its clear statement of the importance of including public health, gives the public health community an opportunity to prove that it can play a valuable role in responses to oil spills, Goldstein concluded.

3

Perspectives on Resilient Communities

BOX 3-1 Points Highlighted by Individual Speakers

- Resilience is a concept that is well understood by communities and is a means to link and address chronic issues that thwart public health on a daily basis and acute stresses that accompany disasters (Chandra).
- Resilience is a new way of operating; it requires a transdisciplinary workforce and new approaches to civic engagement, in which communities are partners (Chandra).
- Top-down (or formal) approaches to resilience could be better integrated with the social networks, mobility, and ingenuity of local (inherent) resilience practices that have allowed communities to successfully adapt and respond to a variety of past challenges (Colten).
- Measuring and mapping community assets and monitoring them over the long term can provide baseline information and reveal successful resilience strategies (Colten).
- A resilient community is educated, equipped, empowered, engaged, and experienced. Ensuring community involvement in and benefit from resilience-related research is an important way to develop these characteristics (Hosey).
- Technological disasters are often followed by a "money spill" including back-end litigation, which can drain the social capital of communities (Picou).
- Renewable resource communities are particularly vulnerable to emergent and unanticipated ecological problems that follow disasters (Picou).
- Psychosocial effects of the *Exxon Valdez* oil spill are still evident 15–25 years after the disaster. Education, outreach, and other activities that build participatory social capital have been useful tools for building trust and mitigating negative impacts (Picou).

The Gulf region has experienced a variety of disasters in the past decade—from droughts that devastated fishing communities to a series of powerful hurricanes, the 2008 economic recession, and the 2010 *DWH* oil spill, noted LaDon Swann, director of the Mississippi-Alabama Sea Grant Consortium. He noted that discussion of resilience often focuses on the built environment, but that this workshop would focus on the human side of resilience, which is influenced by complex interactions among health, social, and environmental factors. He also observed that, in his experience, the characteristics of resilient communities seem to transcend any one particular disaster.

Presentations summarized in this chapter provided a brief introduction to characteristics of resilient communities and identified some important considerations for developing programs to improve the health, well-being, and resilience of Gulf communities.

DEVELOPING A RESILIENCE MINDSET

Anita Chandra, senior policy researcher and director of Justice, Infrastructure, and Environment at the RAND Cooperation, has spent the past decade working to improve resilience and long-term disaster recovery in communities in the United States and across the globe. In her presentation, Chandra offered three observations from her work to effectively partner with communities and to ensure that resilience-building activities, which generally target infrastructure, environment, and economic issues, also include consideration of health, social, and human services.

According to Chandra, activities to build resilience in the Gulf region are tremendous opportunities to address disaster preparedness and recovery in language that communities embrace and understand. The concept of resilience provides a means to talk with people

about the risk continuum in which they live and ways to strengthen and protect their communities, she said. Both the asset-based framework that guides resilience planning (i.e., not simply focusing on community risks and vulnerabilities but the resources a community has to overcome those risks) and its requirement for civic engagement across a wide variety of stakeholders is resonant with communities, she said (Chandra et al., 2011).

Particularly important is to develop a "resilience mindset,"[1] said Chandra. Such a mindset allows communities to link sources of chronic stress that thwart public health on a daily basis (e.g., economic downturns, housing difficulties, community violence) with acute stresses that accompany technological accidents and natural disasters. A resilience mindset also provides a common framework to address these stressors through routine community activities like health promotion or economic development (Chandra et al., 2011).

Chandra emphasized the importance of embedding resilience development within ongoing civic engagement processes. Integrating the work of governmental and nongovernmental organizations can be difficult for government leaders, because it means changing the dynamics of governance. "What does power mean? What does asset mapping mean when you are trying to have that infuse both local and national policy?" When governmental and nongovernmental organizations are working hand in hand, she said, communities are more resilient (Acosta and Chandra, 2013).

Another important need is to build a workforce to support resilience, noted Chandra. Developing resilience is an inherently transdisciplinary undertaking.[2] But, she said, those who work on resilience have not yet "made good" on coalescing around a common framework and metrics for resilience, and a core set of disciplines. Public health could potentially take the lead in developing a common framework for resilience, because public health research and practice occurs in "multidisciplinary settings as a matter of course," said Chandra. "How do we integrate public health approaches to resilience with those of environmental science, technology, industry, and economics," she asked. Understanding how disciplines work together, what metrics are common and shared, and how systems interact for resilience development are important research needs.

Today, people tend to view resilience as an overlay to policy. It needs to become a nested and routine part of the conversation, Chandra said. Having public health considerations embedded in guidelines and frameworks requires having a different composition of people sitting in panels, committees, and other government structures. "That's going to be the key motivation that moves human health into the larger conversations around resilience," she concluded.

RESILIENT COMMUNITIES: LEARNING FROM THE PAST AND PLANNING FOR THE FUTURE

Building resilience demands a long-term perspective, in which communities learn from the past as they plan for the future, said Craig Colten, Carl O. Sauer Professor of Geography at Louisiana State University and director of human dimensions at the Water Institute of the Gulf. In his presentation, Colten stated that much could be learned from the ways in which economic and environmental factors have affected the health and well-being of communities in Louisiana. In addition, a great deal can be learned from the communities themselves and the ways in which coastal communities have successfully adapted and responded to a variety of past challenges.

Louisiana's environment has been dramatically transformed by external economic activities, he said. For example, since the 18th century, levees[3] have been built on the Mississippi River to support and protect agriculture, cities, and the petrochemical industry. However, these structures also have contributed to coastal land loss[4] and, by creating clusters of industrial activity, have had profound effects—from atmospheric pollution, residual chemical dumps, and superfund sites—that have contributed to environmental justice concerns and impacted the health and well-being of surrounding communities. "We need to consider these kinds of impacts when we talk about planning future coastal restoration projects and other environmental changes," said Colten.

Other examples of environmental change that have negatively impacted communities in Louisiana include the construction of canals and pipelines, intentional river diversions, and oil spills. All three have been occurring in the Gulf region for decades. Canals have benefited loggers, trappers, and fishermen alike but have also contributed to coastal land loss and wetland degradation. Intentional diversions such as the Bonnet Carré and the Morganza Spillways have damaged marine resources by altering coastal salinities when used to redirect freshwater into bays and estuaries. Oil spills are quite frequent in Louisiana he noted, and while not on the scale of *DWH*, these events have severe impacts on the environment (Colten et al., 2012).

[1] See http://www.rand.org/pubs/infographics/IG114.html.

[2] Transdisciplinary research is defined as when investigators from different disciplines work together to create new conceptual and translational innovations that integrate and move beyond discipline-specific approaches to address a common problem.

[3] An embankment built to prevent the overflow of a river.

[4] Levees prevent regular flooding which in the past deposited sediment across the floodplain. By directing sediment into the Gulf of Mexico these structures have largely eliminated natural processes that offset subsidence of the delta (Gagliano et al., 1981).

All of these activities have become larger and more impactful over the years. A series of events in a short span of time can overwhelm the capacity of communities to cope. For example, oil spills force the closure of fisheries, which produces a temporary loss of activity and income that has ripple effects through local economies in general. As the region loses market share, such events begin to have regional impacts, affecting the commodity chain—including suppliers, providers, and shippers. As a result, the strain on communities becomes even more profound. In this way, environmental impacts have regional effects, said Colten.

Colten introduced the concepts of formal and inherent resilience and identified their integration as a key opportunity for strengthening resilience in the Gulf region (Table 3-1). Formal resilience is the result of government and corporate resilience programs, which tend to have sizable budgets and large organizational infrastructures. Inherent resilience is unplanned, locally based, and finely attuned to local environmental situations (Colten et al., 2012). "Such practices are sustained by social memory, not by big manuals on the shelf." Formal resilience works well for frequent small-scale events, but with larger events, such as Hurricanes Katrina and Rita[5] and the 2010 oil spill, the incidents exceed the capacities to respond. "This is when stress really gets compounded at the local level and produces great strain." In addition, greater reliance on formal resilience tends to diminish inherent resilience over time, and when formal resilience fails, an incident can become a disaster.

What is needed is to bring together the social networks, mobility, and ingenuity of local inherent resilience practices with large-scale, better-organized, and better-financed formal resilience programs, said Colten. On one hand, formal plans do not include procedures to take advantage of the highly effective local social networks, and can be slow to reach communities and poorly integrate local expertise. Small communities, on the other hand, that rely on social memory may not be able to mobilize the latest technologies in response to a calamity. By merging formal and inherent, these gaps in capacity can be reduced. This integrated approach then needs to be sustained and not lapse over time, which fits well with the duration of the Gulf Research Program. "How do we prevent the lessons learned from becoming the lessons lost? Already we are hearing here in New Orleans with the start of this hurricane season that there is a loss of urgency, a sense of complacency emerging, 9 years after Katrina.[6] Unthinkable."

Communities can and have been resilient to past disasters, but we need better ways to measure resilience to understand how and why. This will require going beyond the usual metrics, which in turn requires working with communities. A significant opportunity for the Gulf Research Program is to help coastal communities map, measure, and monitor things that are currently "immeasurable." Researchers need to work with communities to identify things that matter to communities, not just what economists consider important, Colten said. For example, despite regular hurricanes, coastal residents are resistant to suggestions that they relocate inland. Attachments to place and family connections are among the immeasurable forces that motivate them to stay and are overlooked in resilience tools that rely on proxy data.

Resilience is a fundamental building block of a sustainable society. Understanding resilience demands a long-term perspective, such as that offered by the Gulf Research Program's 30–year duration. Measuring and mapping community assets over the long term can provide important baseline information for communities. It can also reveal how communities respond and adapt to challenges, whether hurricanes or shifting demographics, and thus help communities to learn from successful resilience programs in the past, he concluded.

KEY CHARACTERISTICS OF RESILIENT COMMUNITIES

John Hosey, the Gulf Coast Restoration Initiative Director of Development for The Corps Network, has worked on a variety of programs to improve disaster recovery and resilience in Gulf communities, including working as a Board Member and President of the South Mississippi Voluntary Organizations Active in Disasters. More recently, Hosey has worked on developing community partnerships between government and non-governmental organizations to develop workforce programs designed to train at-risk young adults (18–28 years old) and recently returning veterans to assist with the ecological and economic restoration efforts in the Gulf region.

Like any recipe for gumbo, Hosey said, resilience is a mixture of essential ingredients.

- First, a resilient community is educated. Hosey emphasized the importance of reaching out to young people. "If you are going to change a culture, you have to change from the beginning, when people are teachable."

[5] In late summer of 2005, two hurricanes—Katrina and Rita—caused nearly 2,000 deaths and an estimated economic cost of $160 billion, including heavy losses for the commercial fishing and other industries. Louisiana bore much of the burden, but coastal counties in AL, MS, LA, and FL were affected. See http://stateofthecoast.noaa.gov/insurance/hurricanetopten.html.

[6] Hurricane Katrina overwhelmed the levees protecting New Orleans, inundated 80 percent of the city, and caused more than 1,000 fatalities.

TABLE 3-1 Integrating Formal and Inherent Resilience

FORMAL RESILIENCE	Anticipate	Reduce Vulnerability	Respond	Recover
Government	Contingency plans Drills	Close fisheries Monitor seafood quality	Biological analysis Alternate employment programs Oversight of response	Postpill legislation Compensation program Natural Resource Damage Assessment (NRDA) process (hold responsible parties liable for costs)
Corporate	Organization with response capabilities Blowout preventers	Containment devices	Cap well, skimming, burning, dispersant, boom	Beach cleanup
INHERENT RESILIENCE				
Community/Family	Social memory	Social/kin networks	Family aid Fish elsewhere Personal economic diversification	Lawsuits Unemployment compensation

[a] NRDA is a process, which collects data and conducts studies to determine the extent of damage to resources, methods for restoring those resources, and the type and amount of restoration required. SOURCE: Colten et al. (2012). Presented by Craig Colten on September 23, 2014.

- Second, a resilient community is equipped. They have tools like resilience indexes, training, and the necessary resources for recovery.
- Third, a resilient community is empowered. "They are not someone who gets a deliverable. They are the ones who help create the deliverable."
- Fourth, a resilient community is engaged. The more engaged a community is in the process of recovery, said Hosey, the more independent they are and the stronger they are in their response to disasters and hardship. The community is part of the solution, not the problem. They help prepare their neighbors, friends, and family members.
- Finally, a resilient community is experienced. Community members are trained for specific roles and tasks and they practice these roles.

One way to achieve all these ends, said Hosey, is to involve communities in resilience-related research. Communities need not only to inform and participate in research but to benefit from that research, Hosey said. They need to learn about the findings of a research project and the implications for that community.

In response to a question, Hosey also identified four barriers to achieving the ends he described. One is poverty. Workforce development, especially at the middle-skilled[7] level, will be essential to build resilience, he said. A second barrier is communicating with communities in ways that foster a culture of resilience. He suggested that social media tools could be used to help educate and communicate with communities. A third barrier is trust. Many people do not trust government agencies or businesses to respond in a way that will speed response and start recovery. "There are opportunities for us to think about how we build trust in communities, and that takes a long time." The fourth barrier is complacency. Hurricane Katrina hit 10 years ago, and already people are forgetting its lessons, he said.

LESSONS FROM THE *EXXON VALDEZ* OIL SPILL

The *Exxon Valdez* oil spill occurred in 1989 when an oil tanker setting out for California struck a reef in Prince William Sound, Alaska, and spilled more than 10 million gallons of crude oil into an environmentally sensitive area. The oil from the spill washed on shore across approximately 1,300 miles of coastline and caused an estimated $300 million of immediate economic harm to those whose livelihoods depended upon commercial fishing.[8] The effects of the spill on affected communities have been studied for 25 years, noted J. Steven Picou, professor of sociology at the University of South Alabama—nearly as long as the planned duration of the Gulf Research Program. While there are some important differences between the spills, thanks to 25 years of monitoring, Picou said, we have learned many important lessons about the social impacts of a major oil spill. These lessons can inform the use of mitigation strategies for building community capacity and enhancing recovery from the *DWH* spill.

First, the economic, social, and psychological impacts of such an event persist well into the future—"15

[7] Middle-skilled occupations are those that require considerable skill but not an advanced degree. See Gulf Research Program (2014b).

[8] See http://oceana.org/en/our-work/stop-ocean-pollution/oil-pollution/learn-act/exxon-valdez-oil-spill-facts.

to 25 years," said Picou. Uncertainty, conflict, disruption, and psychological stress, among other factors, can have dramatic consequences for communities. Among these impacts are increasing bankruptcies among people and communities, business failures, increases in domestic violence, increases in divorce, increases in juvenile delinquency, increases in the number of people affected by depression and intensity of their depression, suicide, and health care delivery problems as support systems in communities become ineffective. These are "corrosive communities," Picou said, communities that have been drained of social capital (Picou et al., 2004, 2009).

Many forces drive this pattern of effects, Picou observed. In Alaska, renewable resource communities[9]—were particularly vulnerable to emergent and unanticipated ecological problems. The Pacific herring population, a major resource for the community,[10] disappeared in some areas, and strange patterns appeared in the salmon fishery 5 to 10 years after the oil spill. As of 2010, only 10 of the 26 resources/species are considered recovered (Exxon Valdez Oil Spill Trustee Council, 2010). These effects have had powerful consequences for the people in fishing communities.

In addition, said Picou, "back-end" litigation sparked by a technological disaster like an oil spill can last for many years. Ten years after the *Exxon Valdez*, he said, the main source of stress and disruption was no longer the oil spill but the litigation it created. "The litigation takes on a life of its own" (Picou, 2009).

Picou also noted that the "money spill" that occurred after the *Exxon Valdez* oil spill and the *DWH* oil spill further disrupts communities due to issues of inequitable distributions of damage payments to survivors. In such circumstances, rumors and misconceptions can flourish as opportunists try to take advantage of the vulnerability of the survivors.

Finally, Picou mentioned that long-term fears concerning personal exposure to toxins, the future of commercial fishing, the safety of harvested seafood and overall public health combine to negatively impact the mental health of survivors.

All of these drivers threaten community resilience, disaster preparedness, and social capital, he said. These issues will be contested in the courts. Litigation outcomes provide no consensus and so the debate concerning the damages, their origins and who is responsible will lead to further social disruption.

The good news, Picou continued, is that these chronic community impacts can be mitigated. Education, outreach, training and the building of participatory social capital can enhance resiliency. Understanding the human impacts of disasters—including social disruption, economic impacts, and psychological impacts—can help individuals and communities transform themselves, Picou said. Faith-based groups, churches, educators, and other institutions in the local community that are transparent, trusted, and long standing can help dispel rumors and educate communities about possible solutions. Picou noted that there are several active programs in the Gulf region that are applying lessons learned in Alaska to communities impacted by the *DWH* oil spill. Examples are the Gulf Region Health Outreach Program[11] (GRHOP) and the Consortium for Resilient Gulf Communities. Both of these efforts focus on building community capacity through enhancing medical infrastructure, mental health services, providing community health workers, training community volunteers and facilitating the activities of faith-based organizations, free clinics, Federally Qualified Health Centers, and other community groups. Taken together, these efforts build social capital and community resilience.

In conclusion, Picou especially emphasized the importance of using a participatory model for research and mitigation, which was a theme throughout the workshop. The more the community is involved, the better research results will be received, he said. This participatory model in itself is therapeutic, and it requires an organizational infrastructure. In Alaska, the Prince William Sound Regional Citizens' Advisory Council (PWSRCAC) serves this role. People in the community serve on the council, which builds trust and transparency, and the council serves as an intermediary between government and business.

RESILIENCE AS ROUTINE PRACTICE

During the discussion session, several participants commented on the importance of building resilience into routine practices of governments, industry, and communities.

Chandra noted that federal approaches to preparedness and response take an "all hazards" approach that embrace resilience principles, but the challenge remains to integrate local emergency preparedness and response personnel with departments of public health that may have valuable and ongoing connections to community partners. Such alignment is needed across all government agencies and across every sector, so that responses to disasters are built into their routine activities.

[9] Communities that depend upon renewable natural resources, such as seafood, for their social, cultural, and economic existence.

[10] In the Alaskan community of Cordova, the herring industry pre-disaster was worth $12 million. "It accounted for almost one-third of the local economy, employed more than 1,100 people, and provided economic stability" (Gill et al., 2014).

[11] See http://www.grhop.org/Pages/Default.aspx.

Maureen Lichtveld of Tulane University noted the need for community capacity building in the period between disasters. "We cannot just partner with communities when we want to do research," she said. "We need to invest in communities," she said, by building capacity such as environmental health literacy or mapping and linking community assets. Such investments lead to relationships and information that can be essential during disasters, she said. Lynn Goldman of George Washington University pointed to the need to better involve the social sciences and behavioral health sciences to better understand community needs and how to change the relationship between communities, their government, and companies in ways that will make communities more resilient.

Paul Sandifer, noted that resilience is a concept that can help communities "bounce forward," rather than back to the way things were before a disaster, and he encouraged participants to think more about "what do we need to do to get to where we ought to be, both from an environmental standpoint and, especially, from the social cultural and the public health standpoints."

BREAKOUT DISCUSSION SUMMARY

Summarized below are responses generated by a breakout discussion that explored the following question:

Breakout question: What are the potential opportunities for research (basic or translational) and monitoring that could significantly advance understanding of the factors that support and enhance resilience of communities in the Gulf region?

As a summary of the breakout discussion, LaDon Swann, Mississippi-Alabama Sea Grant Consortium, presented the list, below, to all workshop participants. This list summarizes items suggested by individual or multiple participants during the breakout discussion and should not be seen as the consensus recommendations of the workshop participants; nor are they necessarily actions that the Gulf Research Program should undertake:

- **Assess effectiveness of past resilience-building activities to identify lessons learned and successful strategies.**
- **Encourage researchers to explore resilience factors within a common framework to allow comparisons across case studies.** Develop a common platform for aggregating and integrating analyses from different research teams.
- **Develop an integrated framework for resilience that includes consideration of ecosystem, social, health, and economic factors that influence the resilience of communities.** System level analyses could inform the development of common resilience metrics, improve understanding of how different systems interact and how disciplines could work together to build resilience.
- **Develop core resilience measures that have comparative and practical value (i.e., can be used to develop best practices).** Core metrics could guide the development of more informative monitoring systems. Individual participants identified several areas of related research:
  - o Opportunities to use existing health datasets to measure resilience
  - o Importance of cultural context in developing and sustaining resilience
  - o Metrics for community versus individual resilience
  - o Metrics for formal versus inherent resilience
  - o Metrics for capacity and processes
  - o Linking metrics to resilience practices
  - o Understanding the value of ecosystems (community and economic perspectives)
- **Explore needs and opportunities for linking environmental, social, and health data.**
  - o Data architecture needs for socio-ecological resilience research.
  - o Platform and other technology needs for improved integration, availability, and use of data.
  - o Improved methods for integrating social, ecological, and health data *at the time of collection*; methods for linking and mining existing datasets.
  - o The use of standard open source approaches to support the development of easily retrievable and sharable code.
- **Build models to improve ability to forecast socio-ecological-health issues relevant to resilience of communities.**
- **Develop capacity for cross-boundary interactions.** Resilience is a new and dynamic field of research that requires better integration of concepts and practices across disciplines (e.g., disaster preparedness, sociology, ecology, health). This could be facilitated through:
  - o Linked grants, education, and training opportunities that support interactions across disciplines and sectors and cross-boundary knowledge development.
  - o Providing opportunities for groups funded by the Gulf Research Program to interact with each other in ways that encourage a more system-level and systematic approach to researching and monitoring factors that influence resilience.

4

Reducing Risk and Improving Disaster Recovery

BOX 4-1 Points Highlighted by Individual Speakers

- Assessing long-term impacts of disasters is difficult because of the absence of baseline information about community health and resilience, but new opportunities are emerging as more data are collected and more datasets become publicly available (Horney).
- Funding constraints and the lack of common measurements have limited the ability of disaster researchers to monitor change over time or compare outcomes across studies. New interdisciplinary research programs are attempting to address these gaps (Horney).
- Few studies have looked at mental health after the *Deepwater Horizon* (*DWH)* disaster, although some data suggests that depression and anxiety increased afterwards (Powers).
- Peer counselor programs were useful for identifying and addressing mental health needs during the *DWH* disaster (Powers).
- First responders, recovery workers, and those who work over the long-term with vulnerable communities may benefit from mental health training programs (Grajeda).
- Developing plans for recovery, in advance of disasters, helps communities articulate a common vision for their community's future and can speed recovery (Grajeda).
- Many health conditions are mediated by social factors that call for interventions outside the traditional scope of public health practice (Baumgartner).
- Health equity contributes to resilience, and efforts to improve the health equity and the resilience of communities should be better linked (Baumgartner).
- The increased availability of data and development of information interfaces for the public are two key trends that can support community-driven improvements in health and resilience (Baumgartner).
- Many segments of the coastal populations have a unique life cycle and health care risks. Little is known about the health of workers in the coastal maritime industries, the coastal tourism industries, and the natural resource extraction industries (Powers).

Many workshop participants shared examples from their experience assisting with disaster response, recovery, and rebuilding efforts in the Gulf region. Their remarks illustrated some opportunities for preventing and mitigating health impacts of disasters and underscored the importance of having baseline information about the health of communities. This information, combined with a greater understanding of the broader, social factors that affect health and well-being, provides an important basis for effectively responding to disasters, assessing health effects and mitigation strategies, and improving the health equity and resilience of communities. Their comments also identified some possible avenues for research or capacity building that could contribute to recovery and resilience.

ASSESSING POSTDISASTER HEALTH IMPACTS

Jennifer Horney, an associate professor of epidemiology and biostatistics at the Texas A&M University Health Science Center School of Public Health and the Hazard Reduction & Recovery Center, has worked on a team of public health practitioners that has responded to several hurricanes, including Katrina. The team used the Community Assessment for Public Health Emergency Response (CASPER) rapid needs assessment toolkit to collect data on disaster impacts, determine public health needs, better understand resident perception of various risks, and help make decisions around evacuation.

In describing lessons learned from these experiences, Horney said it is difficult to measure the long-

term effects of disasters because there are few ongoing or nationally representative cohorts, and because the potential number of affected respondents is typically small. "Generalizing from one disaster to the other is difficult," she added. In Texas, she said, "Port Isabel is not going to be the same as Galveston. And we cannot do a study in one of those places and expect it to carry it over to the other."

Funding for disaster research is almost exclusively focused on case studies of single disasters, she noted, which has precluded the ability to monitor change over time. Although different studies may use certain common measurements, researchers like to ask their own questions, so "there's little opportunity for us to look across studies."

Another point is that the United States has an amalgam of public and private data systems, which makes it difficult to track injuries or cases of disease and determine whether they are attributable to a specific disaster. If a food-borne disease outbreak happens, for example, can researchers determine if it actually was associated with something that occurred after a disaster, or are postdisaster and routine public health surveillance linked in the ways that they need to be in order to uncover these types of events?

Horney described a few opportunities for developing better baseline information to assess recovery and resilience. Various projects are under way to create indices and metrics that measure the quality and completeness of disaster recovery. For instance, as part of the President's Climate Action Plan, NOAA and other agencies are making new efforts to catalogue pilot-tested resources, indicators, and metrics. NOAA, for example, is developing a scorecard of existing resilience indices and metrics, including metrics for the quality and completeness of recovery (Dwyer and Horney, 2014; Horney et al., in press). The Department of Homeland Security is documenting existing resilience indices and measurements to better coordinate federal agency climate change adaptation and preparedness efforts. The U.S. Department of Housing and Urban Development, as part of the activities taking place in its Hurricane Sandy Project Management Office, has developed a Sandy Index of Indicators, which include indicators and data sources related to measuring housing recovery. The Federal Emergency Management Agency (FEMA), in partnership with the Coastal Hazards Center of Excellence at the University of North Carolina at Chapel Hill has developed a checklist of 79 recovery metrics, categorized by Recovery Support Function and Core Capability (Dwyer and Horney, 2014; Horney et al., in press).

A second opportunity is that new funding is becoming available for interdisciplinary research with a particular focus on vulnerability, sustainability, and resilience. In December 2014, the National Science Foundation (NSF) accepted applications for the second round of its interdisciplinary research program in hazards and disasters—known as Hazards SEES[1]—which specifically requires real engagement of community stakeholders and partners.[2] In addition to requiring research that is integrated across disciplines, Hazards SEES research must also be broadly applicable and transferable, and substantively engage stakeholders and community partners "*at the early phases of problem identification and definition*." This explicit recognition of the value of so-called ordinary knowledge may bring to light new research questions and planning policy frameworks that are important to address community resilience to future disasters.

Third is an opportunity for investigations based on the recent increase in openly available data, in part due to the Obama Administration's Open Data Initiatives.[3] Nearly 150,000 data sets are freely available at data.gov for research, application development, and other projects. For example, the Centers for Medicare and Medicaid Services have released data on spending, utilization, and quality through their Geographic Variation Public Use File[4] that allow researchers and policy makers to evaluate geographic variation in the use and quality of health care services. Horney recently analyzed Medicare claims from 2008 to 2012 across the United States at a county level in conjunction with FEMA disaster declarations to look at increases in certain disease and injury outcomes associated with disasters, as well as changes in health system utilization. "We are seeing things like fewer home health visits or more missed rehabilitation care visits in the period after disasters." This is county level data, she acknowledged, but such research is a start at examining the kinds of health impacts that may arise regardless of the type of disaster or where it happened—impacts that public health systems need to think about in advance to achieve resilience to future disasters, Horney said.

MENTAL HEALTH IMPACTS OF DISASTERS

Psychiatrist and neuropathologist Richard Powers offered a ground-level account of the response to both Katrina and the *DWH* oil spill. "Katrina taught us a lot," he said. As Medical Director for the Alabama Department of Mental Health, he received a call from the Alabama governor's office very early after the hurricane "that there were a couple thousand folks from New Or-

[1] For more details, see http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504804&org=NSF;http://www.nsf.gov/pubs/2014/nsf14581/nsf14581.htm.

[2] See http://www.nsf.gov/pubs/2014/nsf14581/nsf14581.htm.

[3] See http://www.whitehouse.gov/open.

[4] See http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/Medicare-Geographic-Variation/GV_PUF.html.

leans sitting in the Birmingham-Jefferson civic center, and would we mind going down there and fixing that problem;" especially for persons with mental illness or intellectual disability. He had to troubleshoot a variety of unanticipated issues, such as how to convince doctors to write pharmaceutical prescriptions for patients for whom there were no medical records available. He and his team confronted a number of challenges, many of which could be planned for in advance, he said. For example, when an urban annihilation event impacts a major urban area such as New Orleans, we can make predictions about the flow of people that are leaving, and where they are likely to run out of gas, he said. Such planning would help health departments to better target their resources during disasters. The prescription of controlled substances, especially narcotics such as methadone pose a unique challenge. Treated individuals may go into withdrawal if unable to receive their maintenance dose or engage in drug-seeking behavior in their host location creating other problems.

The *DWH* oil spill was not a natural disaster but a slowly evolving industrial disaster, "so people had a chance to get very anxious about what is about to happen." Maintaining mental health in the affected communities was a challenge, particularly with "different people coming in with their own different agendas," Powers said, such as lawyers with their scare advertisements and the petroleum industry with their own perspective on the event. In contrast to natural disasters, the oil spill was caused by a preventable mistake, he said, which lent a different quality to those that suffered losses.

Then there were the "agenda scientists," he said. These are scientists who show up to do research but who "already have in mind what they think they're going to find" and then make unfiltered pronouncements on CNN. "That has a direct impact on the psyche of the population that you are trying to keep calm, because now they are hearing, 'Scientists are saying this, or scientists are saying that.'" Statements to the media like "the seafood is poison" or the oil spill is "killing both the tourist and the fishing industry" made his job of maintaining mental health a real challenge, Powers said.

The research literature in PubMed includes few citations on mental health issues related to the *DWH* oil spill. But Powers believes that enough data exist to demonstrate an increased frequency of depression after the spill. Anxiety disorders certainly increased, and Powers is convinced that the rates of substance abuse also went up after the two disasters (Hurricane Katrina and the *DWH* oil spill). Galea et al. (2007) reported that 49 percent of New Orleans residents who were impacted by Hurricane Katrina met DSM[5] criteria for anxiety or depression at six months after the event as opposed to 26 percent in adjacent areas that were not flooded. In the same group, 30 percent met criteria for posttraumatic stress disorder (PTSD) in comparison to 13 percent in the adjacent areas.

The mission of public mental health officers includes preventing suicide, reducing domestic violence, and creating a permissive environment for a community to talk about and seek help for mental health issues, he said. After Hurricane Katrina and the *DWH* oil spill, the Alabama health department sent out crisis support counselors through a program called Project Rebound.[6] These counselors were local residents who went into their coastal communities and brought people back in for attention within the established mental health system, which the state then had to ensure was ready to care for them.

Such work legitimized the counselors' standing within communities, Powers noted, so public health researchers were later able to tap them in assisting with CASPER studies. Thus, efforts like Project Rebound can be an avenue for promoting appropriate research in affected communities.

Powers reported that the BP leadership, including the medical leadership, was reasonable in providing support for Project Rebound. The response from the federal leadership was less helpful.

During the discussion sessions, Powers noted that the recent move toward a minimalistic, small-government approach in many states will mean losing people with technical expertise in disaster response and recovery, he said. For example, Alabama has no current medical director for its mental health department, because it eliminated that position. Down the road, state governments, which are ultimately tasked with dealing with disasters, "are going to lose their ability to have the people online to manage some of these things."

Furthermore, the public mental health system has become privatized, he said. But the private companies will not have a response infrastructure ready to go like a public system has, and they will not step up to do the job "unless you throw a lot of money at them." In setting up a capable healthcare workforce to take care of traumatized people after disasters like Hurricane Katrina or the *DWH* oil spill, he said, the peer review literature says that the most effective mental health interventions are cognitive processing therapy and exposure therapy. However, both treatments are very time intensive. That raises important questions: How much of a workforce to deliver those therapies will be present and in reserve in a community? What kind of public health programs will agencies need to try to minimize morbidity?

[5] The *Diagnostic and Statistical Manual of Mental Disorders* (DSM) is the standard classification of mental disorders used by mental health professionals in the United States.

[6] See www.projectrebound.org for more information.

Finally, he encouraged the Gulf Research Program to engage the Veterans Health Administration and the Department of Defense, which are organizations with "tremendous experience with resiliency, trauma management, and toxicology."

LINKING COMMUNITY RECOVERY AND RESILIENCE

Eight years ago, Angela Grajeda began working in the Gulf region as a member of the American Red Cross's recovery team helping communities rebuild after Hurricane Katrina. Now she is disaster program manager for the charity's south Mississippi chapter. Her experience includes working on a Red Cross pilot program working to strengthen the resilience of communities along the Gulf Coast in Mississippi and New Orleans, as well as in Miami.

In the aftermath of disasters, the "mental health concerns of the community are huge, but we also need to make sure that we are taking care of the responders," she said. These are individuals on the front lines of disasters who see the dead bodies and other devastating impacts of a disaster, but their mental health issues are not routinely addressed. "Compassion fatigue" can also set in among recovery workers who often hold communities together during the recovery period. These workers can become overwhelmed by the many surrounding, tragic stories of loss, said Grajeda. "As they get fatigued in their work, the community network that you have built begins to crumble to some degree."

Grajeda said it would be ideal to look at how to address these needs ahead of time. For instance, how can a standard be set within the response community that seeking help is acceptable? How can mental health services be made easily available to emergency response managers, so they do not have to leave their workplaces to seek help elsewhere? In addition, emotional fallout from disasters can often occur long after the disaster has passed. How can mental health support be better integrated into the daily life of vulnerable populations, such as children?

During the discussion, Leanne Truehart from the St. Tammany Parish chapter of the National Alliance on Mental Illness noted that a helpful resource is the American Psychiatry Association's disaster psychiatry committee, which can offer phone support to local mental health providers.

Another often unanticipated effect, Grajeda said, is the stress caused by the influx of volunteer relief workers and emergency funds. Volunteers often rush to help after disasters, but they often do not understand the community and are not well organized. Thus, communities need to plan in advance for volunteer intake centers and for the influx of dollars, she said. A lack of an organized entry point "creates competition among those very resources that are doing the work, and then you get a disjointed recovery process."

These and other issues have come up as part of the Red Cross's pilot program to help communities plan for recovery. Many community residents have adapted to periodic natural disasters as a routine part of their lives, she said. Major disasters become part of "a community memory," and communities "reset" themselves after each natural disaster knowing that whatever they do in response is also a means to prepare for the next event. In its pilot program, the Red Cross takes advantage of this time between disasters to help develop community networks and plans that can guide recovery from the next disaster. Focusing on needs identified by community residents, the program helps the community create a plan for recovery, as well as helps to put that plan into action, she said.

As a final point, Grajeda emphasized that in planning for recovery, it is important to know what a community's vision is and what it is working toward. That knowledge will allow for recovery to progress more quickly.

During the discussion, Grajeda said that after a disaster, considerable delay tends to happen at the point after the immediate response to a crisis has been taken care of, when people start thinking about planning the recovery. Recognizing this gap, the Louisiana and Mississippi Regional Resilience Network, which she works with, is looking at how to take people who are immediately focused on the recovery phase and "implant" them within the response phase from the start. "One of the things we need to be looking at 10 years down the road is how do we allow the system to breathe properly?" Grajeda said. In a crisis, there is a need for an influx of workers and staff to come into a community to establish and offer a service, but most of those people later leave. The question is how to develop these capacities within the standing community so when a crisis is over, "There's not a huge void left."

HEALTH EQUITY AND RESILIENCE

The definition of public health has evolved, noted Eric Baumgartner, a public health physician who is the policy and program planning director for the Louisiana Public Health Institute. Public health has broadened beyond the historical focus on tactical interventions targeting immediate events such as infectious diseases or trauma towards a contemporary understanding that individual and collective health arises from the interplay among broader determinants of health. "Most of what impacts population health is in fact the interactions between people with their environment," he said. That includes not just the natural and built environment but also the social environment, which influ-

ences "the ability of people in the context of family and neighborhood to achieve their potential [in] health and independence throughout the life continuum."

As the view has evolved beyond the control of infectious diseases, the public health sector has recognized that many health conditions are mediated by social factors that may call for interventions outside the traditional scope of public health practice. For example, clinicians and health insurers increasingly recognize that clinical care visits alone may not control a diabetic patient's blood sugar levels; instead, what matters most are the things that happen in that person's daily life between medical appointments, such as access to nutritious food and safe places to walk or exercise. "That's a very complex thing to deal with," Baumgartner said, noting that success stories in community health are commonly led by sectors other than public health, such as urban planning, housing, and transportation.

Many people working in health-related disciplines have come to see the world through the lens of health equity,[7] which is built upon social justice, he said. Achieving health equity will take deliberate consensus across different sectors and structural change in communities including formal policy changes and shifting cultural norms. Health equity also contributes to resilience because it is "the enduring, underlying nest" or base from which a community could prepare for and rebound from a hurricane or other disaster, he said. Efforts are needed to better connect and align discussions of health equity and community resilience, he said.

With the growing understanding that many factors influence a community's health, more and more cities across the United States are creating interactive Web-based platforms for "democratized data"[8] that have been "translated into informational products that communities can consume," Baumgartner said. In partnership with the Gulf Region Health Outreach Program (GRHOP), the Louisiana Public Health Institute, with funding from the Baton Rouge Area Foundation, is working with central coast communities to build such platforms, which can provide information about major health determinants such as household income and education level as well as data on the environment, economy, education, and transportation issues. Democratized data platforms could help inform people's decisions on matters such as whom to elect, how resources should be allocated, and how to deal with economic shocks or hurricanes. In addition, because of the development of open, interactive websites, "There have never been more affordable, easier, actionable ways to democratize data in informational products."

Information availability and access can also be critical during disasters, Baumgartner observed. Hurricane Katrina affected New Orleans residents differently depending on who they were and what neighborhood they lived in. Many did not leave their neighborhoods because they had unmitigated chronic diseases and did not trust they would be able to get their prescription drugs or medical help if they sought refuge elsewhere. At the same time, many people who fled New Orleans during Katrina "didn't come back because they didn't know if their service providers were back," he said. And, for many that did return, there was no official record about the health services they received while displaced. There are many opportunities to think about how improved access and availability of health information can contribute to health equity and resilience, he said.

Baumgartner summed up his talk with the message that the perspective of health equity can be very instructive, especially in the current era of an unprecedented alignment of health care financing, health care delivery, and public health. Furthermore, when disruptive events such as Hurricane Katrina happen to vulnerable communities, "It does spark a renaissance of civic engagement" that can help drive new policies and allocations of resources to give communities a better chance of moving toward health equity and greater resiliency.

ACCESS AND USE OF HEALTH INFORMATION

Linda McCauley, Emory University, commented that with many communities increasingly engaged in understanding, collecting, and mapping environmental monitoring data, her dream for the next decade is to see communities access and get engaged in their health data so "they get the entire picture that crosses the environmental and health side."

Eric Baumgartner, Louisiana Public Health Institute, discussed the need to recognize the ongoing "sea change" in the availability of information that can inform complex activities, including community resilience. It is currently possible to electronically obtain health data at the enterprise level (across a health care organization) for a healthcare provider, whereas in the past that information could only be accessed through on-site audits. What still lies ahead is the challenge of getting systems-level data on the services that a patient receives from a multitude of entities, he said. At the same time, health

[7] Health equity is achieved when every person has the opportunity to "attain his or her full health potential" and no one is "disadvantaged from achieving this potential because of social position or other socially determined circumstances." Health inequities are reflected in differences in length of life; quality of life; rates of disease, disability, and death; severity of disease; and access to treatment. http://www.cdc.gov/chronicdisease/healthequity.

[8] Enabling community actors to access data and to use it to build community capacity to effect social change (Treuhaft, 2006).

data collected at the level of small areas—rather than at a large geographic scale—remain scarce, and a deliberate effort is needed to fill that gap to analyze where health disparities really lie. With individual and population health being the sum result of the interplay of factors across various domains of daily life of residents in their natural, built, and social environments, seeing the big "ecological view" will require aggregating and juxtaposing data from different parts of the community picture, not just health care. The emerging digital information interfaces are starting to make that possible, which will help communities plan and act, he said.

Maureen Lichtveld of Tulane University added to the conversation about democratizing data by noting, "It is one thing to put out the data, it is another thing to make the community truly a partner by being able to interpret the data in a way that the data should be interpreted." While public health experts can talk all they want about engaging communities, she said, it will not happen "if we do not provide all communities with the tools to truly partner."

Lichtveld mentioned two experiments where that is starting to happen. By using Public Participatory Geographic Information Systems, a community organization in New Orleans has mapped the loss of street lights and traffic lights, and community violence. She and colleagues also are working with the Louisiana Public Health Institute on a unique community-based participatory research training project for community members.

An important piece of how health systems data might help governments or other organizations do a better job is the scale of time and the issue of whether data can be generated in closer to real time, noted Lynn Goldman of George Washington University. Goldman has observed that government delays in making decisions about how to deploy resources—whether in health care, social services, money, or workers—are a source of considerable strain in communities. Some of that delay comes from problems intrinsic to the government process, but some of it has to do with the data, she speculated, noting that this could be a question for potential research into "how to make government work the way we all think it ought to work."

Finally, Alexandra Nolen, University of Texas Medical Branch, pointed out that over the next three decades, entirely new ways of accessing and using health information are going to develop. "The question becomes not only how do we think about how we could use that information, but how do we intentionally shape the health information data system to better serve planning and response processes?"

HEALTH NEEDS OF COASTAL POPULATIONS

During the discussion, Richard Powers underscored the need to better understand coastal communities. "We have rural health initiatives, but not coastal health initiatives," he said. "Yet coastal populations are different in many ways. How can we bring a greater attention to these issues, particularly among federal agencies, such as the National Institute of Mental Health and the National Institute of Aging?" Many segments of the coastal populations have a unique life cycle and health care risks. Little is known about the health of workers in the coastal maritime industries such as fishing, the coastal tourism industries such as uninsured seasonal workers in the hospitality industry, and the natural resource extraction industries such as the oil platform workers. The coastal populations are exposed to periodic disasters, and these citizens live with the persistent risk for disaster during the increasingly violent hurricane seasons.

In Powers' view, along the Gulf coast there are few major academic centers with schools of public health to advocate for research on these populations and conduct the research, if funded. The reliance on outside experts has many problems. Local communities are unlikely to participate in research conducted by unfamiliar organizations. The local academic leadership often views these intrusions as academic opportunism, because the interest of outside organizations rarely extends past the funding life of the grant. Powers suggested that the Gulf Research Program should focus on developing local academic resources and professionals who could engage in ongoing research on medical and environmental issues that affect the coastal citizens.

BREAKOUT DISCUSSION SUMMARY

Summarized below are responses generated by two breakout discussion groups charged with developing suggestions for (1) research and monitoring opportunities that could reduce long term impacts of disasters and strengthen community resilience or (2) opportunities to improve understanding of baseline community health status.

Breakout question: What are some potential opportunities for research and monitoring to reduce long term impacts of disasters and strengthen resilience?

As a summary of the breakout discussion, Bernard Goldstein, University of Pittsburgh, presented the list, below, to all workshop participants. This list summarizes items suggested by individual and multiple participants during the breakout discussion and should not be seen as the consensus recommendations of the workshop participants; nor are they necessarily actions that the Gulf Research Program should undertake:

- **Improve understanding of the long-term impacts of disasters and the effectiveness of in-**

terventions to reduce these impacts. This information could guide strategic and collaborative investment in long-term, community interventions (by non-profits and philanthropy organizations); support integrative planning at the community level before disasters; improve capacity to predict and mitigate health impacts.

- o Potential opportunities: Assess the impact of disaster-related policies and programs on communities. This might include mapping policy processes against the actual needs of populations; identifying unintended outcomes; and comparing the impact of different approaches. Qualitative and quantitative assessments would help to demonstrate impact and to make the case for the return on investment (for future investment by philanthropy organizations), identify areas in need of improvement/additional research and provide guidance for future disaster response and recovery. Specific areas to assess:
  - o Claims processes (e.g., The Gulf Coast Claims Facility): What are the impacts on the health and well being of residents? Are there opportunities for improvement or other models that could be used?
  - o The Vessels of Opportunity program in the Gulf: How did this impact the clean-up effort and communities? How does this compare with the impacts of the fishing vessel response program developed in Alaska?
  - o Mental health interventions: What has or has not worked well during and after disasters? What policies and capacity need to be in place before a disaster strikes? How can these approaches be integrated into "all hazards" preparedness?
  - o What approaches have "co-benefits" (i.e., they support preparedness and response, but also are good for public health in the absence of disasters).
  - o What factors support sustained attention and focus on resilience? Can approaches with "co-benefits" help to maintain capacity over time? What can we learn from looking at the period between Hurricane Katrina and the *DWH*?
  - o What are the benefits of response activities that involve communities in planning and execution?
- **Develop a framework for resilience that will allow researchers to compare impacts—across affected communities and across disaster types.** The framework should include social, environmental, economic, and health factors and enable researchers to understand how the recovery and resilience of communities is influenced by pre-existing conditions, such as health and social equity, public understanding of risk, and the built environment, and by pre- and postdisaster interventions.
- Develop models that better capture the harms of disasters for communities. What are the impacts and risks? There are tools and methods for assessing impacts of certain activities, such as those used by the World Bank the and International Monetary Fund to identify potential impacts (including health), evaluating safeguards currently in place, and identifying gaps. This type of assessment is not currently done for oil spills, but why couldn't a process be developed that could apply these tools before a disaster occurs? This could help guide understanding of what questions should be asked before a disaster occurs. Potential opportunities:
  - o A model could be developed and tested against what happened during the *DWH* and *Exxon Valdez* spills, then refined based on experiences during future disasters. Such a model could help to define the risks, benefits, and a community's rate of return from risky activities such as deep water drilling.
  - o Put together a team that could respond to and learn from disasters. They would be equipped with a plan for how to study the economic, social, environmental, and health impacts of disasters. One possible model is the Natural Hazards Center at University of Colorado Boulder, but it would need to involve communities. Research is needed to propose models/approaches.
  - o The University of Delaware has a Disaster Research Center; The Natural Hazards Research and Information Center at University of Colorado Boulder has archives on the social, economic impacts of disasters. Both of these centers are resources for developing capacity to respond to disasters.
- **Develop community capacity:**
  - o Develop a "reciprocal" disaster response network that allows the exchange of tools, expertise, and information about disaster response and recovery.
  - o Fund non-profits to do integrative planning before disasters, to ensure community needs are identified and can be acted on quickly.
  - o Evaluate existing curricula that have been developed around resilience and disaster preparedness topics—what are some opportunities to expand on this work to educate and train a broader community?
  - o Support development of training for response workers and others working with communities (e.g., teachers, law enforcement, supervisors) focused on stress management. Improve understanding of who is potentially affected. During the oil spill many people provided support functions (bringing gear, food, etc.) for clean-up work and were potentially exposed to stress and contaminated materials.

- **Focus on the incident command structure.** Make sure that this structure is robust and that health and resilience issues are on the agenda.

Breakout question: How can the Gulf Research Program improve understanding of baseline health and well-being to improve the recovery and resilience of communities?

As a summary of the breakout discussion, Bernard Goldstein, University of Pittsburgh, presented the list, below, to all workshop participants. This list summarizes items suggested by individual and multiple participants during the breakout discussion and should not be seen as the consensus recommendations of the workshop participants; nor are they necessarily actions that the Gulf Research Program should undertake:

- **Develop community risk and resilience profiles:** Characterize communities based on the mix of assets and vulnerabilities; information can be used to target combinations of risks versus single issues (e.g., mobility-challenged).
- **Identify relevant data sources outside of traditional public health** (i.e., beyond standard data collected for health -such as maternal and child health and chronic disease—to housing, neighborhood walkability, nature exposure etc.).
- **Capture data at a more granular level:** County-level data are often insufficient, how to move to a more granular level, such as census tract data?
- **Build upon existing surveys** (e.g., Pregnancy Risk Assessment Monitoring System [PRAMS], housing, education): What questions could be added to these tools and how could you validate any new question?
- **Strengthen robustness of results through cross validation.** Look across resources that use different ways of collecting and looking at information (e.g., the Affordable Care Act required community benefit surveys, Robert Wood Johnson Foundation county level surveys).
- **Develop critical network metrics that help us understand resilience, for example, what factors contribute to adaptive capacity?** How do we understand how individuals are nested within networks?
- **Develop and validate recovery/inter-disaster indicators that can be used to monitor recovery;** what interventions need to be deployed and evaluated. (Partner with those working on this after Hurricane Sandy.)
- **Develop methods and approaches that would be least burdensome, so that data can be collected during disasters.**
  - o **Explore the use of new technologies to quickly get information that can establish a baseline** (e.g., crowd sourcing, and self-reporting data: what is valid what is not; how to use this data). Are there opportunities to use these and other developing technologies to collect data *after* a disaster to develop a better understanding of community needs and to assess effectiveness of response and recovery?
- **Support retrospective studies and modeling to guide thinking about approaches to preparedness, response, and recovery.** Does this change by region? By disaster type?

5

Building Resilience in the Gulf Region

BOX 5-1 Points Highlighted by Individual Speakers

- Health impact assessments and embedding "health in all policies" are important approaches used by public health agencies to address issues at the intersection between human health and the environment (Shah).
- Public health agencies need better information about how factors such as transportation, education, and economics influence health, and how to best align these sectors to support health and resilience (Shah).
- Social and economic inequities drive the need for massive response (Nolen).
- In advance of disasters, responses could be better mapped to community needs. Tools for recovery planning are also needed to support the effective and equitable use of postdisaster funding by communities (Nolen).
- Hazard mitigation plans often do not address the health and social impacts of disasters. Social infrastructure (e.g., functioning businesses), informal support networks, and a diversified economy are important factors in resilience (Sempier).
- Slow moving and chronic threats, such as environmental degradation and globalization, may represent a greater challenge than acute threats to the resilience of many communities in the Gulf region (Caffey).
- Community involvement is essential for resilience and needs to be a dialogue. Researchers need to listen to communities to understand community needs and help to develop solutions that benefit communities. Networks and organizations that are already embedded in communities are important potential partners (Caffey).
- Gulf Coast communities have critical knowledge and capabilities that are often overlooked but represent an important resource for researchers and managers of restoration projects (Laska).
- Information developed by the Prince William Sound Regional Citizens' Advisory Council, based on experiences following the *Exxon Valdez* oil spill, provide important guidance to communities affected by the oil spills. The Council also provides a model for community-driven research, monitoring, and other activities (Banta).

As emphasized throughout the workshop, the Gulf region has significant strengths, including a wide variety of programs that are working to strengthen health and resilience of communities and to restore and protect the environments in which they live. Several presentations at the workshop highlighted some of these existing programs, networks, and approaches, and identified opportunities for the Gulf Research Program to learn from, and extend the benefits of, these programs to other coastal communities.

PUBLIC HEALTH IN A GULF COMMUNITY

"The better your community is before you get into a disaster or emergency, the better your community is going to be during the disaster or emergency, and the better your community is going to be coming out of the disaster or emergency," said Umair A. Shah, executive director of Harris County Public Health and Environmental Services (HCPHES). HCPHES's jurisdiction includes all 4.09 million residents of Harris County, Texas, including the City of Houston. In his presentation, Shah reviewed the central and often invisible role of public health departments in addressing issues at the intersection between health and the environment and suggested some opportunities to build upon this foundation to strengthen the resilience of communities.

HCPHES has five offices that cover health education and promotion; policy and planning; public health preparedness and response; public information; and operations and finance. It also has five divisions that cover disease control and clinical prevention; environmental public health; mosquito control; veterinary public health; and nutrition and chronic disease prevention, which is a new division. As Shah said, chronic disease "is what's killing most of us, and we need to really think about ways in our system that we can bring in chronic disease prevention efforts."

The activities undertaken by an agency such as HCPHES are "largely invisible," said Shah. Yet the agency

has a large impact on health, because the department works in many different settings, and "place matters." Shah said his agency believes that health is a function of where people live, learn, work, worship, and play. Physicians interact with patients only every few months or once per year. In contrast, once patients leave their physician's office, they "are in the community all the time."

He also noted the incredible value and cost-effectiveness of public health approaches to community problems. For example, every $1 invested in an effective school-based tobacco prevention program saves almost $20 in medical costs, and if 10 percent of U.S. adults began a regular walking program, heart disease costs could be reduced by $5.6 billion, he said. Yet only about 3 percent of health spending in the United States goes toward public health prevention-type activities.

Shah noted that HCPHES has a staff of about 600, down from 700 in 2011, a reduction due to funding constraints—the good news is that this number has been increasing more recently. Yet Harris County, Texas, is the third most populous county in the United States, with a demographically and politically diverse population of 4.3 million people spread over an area the size of Rhode Island. The population has grown 28 percent since 2000—10 percent in the city of Houston, and 68 percent in unincorporated areas of the county, making the population of unincorporated parts of Harris County greater than that of Phoenix or Philadelphia.[1]

Many factors play a role in creating healthy communities and healthy people. Shah particularly emphasized social connectedness, which is a key piece of resilience. Many social factors also contribute to community vulnerability, including poverty, factors related to education, transportation, and even the ability to take on chronic diseases. Yet everyone is vulnerable, if stressed enough, Shah emphasized. This is especially true when the public health system is itself stressed or under-resourced.

Shah concluded by pointing to several specific opportunities for the Gulf Research Program to help communities build resilience before a disaster happens:

- Articulating (and promoting the understanding of) the critical intersection between human health and environment;
- Leading efforts in incorporating concepts of "health in all policies" and health impact assessments into ongoing work; and
- Advocating for population health to be at the "table" in planning and promoting integrated approaches to health issues which includes
  - o Investing in research on the role of social determinants of health and promoting the health equity agenda;
  - o Furthering the development and use of sound data systems and mapping for targeted interventions and for all members of a community; and
  - o Engaging the whole of communities (through social media and other means) including decision-makers, funders and the lay public.

During a discussion of the kinds of projects the Gulf Research Program could fund, Shah pointed to the need to understand better the influence of such factors as transportation, education, and economics on health. "We don't have good ways to study those intersection points and even to pull them together." These sectors can contribute to improved health of communities, especially if public health is at the table in discussions and if we understand how best to align these sectors to support health.

However, he said, health data, informatics, and surveillance systems are not robust at present, and further many gaps exist in knowledge about the potential effects of disasters on communities. He also pointed out that reaching all community members requires keeping up with their ways of communicating with each other, such as through emerging social media. "You have to figure out how people are communicating in the community and how to intersect with them."

RECOVERY PLANNING IN GALVESTON, TEXAS

Hurricane Ike made landfall on September 13, 2008, near Galveston, Texas, with maximum sustained winds of 110 mph. Ike produced a destructive storm surge that affected the upper Texas and southwest Louisiana coasts (NOAA, 2014). With a 14-foot storm surge, the hurricane swept over the barrier island of Galveston, severely damaging or destroying more than 70 percent of the buildings. A city of 50,000 with disproportionate poverty, Galveston was left with entire neighborhoods abandoned for years after the storm. The hurricane resulted in the devastation of the community's most vulnerable populations and many of the social services that supported these populations. Following Ike, the community of Galveston, Texas, received funding from the National Institutes of Health to help "rebuild Galveston in a healthier way," said Alexandra Nolen, director of the Center to Eliminate Health Disparities at the University of Texas Medical Branch in Galveston. The underlying concept was to use disaster recovery planning as a way to restructure the city's infrastructure and advance community health, using a "health in all policies" approach.

As part of this process, Nolen and her colleagues used Geographic Information System (GIS) mapping to assess approximately 125 health, social, economic, and environmental indicators, many at the level of census blocks. Indicators were adapted for local scale and context from the Sustainable Communities Index, which was developed by Rajiv Bhatia, Lili Farhang, and colleagues as an easy to use equity-oriented assessment and planning tool for urban environments to advance healthy communities (see www.sustainablecommunitiesindex.org). They also worked with the Institute for

[1] http://www.harriscountytx.gov/budget.

Alternative Futures to develop scenarios of how planning for recovery could have been improved before the storm. "We engaged about 60 city and county level officials, planners, social services directors and community leaders in a process of thinking creatively about the next time," Nolen said. "How could we have planned better to get child care back up and running more quickly after the storm? How could we have planned better to provide bridge funding for some of our social services agencies? How could we have planned better to make sure that food security wasn't as dramatic an issue as it turned out to be? And what difference would this have made to our recovery as a city, and to the ability of everyone to have a chance to return and reintegrate in the community?"

The mapping and scenario building exercises involved working with grassroots community groups to learn how best to conduct mapping and interpret the maps. The resulting conversations in turn led to community-driven priority setting around broader issues, including early child development and housing quality, among others, with many of these priorities later being integrated into master plans, recovery plans, and community planning.

Following an assessment of public health impacts, a second project focused on using a Health Impact Assessment[2] to discern how to best recover public housing, which turned out to be a very contentious issue, Nolen said. "We had to think carefully about how to frame issues to make sure that we were including a lot of different kinds of constituents. We knew we would need community backing of influential, thoughtful people, so we brought together a Steering Committee of people from the community that included bankers, the police department, city council members, housing and civil rights advocates, social services workers, and a whole spectrum of other people, many of whom did not share a vision for public housing recovery." Despite these disagreements, together the group developed consensus by focusing on neighborhood improvement indicators that impact health to guide the methodology and recommendations. By doing this, groups that had been actively opposed to public housing recovery on the island began to support the use of the tool for broad planning over the long term, and even acknowledged its usefulness for guiding planning for public housing.

A third component of the work involved an environmental justice initiative in the petrochemical-based city of Port Arthur, in partnership with the Community In-Power and Development Association. The project "reawakened the community's interest in the concept of resilience and led to a broader conversation about disaster planning." The work started with analyzing air quality data—the key concern expressed by community members—then added a community-based participatory research approach to map social determinants of health and potential postdisaster health threats related to proximity to industry, along with asset mapping (including "lost assets" that no longer existed). By the end of the 18-month initiative, community members had refocused the aims of their advocacy language and goals to include broader social determinants of health such as development of grocery stores and reducing incarceration, and were incorporating disaster planning concepts into their environmental justice conversations.

Nolen drew three lessons from her experiences following Hurricane Ike. One is that existing social and economic exclusion inequities drive the need for massive responses. "We have ongoing low level disasters in our communities," said Nolen. "We have to use equity-oriented health impact assessments and health in all policies approaches, which are gaining momentum in many communities across the United States, to respond to these 'small disasters' so that when larger disasters hit, they are not as devastating to vulnerable populations; reciprocally, we need to more actively incorporate disaster components into health considerations in planning." Furthermore, this disaster planning needs to be specific, tackling issues that are critical to supporting healthy communities, such as how to resume daycare services quickly following a disaster, or other services that will support re-inhabitation of neighborhoods by a critical mass of people, that in turn, can drive the local economy into recovery. "This is not just a technical fix; it is also a social justice issue."

The second lesson is that more planning tools are needed to support communities to effectively and equitably use the funding available postdisaster, "the money-spill," she said, including mapping the entry points for opportunities and additional support structures needed. For instance, communities should know ahead of time how and on what timeline FEMA sets up recovery committees or rolls out Social Services Block Grants (including the typical time from disaster to actual disbursement of funds), and what the conditions are for receiving funding; this would help social service providers know whether they would be eligible and how long they will have to operate without funding after a disaster or support a community to set up a process to immediately respond to needs. An important issue, said Nolen, is whether the responses to a disaster map well with community needs. In many particular areas they do, but they may not do so comprehensively. For example, after Hurricane Ike the local banks in Galveston came together and quickly extended low-interest loans to tide over social services organizations until federal disaster recovery grants could come through. However,

[2] According to the World Health Organization: "Health Impact Assessment (HIA) is a means of assessing the health impacts of policies, plans and projects in diverse economic sectors using quantitative, qualitative and participatory techniques. HIA helps decision-makers make choices about alternatives and improvements to prevent disease/injury and to actively promote health" (http://www.who.int/hia/en accessed November 17, 2014).

many local social services and agencies still closed unnecessarily. If the appropriate steps were taken during a planning stage, said Nolen, distributive principles and priorities could be discussed in advance of a disaster and important services could have been maintained.

The final lesson is that community coalitions at the meso-level are important for speeding recovery. They should be brought together prior to disasters to discuss how they could support each other after disasters, including by adopting cooperative and not competitive principles and processes, shared priority setting, integrated budgets and personnel (whenever possible), and bringing in decision makers from a variety of sectors who can contribute. Of course, such commitment requires prior relationship building and explicit agreements and processes that can be set into motion quickly when needed.

THE COASTAL RESILIENCE INDEX

As coastal storms outreach coordinator for the Mississippi-Alabama Sea Grant Consortium, Tracie Sempier helped to develop the Coastal Community Resilience Index,[3] which is a tool communities can use to examine how prepared they are for storms and storm recovery. The index can be used by community leaders to guide discussion about resilience to coastal hazards. The index outlines six domains of resilience—critical facilities, mitigation measures, business plans, transportation issues, community plans and agreement, and social systems.

In her remarks, she presented several ideas on how resilience-strengthening activities can also contribute to improving health and well-being. These ideas emerged from roundtables held in 47 communities across the Gulf to identify elements missing from a Coastal Community Resilience Index. These meetings explored critical issues related to the human impacts of disaster, including issues of how communities might be impacted by disasters, how to communicate the health and social risks of those disasters to the broader public, and how community organizations can help the public adopt mitigation or adaptation strategies, particularly given that the large effects of some changes in climate may show themselves only gradually.

A key opportunity to better align health and resilience is to bridge discussions of public health officials with those of city planners, floodplain managers, mayors, public works officials, businesses, and the non-profit sector, Sempier said. Those discussions "have not happened," she said, yet they can alert public and private officials to often neglected human factors, such as the need for hospitals, the availability of vaccinations and medications, psychological well-being, the prevention of standing water, and having an adequate and informed physical, mental, and behavioral health workforce.

As an example, she mentioned incentives to mitigate the impacts of flooding due to climate change. A floodplain manager may be very interested in storm water management from a drainage perspective, whereas a public health official may be interested in how standing water may affect the mosquito population. But those concerns cannot be connected if the people involved are not connected. "Connecting the dots from all these different audiences is extremely important," she said.

The roundtable conversations also underlined the importance of social infrastructure (including functioning businesses), informal support networks, and a diversified economy to health and resilience. Communities may have hazard mitigation plans, but these plans generally do not address the health and social impacts of acute or slow moving disasters. Community infrastructure asset mapping is important, said Sempier, as are exercising and practicing resilience, "which is not something that we're used to doing." Framing messages through a lens of social responsibility and sustainability can let everyone know that they have the responsibility to help mitigate disasters and promote self-sufficiency.

Communities can do a lot with surprisingly few resources, Sempier observed, when discussing opportunities for the Gulf Research Program. Small grants ranging from $50,000 to $150,000 to help communities take actions to address some of the less expensive vulnerabilities identified through the Coastal Community Resilience Index can achieve a lot, she said. The Gulf Research Program should also mobilize existing community assets such as emergency management, faith-based, ethnic, and business organizations to build capacity, she said. Finally, messages that are simple, reiterated, and tied to relevant community issues can spur action. "When I go into communities and talk about things like rising sea levels, for instance, [communities] really don't want me to tell them about every paper that was ever written on that topic; they just want to know the five most important things they need to do."

SEA GRANT AND THE GULF REGION'S FISHING COMMUNITIES

Fishing communities—whether recreational or commercial—in the Gulf region have been impacted by a series of disasters over the past decade, said Rex Caffey, professor of natural resource economics at Louisiana State University. The region was hit by a series of devastating hurricanes, including Katrina, Rita, Gustav, and Ike, followed by the 2010 *DWH* oil spill. In his remarks, Caffey highlighted the work of the Gulf region's Sea Grant program to help these communities recover quickly.

The National Sea Grant College Program is a nationwide network of colleges and universities that work on the conservation and use of U.S. coastal regions, whether along the Pacific, Atlantic, Gulf of Mexico, or

[3] See http://masgc.org/coastal-storms-program/resilience-index.

Great Lakes. The Sea Grant system parallels the land grant model of research, teaching, and extension in states with a coastline, but with an emphasis on commercial and recreational fishing communities rather than agriculture.[4] Louisiana Sea Grant has about 20 marine extension specialists and agents. About half of them are subject matter specialists in areas such as seafood technology, marine law, economics, and biology management. The other half is made up of agents who live and work in coastal communities. "They go to church with our stakeholders; they recreate with them; they become part of the community. Many of them have been in these communities for 30 or 40 years. There is an element of trust that we have through that network."

In the aftermath of Hurricanes Katrina and Rita, the Louisiana Sea Grant program helped form the Louisiana Fishing Recovery Coalition, which then served as a model for activities subsequent to Hurricanes Gustav and Ike. The goal of the coalition was to arrange for the different subsectors of the commercial and recreational fishing communities to begin communicating with each other. On a weekly basis, Sea Grant agents worked with coalition members, helping with damage assessments, making the case for damage recovery and fishery disaster assistance, and helping to allocate those dollars in equitable ways.

Acute events such as hurricanes and oil spills challenge the resilience of these communities, Caffey said, but chronic threats represent an even greater challenge, because they are "so insidious and long term." For example, Louisiana has lost approximately 1,900 square miles of land to the Gulf over the last century, which represents "an environmental threshold that is looming for a number of our resource-dependent communities." Another, less widely recognized threat is globalization, he said, which threatens the livelihoods of community members. To illustrate the vulnerability of many within natural resource-dependent communities, Caffey noted his work to track the extent of insurance coverage among businesses and individuals, which is a measure of who might be better able to mitigate risk and be more resilient to disasters. Among the charter boat industries in the shrimp sector, only 5 percent had any sort of insurance, whereas the recreation-for-hire sector has about 95 percent coverage.

Caffey identified two types of research that need to be continued and developed. Descriptive work needs to be done to identify baseline conditions and metrics for characteristics of communities that may make them more resilient or vulnerable to the economic, social, and environmental impacts of disasters. "The time to do this work is before a disaster," he said. The real challenge, however, is the other type of work, which is prescriptive—identifying what can be done to solve a problem. "One of the biggest things I've learned from extension work in 20 years is that if you go into a community, you need to have something to offer."

The people in Louisiana have meeting fatigue from being involved in many discussions about coastal restoration and responses to hurricanes, oil spills, and other disasters. But community involvement is essential, and when working with communities, he said, "more than speaking, people need to listen. Find out what [the community] needs and be responsible for those, versus a one-way communication." This is a huge challenge, but networks and organizations that are already embedded in communities throughout the Gulf, such as Sea Grant programs, will be important partners in this work.

LINKING SCIENCE AND CITIZENS

Gulf Coast communities have amazing capabilities upon which researchers and restoration project managers could draw, said Shirley Laska, professor emerita of sociology at the University of New Orleans. "Shrimp harvesters have an incredible ability to purchase and maintain their boats, to know how to use the GPS, to know where the fish are, to ride out a storm and survive it, and to protect their boat when there is a hurricane," she said. She continued,

> Offshore oil workers have abilities that are so well known for over a century that the state of Louisiana leads the world in terms of providing experts on oil extraction wherever you find it in the world.… The wives of these men have to run their households pretty much all by themselves because their spouses are away so much, and they know how to manage the finances, how to manage the children, and how to be part of extended networks in their families and friendship groups that give them great strengths. And isn't it amazing that Native American communities know how to respond in a storm, because their community is right on the water. They will put their shrimp boats together, take them out … and tie the boats together, and they'll put all their valuable items on those boats because they know how to be seamen, and how to keep those boats together while the storm comes.

Other groups that value a different type of educational experience and expertise tend to overlook these capabilities, Laska continued. Members of these groups, therefore, sometimes see these communities as needing help, even when these communities are capable of helping themselves.

An excellent example of a project that demonstrates this observation is the Sci-TEK Project in coastal Louisiana. Sci-TEK integrates traditional ecological

[4] Sea Grant concentrates effort in four interrelated focus areas to support the health and vitality of the nation's communities and coastal resources: Healthy Coastal Ecosystems; Sustainable Fisheries and Aquaculture; Resilient Communities and Economies; Environmental Literacy and Workforce Development. See http://seagrant.noaa.gov.

knowledge (TEK), often gained from years of on-the-ground experience, into restoration decision making. It builds relationships between scientists and local experts through reciprocal knowledge transfer. In one case, instead of scientists telling harvesters about restoration projects, scientists asked the harvesters for input into the project. "The harvesters were stunned," said Laska. "'You mean you're not going to tell us where to go, like most scientists do?' We said 'No, it's yours.' So when the day came for each one of them to be partnered with agency personnel and scientists, they came as if they were teachers with a game plan." Using their knowledge of how the study should be framed, the harvesters expanded the study area. "It was an amazing engagement between harvesters and agency representatives and scientists that led to conversations they have never had in a public meeting." This interaction built relationships relevant to future interactions.

The Sci-TEK researchers recorded their conversations with the harvesters, transcribed the recordings, and used that information to produce quantitative data about restoration activities. One result, according to Laska, was maps of where restoration projects should occur (Bethel et al., 2014). "For example, [the harvesters] said never put a restoration project in open water, because there's nothing for it to attach to."

"A similar respect for the incredible diversity of expertise that one finds in any community" can be found in the Prince William Sound Regional Citizen's Advisory Council, Laska said. For example, Stan Stevens, a founding member of the council, pushed for many years for a study of vapor control technology, because he was aware of concern in the local community about the issue. This is another example of linking "science and citizens," said Laska.

During the discussion period, Laska expressed the concern that the Gulf Research Program would overlook the field of human dimensions. "What mechanisms have you put in place to protect those disciplines?" she asked. Goldstein responded that the Program is planning to fund good ideas; if there are good ideas put forth those ideas will be funded. Moreover, the Institute of Medicine is part of the Gulf Research Program, which guarantees that human dimensions research will be considered. Linda McCauley, Emory University, added that the Gulf Research Program has stated its intention to fund cross-disciplinary ideas, which would include the social sciences.

LESSONS FROM THE PRINCE WILLIAM SOUND REGIONAL CITIZENS' ADVISORY COUNCIL

Joe Banta, senior project manager for the Prince William Sound Regional Citizens' Advisory Council, offered an overview of how the Council has contributed to the recovery of communities affected by oil spills. The Council was formed immediately after the *Exxon Valdez* spill by federal mandate through the Oil Pollution Act of 1990 as a permanent, industry-funded citizens' organization for overseeing both the oil shipping industry and its government regulators. One useful action taken by the council to support people in the Gulf following the 2010 *DWH* oil spill was creating a website, www.pwsrscac.info, for sharing documents and resources to help answer the many questions and information requests that poured in during the crisis.

The council gets its funding from the Alyeska Pipeline Service Company but with "no strings attached," Banta said; no company personnel sit on its board, although the council works with industry on its plans, permits, and operations and research. "We're an innovative concept, and what we get out of it is that equal standing with industry." The council's board includes a diverse array of community voices, including Native Alaskans from tiny villages, chamber of commerce representatives, and fishermen.

The organization conducts a broad variety of research, from toxicity of hydrocarbons and oil dispersants to operational issues such as hull corrosion and seismic engineering. One of its programs conducts long-term monitoring of environmental impacts. Other work includes community-based citizen science initiatives that monitor harmful invasive species such as European green crab and tunicates (sea squirts), which can hitch a ride into the region on the hulls or in the ballast water of oil tankers (PWSRCAC, 2014).

The *Exxon Valdez* oil spill was a huge driver of positive change in the oil industry, forcing very strong regulations that required it to develop oil spill contingency plans and response plans, Banta said. "The participation that we have with industry dealing with those plans on a day-in, day-out basis is incredible. Work groups, work processes, and meetings with them and with the regulators are pretty much a constant process for us."

The contingency plans include an ongoing nearshore fishing vessel response program that is relevant to the workshop's focus on community resilience and sustainability, Banta said. That program reflects a process that involves local people and provides them with a means to protect themselves and their livelihoods. When the *Exxon Valdez* accident happened, no formal plans were in place to include fishing vessels in any oil spill cleanup; the industry only had a temporary "vessel of opportunity" strategy to call in all available boats and put them through cleanup training. But under the contingency plans required by the state after the *Exxon Valdez* spill, the industry in Prince William Sound is required to annually train and drill hundreds of fishing vessels, and approximately 350 vessels participate. In the Prince William Sound region, "a big part of having a resilient community is having these people take care of themselves," and that is what the 350 vessels are doing, Banta said. Unfortunately, such an ongoing fishing vessel program with contracts and training was never developed after the *DWH* oil spill, he said.

In terms of community impacts planning, the council developed a manual, *Coping with Technological Disasters: A User Friendly Guidebook*, which is a resource for what to expect and how to prepare for disasters that can affect a community or small business (PWSRCAC, 2004). The guidebook was a source of guidance during the Gulf oil spill. Several community and academic program leaders, for example, adopted its peer listener training program.

Leanne Truehart, from the National Alliance on Mental Illness, commented during the discussion that she liked the idea of the peer listener training program, because "nowhere in there does it say psychiatrist, therapist, [or] mental health." The stigma of mental illness prevents many people from seeking help, and addressing that barrier should be part of the ongoing discussion, she said. A peer listener program could quickly be put into place during a disaster as a preventative intervention, as opposed to doing nothing and watching the suicide rate go up 18–24 months later, Truehart said, which is what happened in her community and has occurred in other parts of the world following disasters.

Another workshop participant asked how the concept of the Prince William Sound Regional Citizens' Advisory Council might translate to the Gulf region, which spans five states that are frequently in competition. Banta replied that members of the council's diverse board do "mix it up," but once the organization was formed, they worked well together for the common mission. Creating such a group does, however, take political will—and a source of funding, he said.

A major strength of the citizens' council is that it is funded and has a paid staff, but it also has a diverse community-based board that directs the staff, he noted. In this way, the community can drive research that it would like to see done and is not getting done otherwise. For instance, when the shrimp fishery reopened in Port Valdez after the oil spill, where oil tankers discharge ballast water at the marine terminal, people wanted to know if the shrimp had any hydrocarbons in them, "so we did that study," Banta said. The study concluded that hydrocarbon tainting of shrimp muscle is not a concern for the shrimp fishery in Port Valdez and observed concentrations do not pose a human health risk. However, PAH accumulation in some shrimp eggs may potentially impair development.

BREAKOUT DISCUSSION SUMMARY

Summarized below are responses generated by two breakout discussion groups charged with developing suggestions for (1) education and training activities to improve community preparedness, recovery, and resilience and (2) how to effectively engage and benefit communities.

Breakout question: What types of collaborative, educational, or training activities could significantly enhance current efforts to improve how Gulf communities anticipate, prepare for, and recover from disasters and environmental change?

As a summary of the breakout discussion, Steven Picou, University of South Alabama, presented the list, below, to all workshop participants. This list summarizes items suggested by individual and multiple participants during the breakout discussion and should not be seen as the consensus recommendations of the workshop participants; nor are they necessarily actions that the Gulf Research Program should undertake:

- **Improve understanding of the science of science communication.** How can research results be delivered at the community level, so that communities are informed and can make decisions to manage risks? What is the effectiveness of various communication methods to reach different communities (e.g., at-risk communities have a variety of language, financial, cultural issues that complicate communications)?
- **Support educational programs about the developing science of recovery and resiliency.**
- **Support programs that bring community organizations, public health and environmental monitoring communities together to improve communications about the links between the "health" of coastal ecosystems and human health.** These communities could be better integrated through education/training or collaboration opportunities that support learning together, and the growth of trusted relationships and networks.
- **Support the development of a new learning community (beyond the familiar fellowship and K–12 models).** Think about educating new and different target audiences in the community, such as public health providers and practitioners, community groups, science first responders (those that can be deployed quickly to do work within communities). Include research to better understand effective network formation.
- **Support longitudinal work to track outcomes and behavior changes in response to education and training.** For example:
  - o Tracking outcomes of students selected for Gulf Research Program fellowships.
  - o Longitudinal study that begins by working with STEM faculty in academia to refine curricula for the education majors they teach and assesses pre-service teacher training and effects on students.
- **Link education and training programs with research funding.** (e.g., NIEHS GEO-Health program at the Fogarty International Center).
- **Plan for sustainability of these programs.** Must have buy-in from communities, and educational institutions, as well as long-term funding to keep effective programs going.

Breakout question: How can the Gulf Research Program ensure that its activities effectively engage and benefit communities? And, how can the Gulf Research Program extend the benefits of resilience building activities to other coastal communities affected by oil and gas production?

As a summary of the breakout discussion, Linda McCauley, Emory University, presented the list, below, to all workshop participants. This list summarizes items suggested by individual and multiple participants during the breakout discussion and should not be seen as the consensus recommendations of the workshop participants; nor are they necessarily actions that the Gulf Research Program should undertake:

Trust is critical to successful community engagement and is built through long-term interactions. The Gulf Research Program could explore new models for funding that brings together traditional academic universities, communities, and community-based organizations in new ways to support community-focused and innovative research. For example:

- **Requests for applications (RFA) could specify community engagement as a requirement.**
- **Proposals could include the demonstration of existing working relationships or allow time for building new relationships.** In the latter case, the proposals and funding could be stepwise: (1) identify and establish relationships; (2) work together to design protocols; (3) collect data; (4) communicate research results to community; and (5) additional funding could help communities use research findings to implement change.
- **RFAs could be designed to attract community-based organizations that would then select an academic partner.** Training programs could be developed by community organizations to help educate researchers about a community's culture, values, and interests.
- **Funding could support a coalition, rather than an academic institution, perhaps around baseline data collection and monitoring.** For example, RFAs could ask applicants to develop strategies for involving scientists and citizens to work together to develop baseline data. Programs could also train citizens, agency personnel, and others in standardized methods for collecting baseline data, so that when a disaster occurs, citizens and agencies are ready to work together to understand impacts.
- **Activities could support community ownership and longevity of data:** RFAs could promote longevity of data by providing funding for data visualization and iterative meetings with community members so that the presentation and interpretation of data become intuitive to the community. Researchers should also return collected data back to the community.
- **RFAs could include mechanisms to promote accountability of researchers and community members, the equitable and functional distribution of resources, and to incentivize community involvement.** Universities often interpret requirements differently and projects often do not truly involve communities. Community members and organizations should be compensated appropriately for their time.
- **Funding to support leadership development activities for community partners** so communities can be a driving force for identifying research questions, obtaining grants, reaching out to the community, and disseminating information.
- **Consideration of proposals with lessons learned that are transferable to other coastal or even inland communities.** For example: How to quantify personal exposure to chemical mixtures. In general, research looks at community-level exposures to single contaminants. Potential research to benefit communities;

o Look at the individual level as well as the community level
o Understand impacts of contaminants on humans (too often limited to just understanding the contaminant, not its effects in humans)
o Extend beyond looking at "one chemical at a time" to multiple exposures
o Include understanding of personal risk/susceptibility. Look at the susceptibility of individuals, and extrapolate from there the way that the community should respond. A community response might not be defensible if only a minute portion of the population is truly at risk.

6

Capacity to Address Environmental Health Risks

BOX 6-1 Points Highlighted by Individual Speakers

- Understanding the health and connectivity of ecosystems requires knowledge about sustainable practices on land and at sea, which encompass everything from inland agricultural practices to resource extraction to transportation (Dickey).
- The absence of baseline health and environmental information limits researchers' abilities to assess the impacts of environmental stressors and the thresholds for harm (Dickey).
- High levels of uncertainty and concern remain among Gulf coast citizens about the impacts of the oil spill on the health of Gulf ecosystems (Kane).
- Communities can be engaged with the scientific process and are one of a researcher's most valuable assets (Kane).
- State health agencies need better access to good, local data and expertise during disasters; reliable and realistic regional exposure data are often lacking (Brackin).
- Risk communication and applied risk assessment training for Gulf States health departments could enhance capacity to respond to environmental health threats (Brackin).
- Inexpensive sampling technologies could provide a more comprehensive (across space and time) and holistic (air, water, individuals) view of exposure to toxic substances (Anderson).
- New environmental sampling technologies could help communities to respond to environmental disasters (Anderson).
- Studies that have been done by several National Institutes of Health (NIH) institutes could serve as platforms for future human health and toxicology research (Miller).
- Public health is often relegated to the sidelines during responses to disasters. The inclusion of a public health coordinator into the incident command structure could help mitigate health concerns during disaster responses (Walker).

Several speakers at the workshop examined specific ideas for improving capacity to detect, assess, and manage environmental health risks along the Gulf Coast. The presentations summarized in this chapter reflect the experiences of researchers, health agencies, and communities. Presenters suggested potential opportunities to address persistent and acute environmental health threats and to develop capacity to better respond to environmental health threats associated with disasters. Presenters also offered suggestions for improving communication about environmental health risks among residents, policy makers, and researchers.

SENTINEL SYSTEM FOR ECOSYSTEM AND HUMAN HEALTH

By supporting the development of an integrated understanding of the health and connectivity of human and natural ecosystems—from watershed to coastal oceans—the Gulf Research Program could significantly contribute to coastal health and sustainability over the long term, said Robert Dickey, director of the University of Texas Marine Science Institute. Defining and communicating interdependencies and their influence on human health, ecosystem dynamics, services, and societal well-being is a "very tall order." It requires understanding what sustainable practices are on land, at sea, and along the coast, which encompasses everything from inland agricultural practices to resource extraction to transportation on coastal oceans and inland waterways.

In his previous position as director of the U.S. Food and Drug Administration Gulf Coast Seafood Laboratory in Dauphin Island, Alabama, one recognized challenge was identifying and assessing stressors and the thresholds for harm in aquatic ecosystems, whether acute, chronic, or episodic. Chronic stressors (e.g., ex-

cessive nutrients, sediments, toxins, and pathogens) are often introduced far inland and transit through the watershed to the coastal oceans, making them particularly challenging to trace and characterize, said Dickey. A potential role for the Gulf Research Program is to couple assessments of the "health" of coastal oceans and communities with research to identify upstream inputs and impacts on coastal resources and communities.

A system for assessing baseline health of a community and surrounding ecosystems is essential, he said, "Otherwise, you're not going to be able to detect any differences." As an example of such a monitoring activity, Dickey described the Mussel Watch program, which has been monitoring more than 100 different contaminants in shellfish since its establishment in 1986.[1] This has been an extremely valuable program, said Dickey, because it has produced a searchable archive of data that can be "mined" to determine the burden and potential impact of environmental stressors on ecosystems and human health. This program could be expanded to include different sentinel species up and down the food chain, which would provide a much better understanding of the contaminant burden in our coastal oceans and what that might mean for basal human health in coastal communities (e.g., as determined through state and federal programs such as the National Health and Nutrition Examination Survey). The Mussel Watch program is a good model to think about, Dickey said, because it supports research that links the environment with human health concerns. A similarly integrated system that considers the complete life cycle of environmental health threats in the Gulf region could provide information that can guide wise decision making, Dickey concluded.

[1] The NOAA Mussel Watch project analyzes "chemical and biological contaminant trends in sediments and bivalve tissues." It is the longest running continuous contaminant monitoring program in U.S. coastal and Great Lakes waters, quantifying contaminants such as PAHs, PCBs, DDTs and its metabolites, chlorinated pesticides, and heavy metals. See http://ccma.nos.noaa.gov/about/coast/nsandt/musselwatch.aspx.

UNIVERSITY–COMMUNITY PARTNERSHIPS AND SEAFOOD SAFETY

As part of the NIEHS-supported *Deepwater Horizon* Research Consortia, Andrew Kane, associate professor of Environmental and Global Health in the College of Public Health and Health Professions at the University of Florida, has been working on a multidisciplinary program to address seafood safety concerns that have been identified by communities along the northern Gulf coast. Meeting community needs requires coupling community expertise and assets with science, he said. In his work he has found that communities can be engaged with the scientific process and are one of a researcher's most valuable assets in this type of applied research.

Kane noted that high levels of uncertainty and concern remained among many people in the Gulf region about impacts of the oil spill on the health of Gulf ecosystems (Figure 6-1). With respect to seafood safety,

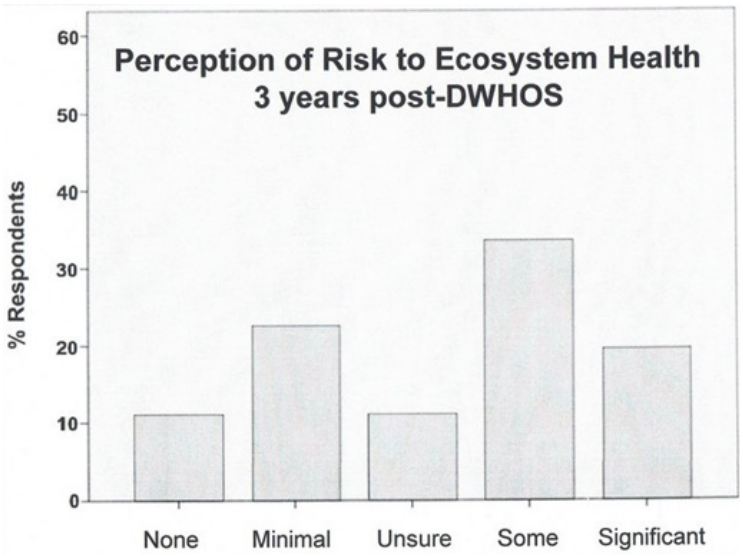

FIGURE 6-1 Environmental health perception data from the Healthy Gulf Healthy Communities project through the University of Florida. Many citizens living along the Gulf coast still perceive notable levels of risk to ecosystem health 3 years after the *Deepwater Horizon* oil spill. Data from more than 300 Gulf coast study participants surveyed about their perception of Gulf ecosystem health and well-being 3 years after the oil spill (differentiated from human health outcomes associated with the spill). SOURCE: Presented by Andy Kane on September 24, 2014.

communities identified concerns centered on what seafood was (and was not) tested by FDA and NOAA during and after the spill, and on the use of national levels of seafood consumption to assess risk. This was especially true for fishing communities, who can eat "a lot more [seafood] than the national average." A goal of Kane's work is to develop seafood consumption risk assessments—in partnership with communities—that are tailored to the people and practices of Gulf communities. The project includes analytical toxicology of self-caught, inshore seafood and the collection of data to assess seafood consumption patterns for multiple Gulf communities. "To date, all seafood samples tested have had levels of polycyclic aromatic hydrocarbons (PAHs) near or below levels of detection for the majority of samples," Kane said, "and all of the samples have been well below the FDA's levels of concern." "This information needs to be effectively disseminated," Kane said. "Effective risk communication underscores the difference between people knowing certain outcomes and *believing* them, and is key to potentially changing the way people think and behave."

Community members tend to trust academics more than they do people from other sectors, such as the government and media, Kane said. "Researchers thus have an opportunity and a responsibility to work with communities to make a difference." "To make it work, the bottom line is that we need to be part of the community," he said. "We can't respond to what we want to do … It's a question of listening carefully and responding to what communities need. Can we really meet some of those needs? And then how do we go about doing it?" To move quickly in a disaster, personal and professional connections need to be in place, said Kane. "What we've learned is that the organization and structure of different communities are different, and those differences matter when communicating and disseminating information. Developing dialogue and trusted partnerships in advance is essential. There's ownership and responsibility and a sense of organization that can be counted on with existing relationships."

PUBLIC HEALTH DEPARTMENT NEEDS AND OPPORTUNITES

The organizational structures of public health departments can vary by state or even by county or city, but they all have certain basic goals when it comes to environmental health threats associated with disasters, said Bruce Brackin, a consulting environmental epidemiologist at the Mississippi State Department of Health.

Before disasters, the most important thing health departments can do is to make sure that critical infrastructure is "hardened" to withstand disasters, he said. Developing systems that ensure the availability of safe water and safe sewage disposal, for example, have significantly reduced health risks related to water contamination following hurricanes, he said.

Another basic goal is to develop a workforce that is able to work effectively during disasters, Brackin noted. Many public health workers are getting older, and there has not been an influx of younger people taking their places. "That's disconcerting," said Brackin. Informal training will be needed to transfer what has been learned from real-life experiences, he said. Just knowing how to manage and talk to people during disasters is important, he said. Common risk communication and applied risk assessment training for health department staff across the Gulf States would be ideal, perhaps working through the Association of State and Territorial Health Organizations or other umbrella groups.

Getting good, clear information out quickly during disasters is another important goal of health departments, said Brackin. One lesson from the *Deepwater Horizon* (*DWH*) oil spill is that if relevant information is not available quickly for health departments and others to communicate to the public, information from other sources will rush in to fill the vacuum. This was the case for dispersants and for seafood safety, he said. While state epidemiologists and others are developing risk assessments "on-the fly, in a hurry, and in high-stress environments," they need better access to good, local data and expertise, he said. They also need the formulated risk and public health messages released. Getting this type of pertinent information out can be difficult in large, multiagency incident command systems.

Public health departments are reliant upon research findings to make decisions and to communicate with the public during disasters. In general, health departments do not get involved in the conduct of basic research, but, because they are consumers of research, they can provide an important perspective on key research needs. One example is reliable and realistic exposure data are often lacking, particularly on a regional basis. This was the case during the *DWH* oil spill and the public health community's need for seafood consumption data to respond to duration of exposure questions. Public health departments are willing partners in this work, he said.

DETECTING AND UNDERSTANDING EXPOSURES

Understanding the human and ecosystem effects of disasters requires understanding exposure, observed Kim Anderson, professor in the Department of Environmental and Molecular Toxicology and director of the Food Safety and Environmental Stewardship program at Oregon State University. However, as evidenced by the

DWH oil spill[2]—which resulted in potential exposures to components of crude oil, such as PAHs, and to chemicals in the dispersants used to clean up the spill—understanding exposures during an environmental disaster is a complex problem (Allan et al., 2012; Kujawinski et al., 2011; Reddy et al., 2011; Tidwell et al., 2015).

In general, all of the chemicals to which people may be exposed following an environmental disaster are often not known at the time of the disaster. Thus, developing detection technologies that do not require advance knowledge of specific chemicals of concern will be critical, Anderson said. There are technologies that currently exist, including sensors and media that can be used to sample a wide variety of chemicals from the water, the air, and individuals, she said, and research is needed to further develop these technologies. Passive sampling devices are one such technological platform that could address some of these issues. Passive sampling devices sequester compounds through passive diffusion, in a time-integrated manner. Water and air passive samplers sequester the water dissolved fraction and air vapor respectively each strongly associated with the bioavailable fraction. Passive samplers are applicable to a wide range of chemicals. The passive sampling technology also may be applied to individuals through the use of simple, lightweight silicone wristbands (O'Connell et al., 2014). Opportunities for sensor technology include other low-cost options that can be deployed on wide temporal and spatial scales, and where the sensors can be stably archived for future use as the spill evolves.

In developing these technologies, it is important to keep in mind what types of information is most helpful in assessing the effects of exposure, she said. For example, bioavailability[3] of chemicals is a critical factor, because in order for a chemical to have an effect, it must get into an organism. The bioavailability of chemicals in oil changes as those chemicals "weather" due to exposure to heat, light, and other environmental processes, she said. Technology that can sufficiently sample the bioavailable fraction is especially valuable because this fraction provides a better way to assess the potential health effects of exposure. The bioavailable fraction, as collected by passive samplers, has been shown to be a good predictor of toxicity (and the lack of toxicity) (Ghosh et al., 2013).

Technologies that take bioavailability into account would also lessen the need to collect biotic samples, such as mussels or other organisms. During environmental disasters, "We already have a situation that puts pressures on organisms—and then we are going to go in and collect more organisms," Anderson said. Baseline data from curated archived samples can be essential to know what has changed after an event. It is noteworthy that many communities have identified a lack of *local and neighborhood specific* sampling and chemical information surrounding disasters, specifically predisaster baseline chemical hazards information. An available sampling platform that allows for informed communities to build their vision of response and recovery will contribute to their health, well-being, and resilience.

Finally, new and inexpensive technologies could support adequate spatial and temporal coverage during an event. Anderson described the "tendrils of oil" that she witnessed during the Gulf oil spill, that would impact some coastal areas but leave adjacent areas untouched. Technologies that can provide a more comprehensive view—over space and time—and technologies that provide a more holistic view across air, water, and individuals are needed, she said.

Another important opportunity for the Gulf Research Program is to encourage the integration of new and developing detection technologies into communities so they are ready to use them when a disaster occurs. "We have fire stations around the country that are equipped with various equipment to respond to emergencies, but we don't equip communities to deal with environmental disasters when it comes to environmental sampling," Anderson pointed out. The Gulf Research Program could support activities to help integrate these tools into communities. She asked, "What are the tools that communities could use when a disaster occurs? And, what is the training they need to use those tools effectively?"

NIH GULF OIL SPILL AND DISASTER RESEARCH RESPONSE

NIH has developed several important programs to address some of the key needs and research questions emerging from the *Deepwater Horizon* oil spill—from training programs for oil spill cleanup workers, to intramural and extramural research on toxicology, health effects, and resilience. Aubrey Miller, senior medical advisor to the director at the NIEHS, provided an overview of these activities and identified some potential opportunities for the Gulf Research Program.

The intramural Gulf Long-term Follow-up Study[4] (GuLF STUDY)[5] is a prospective study of almost 33,000 adults that were involved in cleanup or support activi-

[2] Crude oil is composed of many chemicals including alkanes, cycloalkanes, PAHs, as well as other substituted PAHs. Weathering of the oil mixture generates additional chemicals of concern like oxygenated PAHs. Products used for cleanup are generally composed of a mixture of chemicals, for example dispersants.

[3] Bioavailable chemicals are able to penetrate permeable tissues of an organism. See http://superfund.oregonstate.edu/oilspillglossary.

[4] For more information See https://gulfstudy.nih.gov/en/index.html.

[5] See https://gulfstudy.nih.gov/en/index.html.

ties during the *DWH* oil spill. The project has involved baseline telephone interviews to capture information about job duties, symptoms, and health status, followed by an in-home clinical assessment and biospecimen collection (i.e., blood, urine, toenails, hair) for more than 11,000 people. In addition, the project is now starting a more comprehensive clinical examination of up to 4,000 workers that previously participated in the in-home clinical assessment, and are currently living in Alabama and Louisiana. The GuLF STUDY intends to follow study participants for 10 or more years through follow-up telephone interviews, clinical assessments of identified subgroups, and links to vital records and cancer registries.

The *Deepwater Horizon* Research Consortia[6] is a 5-year, $25.2 million program funded by eight NIH institutes. The Consortia, which ends in 2015, supports the work of four university–community partnerships in the Gulf region to address issues and concerns identified in concert with impacted communities. Projects are focused on women and children, pregnant women, cultural and ethnic minorities, and seafood safety. Approximately 45 community-based partners throughout the Gulf have been involved with the consortia, which offers multiple opportunities for leveraging activities and creating networks for research (Box 6-2).

Additionally, the Substance Abuse and Mental Health Services Administration (SAMHSA) has collaborated with NIEHS and provided funding to expand longitudinal research involving the mental health impacts and risk factors of resiliency among participants involved in the GuLF STUDY and Consortia, as well as the development and assessment of new resiliency training materials (NIEHS Worker Education and Training Program). The goal of this training program is to prepare

[6] See http://www.niehs.nih.gov/esearch/supported/dert/programs/gulfconsortium/index.cfm.

BOX 6-2 *Deepwater Horizon* Research Consortia

5-year $25.2 M Program

Four university/community partnerships
- Tulane University
- Louisiana State University
- University of Florida
- University of Texas Medical Branch

Steering Group Leadership
- Includes GuLF STUDY
- Input from (NTP) National Toxicology Program

Distinct populations & foci
- Women and children
- Pregnant women
- Cultural/ethnic minorities
- Seafood safety

Shared approaches
- Seafood
- Resiliency
- Population studies
- Community outreach & dissemination

> 45 Community Partners (Louisiana, Alabama, Mississippi, Florida)

Mary Queen of Vietnam Community Development Corporation
Louisiana Public Health Institute
Bayou Interfaith Shared Community Org
Assoc. of Occupational & Environmental Clinics
WIC clinics
South East Louisiana Community Coalition
United Houma Nation
Advocacy Center of Louisiana
Catholic Charities – Spirit of Hope
Episcopal Community Services
Louisiana Language Access Coalition
Latino Forum
McFarland Institute
Crescent Regional Collaborative Problem Solving Coalition
Stuart H. Smith Law Clinic & Center for Social Justice
Alabama Seafood Association
Alabama Department of Public Health
South Bay Communities Alliance of Alabama

Center for Environmental and Economic Justice
Mississippi Coalition for Vietnamese-American Fisherfolk & Families
MS Interfaith Disaster Task Force
Cedar Key Aquaculture Association
Citizens Against Toxic Exposure
Be Ready Alliance Coordinating for Emergencies
Families Count
United Way of Escambia
Catholic Charities, NE Florida
Community Resource Associates
Emerald Coast Counseling
Florida Asset Building Coalition
Florida Division of Children and Families
Island Fresh Seafood
RAISE Florida Network – War on Poverty
SAFER: Support Alliance for Emergency Readiness
Franklin's Promise Coalition
Steinhatchee River Chamber of Commerce
Florida Center for Prevention Research
Wakulla County Coalition for Youth

Funding: NIEHS, NCI, NHLBI, NIMH, NIMHD, NINR, NCATS, OBSSR

SOURCE: Presented by Aubrey Miller on September 24, 2014. Credit: Symma Finn, PhD, Division of Extramural Research and Training, NIEHS, 2014.

disaster workers to recognize the signs and symptoms of disaster work-related stress and trauma, avoid post-traumatic stress disorder, make use of organizational and community support resources, and build resilience.

The NIEHS National Toxicology Program (NTP) identified improved characterization of exposure and toxicity of PAHs as a high-priority research topic and is developing a PAH research program to address multiple knowledge gaps and inform the cumulative risk assessment process. The primary aim of the PAH research program is to characterize the toxicity of a broad range of individual PAHs, defined PAH mixtures, and complex environmental mixtures containing PAHs.

Miller identified several needs and opportunities for improving the detection, assessment, and management of environmental risks from disasters. One opportunity is to use NIH studies as resources and platforms for future human health and toxicology research. "[Research conducted] in the 4 years since the spill should not be lost," he said. Newly created cohorts and biomarker repositories are important resources for long-term studies of health, vulnerability, and resilience. Additionally, what do we know about background ambient exposures in Gulf communities? he asked. There are many industries in the Gulf region, including the petrochemical industry that could help in evaluating baseline environmental levels of various substances of concern. Ongoing and new research studies could also help to establish health baselines for different communities. Additionally, it would be especially helpful in understanding baselines if there were biobanking of novel tissues such as placentas, breast milk, and cord blood, with the understanding that sound privacy protocols need to be in place for donors.

Another opportunity is to improve understanding of resilience and vulnerability both at a community and individual level, Miller said. What do we mean by resilience? What metrics can we use to measure resilience, and how can we combine them with socioeconomic and environmental risk factors to reveal the impact of multiple stressors? What biomarkers can we use to study resilience? And how can we integrate this information to develop interventions to promote resilience?

Miller also outlined the need for exposure and toxicology research. He said that an improved understanding of petroleum exposures is needed. "What are the different chemical profiles for different crude oils, and how do these profiles change as oil weathers and degrades?" Research regarding relevant ambient exposures to chemicals mixtures, including PAHs, across Gulf Coast communities is currently lacking. "We also need to better understand the toxicology of oils, the mixtures, and the dispersants, as well as other relevant environmental exposures that come into play," he said.

Uncertainty and the lack of information often undermine the credibility of government programs, Miller observed. In response, NIH has created the Disaster Research Response (DR2) Project[7] to accelerate the development of needed infrastructure as part of a larger effort in the Department of Health and Human Services. The goal, said Miller, is to create opportunities for the more rapid collection of timely health and environmental data across the Gulf, and other areas across the country in response to disasters or other emerging threats. Currently, the DR2 project is focusing on the development of a publically accessible database of environmental health data collection tools, clinical protocols, forms, and guidance, and a national resource of trained EHS disaster "research responders." This effort seeks to involve federal, state, and local officials, academia, responders, and community stakeholders in helping to perform critical health research during disasters and other emergencies. "We need good exposure characterization and a better understanding of the health effects," he said, "and we must be able to capture these quickly and simultaneously."

Looking forward, Miller said that the Gulf Research Program has many opportunities to improve understanding and communication about environmental health risks related to disasters. Activities to enhance the environmental health literacy[8] of NGOs, community residents, healthcare workers, and policy makers are needed, he said, as are programs that enhance community understanding and capacity for evaluating the impacts of future disasters. The Gulf Research Program could also evaluate the effectiveness of existing training materials and programs and conduct research to inform the development of capacity to collect robust and representative health and exposure data in a timely fashion. For all of these activities, the Gulf Research Program can leverage ongoing and established community engagement and outreach activities, such as those supported by NIEHS and GRHOP, Miller said.

CONNECTING OIL SPILL RESPONDERS TO COMMUNITIES AND RESEARCHERS

The Oil Pollution Act of 1990 (OPA 90) established research as a prohibited response expense under the Oil Spill Liability Trust Fund[9] (OSLTF), noted Ann Hay-

[7] See For more information see: http://sis.nlm.nih.gov/dimrc/dr2/disasterresearch.html.

[8] See http://www.niehs.nih.gov/research/supported/dert/programs/peph/webinars/health_literacy/.

[9] The OSLTF has two major components: the Emergency Fund is available for Federal On-Scene Coordinators (FOSCs) to respond to discharges and for federal trustees to initiate natural resource damage assessments. The Emergency Fund is a recurring $50 million available to the President annually. The remaining Principal Fund balance is used to pay claims and

ward Walker, president of SEA Consulting Group. As a result, the U.S. Coast Guard, which administers the fund, cannot authorize funding for research during a spill response or address research related to community resilience and health opportunities through existing oil spill funding mechanisms. The Gulf Research Program, thus represents a "rare and unique opportunity," to advance scientific research and coordination activities that could fill public and community health research gaps and improve decision making for oil spill preparedness and response, said Walker,.

Walker provided several suggestions for activities that the Gulf Research Program could undertake. First and most important, she said, "Connections with the U.S. framework for oil spill preparedness and response are essential to achieve the goal of promoting oil spill-related community health and resilience." As noted by Cheong (2012), a key component of building community resilience is to raise the capacity of communities to adapt following a significant oil spill, and this requires the transfer of resources and knowledge from the response organization to the community. The transfer of knowledge and resources shifts emphasis from self-reliance and encourages collaboration with oil spill experts, which is a necessary component of adaptive resilience.

Walker encouraged public health researchers to be aware of some oil spill research relevant to public health, community resilience, and risk communications. OPA 90 established the Interagency Coordinating Committee for Oil Pollution Research (ICCOPR),[10] which produces the federal government's Oil Pollution Research and Technology Plan. ICCOPR was established to

> coordinate a comprehensive program of oil pollution research, technology development, and demonstration among the federal agencies, in cooperation and coordination with industry, universities, research institutions, state governments, and other nations, as appropriate, and shall foster cost-effective research mechanisms, including the joint funding of the research.

In addition, a European Union project has produced community engagement guidance for oil and hazardous substance spills,[11] and NOAA has supported a project[12] on dispersant risk communications (Bostrom et al., 2015; Walker et al., 2015). Experience with other spills can provide insights into community relations and the use of social media.

To connect with the oil spill community, actions need to be identified that could be taken during a spill to protect human health and mitigate impacts on human health, including the psychosocial impacts on individuals and communities, Walker said. "During a response to an oil spill, rapid and complex decisions are being made inside the command post to reduce risk. There are advantages and disadvantages to almost every choice that has to be made."

Research to inform such decisions is extremely valuable, she said. Walker agreed that interdisciplinary research and research syntheses are essential to address and manage risk perception about oil spills. "I also see a need for synthesizing and applying research from multiple natural, social, and decision sciences," she added. "Take, for example, the highly complex issue of managing seafood safety during an oil spill." Finned fish can swim away from a spill, but shellfish cannot. "To be conservative, fisheries are usually closed, which begins a terrible cycle of scientific dilemmas, marketing challenges, and socioeconomic and psychosocial impacts on fisher folk, which, as you know, can take years to resolve."

She also pointed to several needs and opportunities to improve the detection, assessment, and management of environmental health risks associated with disasters. Specific actions are rapid seafood safety monitoring studies, studies to inform decision making about trade-offs, and health studies and prespill component analyses of chemical countermeasures such as dispersants.

Walker emphasized the need to integrate public health officials and community considerations into the incident command system (ICS) during responses to technological disasters like the *DWH* incident. Analyses of previous responses have shown that public health issues receive less attention than the environment because the regulatory driver in oil spill response is mitigating environmental pollution and associated impacts, and because there is little opportunity for the public to be directly exposed to oil spill hazards. She proposed a model for the integration of public health into disaster responses that includes a public health coordinator as part of the command staff, which would enable broad influence throughout the response (Figure 6-2). The inclusion of a public health coordinator under a unified command would also help integrate public health into a community's disaster responses. Figure 6-2 highlights in blue the areas of functional coordination within the ICS to support improved communications with an affected community about potential public health and environmental risks.

to fund appropriations by Congress to federal agencies to administer the provisions of OPA and support research and development by federal agencies, such as the Bureau of Environmental Safety and Enforcement. See http://www.uscg.mil/npfc/About_NPFC/osltf.asp and http://www.bsee.gov/Technology-and-Research/Oil-Spill-Response-Research/index.

[10] See http://www.uscg.mil/iccopr.

[11] See http://www.arcopol.eu/?/=/section/resources/sub/r_hns/pag/1/resource/147.

[12] See http://www.crrc.unh.edu/center-funded-projects#Dispersant_Initiative_Projects.

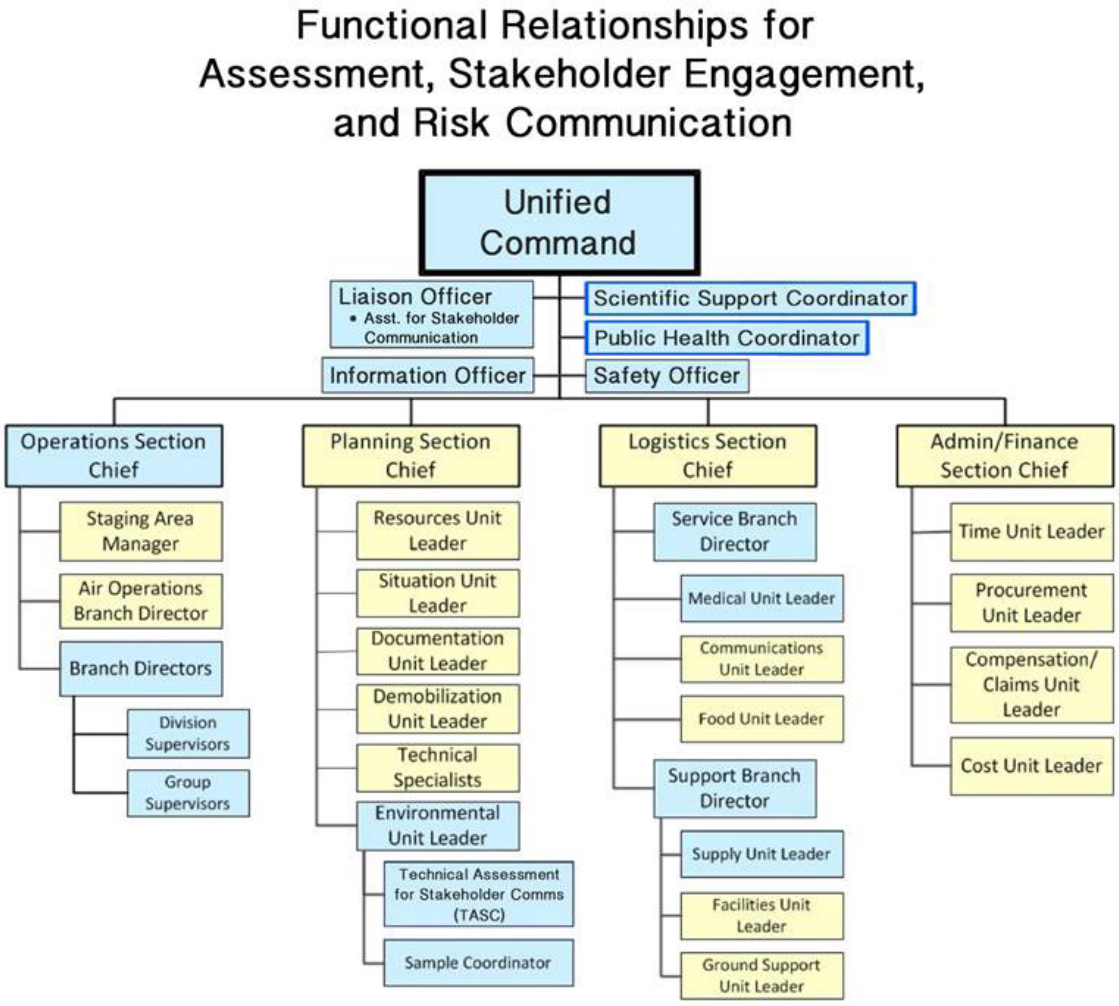

FIGURE 6-2 Example model for integrating public health concerns and communities in the incident command system during response. SOURCE: Walker et al., 2014. Presented by Anne Hayward Walker on September 24, 2014.

RISK COMMUNICATIONS

The remarks of the presenters on risk communications inspired an extended discussion among workshop participants.

Robert Dickey, director of the University of Texas Marine Science Institute, pointed to the need to have a trained cadre of risk communicators and community spokespeople available to translate information into understandable language. "You don't send a practicing analytical chemist to communicate with the general public," he said. Risk communicators tailor their messages to their audiences, relay appropriate information, and build trust. In addition, a cadre of very dedicated and passionate educators can get the word out to the public, some of whom also are specialized in bringing civic leaders up to speed on environmental risk assessments and community planning needs. This applies not only to chemical hazards but other hazards as well.

Andrew Kane from the University of Florida emphasized the need for coordinated outreach efforts. Communities are different, which means that messages need to be crafted with care. "That is often times done with community partners to understand the best ways to get the messages across." He also noted that scientists bring a great deal of credibility to communications and outreach. "Science in a vacuum is meaningless," Kane said. "Experts with insights and experience in the community can provide immeasurable cohesiveness as part of an effective communications team."

Risk communications training for scientists can help them fill this role, said Michael Blum of the Tulane/Xavier Center for Bioenvironmental Research. This training could be linked with a regional center to provide opportunities for researchers, policy makers, and community members to interact and learn, together, about environmental health issues. Academics often speak a different language than do people in communities or policy makers,

observed Kristina Peterson of the Lowland Center. As a result, community members often need to learn a new language, which communications training for academics could help overcome.

Aubrey Miller, NIEHS, pointed out that trusted sources need to be identified early, such as clergy or community leaders. If they can be brought up to speed on environmental health issues, they in turn could greatly help to improve communications with affected communities. Ann Hayward Walker of SEA Consulting Group pointed to the need for oil spill literacy, which is a measure of a person's ability to understand oil spill risks and information and make informed choices about what to believe or do with that information, at all levels—including the federal government and academic communities. Another need is for communicating uncertainty in the face of incomplete information, which is the case for every spill situation especially at the outset of an incident, she said. However, several speakers reminded the workshop about the complications involved in risk communications. As Bernard Goldstein, University of Pittsburgh, pointed out, messages are not necessarily reviewed by experts in risk communication but are controlled by people who may want to withhold information, "and you have to fight very hard to get information out, that's my personal experience." Engaging outside experts as early as possible can be a way to increase transparency and avoid this problem, he said. Similarly, Steven Picou, University of South Alabama, pointed out that litigation can be a complicating factor for risk communication. Messages tend to be reviewed by attorneys before they are communicated, and both litigation and the courts can become involved after massive catastrophes.

USING SOCIAL MEDIA DURING DISASTERS

One prominent topic of discussion was the evolving role of social media in communicating and working with communities during disasters. Aubrey Miller of NIEHS noted that the Red Cross has been using more social media to help provide situational awareness during disasters to help with their response. He also noted that after a recent chemical spill into the Elk River in West Virginia, which contaminated drinking water for 300,000 people, the information getting out on social media did not necessarily correspond with government information. It is important to understand that information is now widely available to the public, and we need to be very cognizant of this in order to have credible risk communications and to effectively address an increasingly well-informed audience, he said.

"That's an ongoing difficulty for pretty much any agency that uses social media," replied Angela Grajeda of the American Red Cross. Organizations would like to have control over information to ensure it is accurate, yet they have to figure out how to do that "without it looking censored." Part of the answer is open communication behind the scenes, she said. Even though the Red Cross has open sites and shares a lot of information across social media, it has specific, designated communicators to whom all information is directed behind the scenes. Those communicators are the ones who develop precise and accurate messages for posting.

Jennifer Horney, Texas A&M University, added that researchers who study the use of social media in disasters find that it can be very effective for informing the public about, say, which roads are blocked off. But she also has heard about local and state government agencies not being allowed to have any social media presence. So, in effect, they have "ceded the territory" of social media communications to whomever else wants to release information, she said.

Linda McCauley of Emory University commented that figuring out how new systems might use the wonderful connectivity resource of social media may be an area of opportunity for the National Academies.

BUILDING TRUST

Several participants observed that the lack of trust among agencies, communities, and scientists often limits effective communication during an environmental disaster. During discussion, several participants suggested opportunities to improve trust, communication, and collaboration among scientists, agencies, and citizens about environmental health issues.

Kristina Petersen of the Lowlander Center noted that distrust was particularly evident during the oil spill, when several concerned communities in Louisiana were willing to help collect environmental monitoring data, but were told that this was already being done by the state health department. Kim Anderson agreed, noting that in her experience agencies would not accept samples collected by citizens, and this can lead to distrust among communities with people saying, "Well, they didn't sample in my neighborhood." Peterson suggested that building trusted relationships between citizens and government around this issue, before the next disaster, would be an important area of work.

Kim Anderson noted that agencies need to be willing to accept samples from citizen scientists, which means that they need to have a level of trust that the samples will be gathered and handled correctly. Anderson has developed training modules, based on her experiences with citizens and representatives of NGOs during the *DWH* oil spill. They received information about passive sampling, explaining the technology in training modules offered in English, Spanish, and Vietnamese. Since then additional training has been created for citizens to participate in the sampling process and sample collection, such as in Ohio near oil/gas pro-

duction, and in rural areas for agricultural workers. This training could be further expanded to other regions to prepare for disasters.

Anderson noted that there have been a number of training modules developed to train citizens as sample collectors. An opportunity for the Gulf Research Program is to look at how to credential such programs to ensure the safe handling of samples and the correct chain of custody. There needs to be metrics developed for quality assurance, she said. Another participant noted the need to include safety training to ensure proper use of protective equipment and awareness of substances that sample collectors might be exposed to in the field.

John Hosey of the The Corps Network Gulf Coast Restoration Corps, raised some opportunities related to the funding that will come to the Gulf States for environmental restoration. His organization is in the process of creating conservation restoration corps, he said, which will create opportunities for communities to be directly engaged in recovery and restoration efforts related to the oil spill. There is a significant need for workforce training, he said, which could bridge many of the topics discussed at the workshop—health, environmental stewardship and sustainability, and resilience. This could include curricula or a credentialed program that would allow the restoration workforce to also support standardized collection of environmental monitoring data as part of disaster response, he said.

Steve Wolfe of the Florida Institute of Oceanography noted that it was important to appreciate that existing networks in the Gulf region contributed to the response effort going as well as it did, especially considering that the economic and physical effects of the spill crossed five state borders and thousands of square miles of ocean and coastal land. The Gulf of Mexico Alliance, for example, is an extensive network of individuals from academia, state and federal agencies, and NGOs. While the Alliance does not focus on oil-related issues, relationships forged through its work played an important role during the response period. Thus, the most effective way to build the desired "network of trust" is to build upon existing networks of relationships, rather than creating new ones for that purpose.

BREAKOUT DISCUSSION SUMMARY

Summarized below are responses generated by two breakout discussion groups charged with developing suggestions for (1) research (basic and translational) or monitoring investments that could improve capacity to detect, assess, and manage environmental health risks associated with disasters; and (2) encouraging needed collaboration across disciplines, sectors, and regions to improve understanding and communication about environmental health risks.

Breakout question: What research (basic and translational) or monitoring system investments could significantly improve current capacity to detect, assess, and manage environmental health risks associated with disasters?

As a summary of the breakout discussion Lynn Goldman, George Washington University, presented the list, below, to all workshop participants. This list summarizes items suggested by individual and multiple participants during the breakout discussion and should not be seen as the consensus recommendations of the workshop participants; nor are they necessarily actions that the Gulf Research Program should undertake:

Investing in improved monitoring systems (including research to support).

- Link to existing efforts, where monitoring for oil could be added in (e.g., Mussel Watch, SWAMPS [System Wide Analytical Monitoring Platforms], etc.) and where there is routine collection and rapid analysis of samples.
- Develop new methods and technologies (e.g., enhanced remote sensing, use of solid phase collection devices for chemicals, development of biosensors).
- Employ human capital (e.g., lifeguards and fisherfolk) who are on the water every day and mobile technologies for instant information that could be mined for early alerts.

Potential opportunities related to threat assessment (risk assessment, hazard identification, exposure analysis, health impacts).

- Improve models to better understand the scale and path of a spill, the populations affected, and exposure. Better parameters could improve these models.
- Improve understanding of how components of oil change due to weathering.
- Characterize components that come from different sources (spills, seeps).
- Improve understanding of biologic responses (especially those relevant to human health risks) to chemicals involved in oil spills.
- Develop high throughput bioassays to more quickly detect the presence of chemicals involved in oil spills.
- Assess physical and mental health via emergency room surveillance and electronic health records.
- Also assess psycho-social determinants of health.
- Characterize the range of potential threats to health from oil spills to better inform response (each spill unique).

Potential opportunities related to risk management:

- System operates within legal, long-standing relationships, which can facilitate or get in the way of an effective response. Whole process evokes different areas of science—people engaged with management science, system engineers, and beyond. Could study how our incident management systems work for managing disasters. Can we develop scenarios and use them to understand how to improve management of public health risks?
- Research to improve the capability of teams to manage disasters, including consideration of human health issues and how to integrate multiple parties that are all used to being in charge.
- In the process of managing environmental health threats, much data and samples are collected; can these data/samples be better curated and coordinated so they have lasting value?
- How can information about health risks and uncertainties, who is vulnerable, and how to minimize exposure be better gathered and communicated to the public?
- Breakout question: How can the Gulf Research Program encourage needed collaboration across disciplines, sectors, and regions, to improve understanding and communication about environmental health threats? What are some potential opportunities?

As a summary of the breakout discussion, LaDon Swann, Mississippi-Alabama Sea Grant Consortium, presented the list, below, to all workshop participants. This list summarizes items suggested by individual and multiple participants during the breakout discussion and should not be seen as the consensus recommendations of the workshop participants; nor are they necessarily actions that the Gulf Research Program should undertake.

Potential opportunities to facilitate collaborations that involve local communities:

- Support tailored communication on what different agencies, the academies, the Gulf Research Program, and NGOs are doing (e.g., research, mission, goals) and the relevance of their work to local communities.
- Identify points of access to different communities (e.g., social nodes such as faith-based groups).
- Develop a map of the local resources and social nodes for various communities (social network analysis).
- Facilitate cross-disciplinary collaborations, by tapping into existing networks, such as Sea Grant Consortia, Gulf of Mexico Coastal Ocean Observing System (GCOOS), Gulf of Mexico Alliance's (GOMA) Environmental Education Network.

Potential opportunities to foster collaborations not centered on a specific request for application (RFA):

- Encourage coalition building across sectors and regions.
- Identify common vision among disciplines/sectors/regions to move toward improved resilience, may be more powerful than individual RFAs.
- Identify factors that have allowed existing partnerships to endure and be self-sustaining over time.
- Develop partnership awards to recognize successful partnerships.
- Develop an inventory of groups (across sectors, regions) that could be potential partners.

Potential opportunities to foster collaboration via the RFA process:

- (At front-end) Make collaboration a requirement in RFA. For example,
  - o Inter-disciplinarity as review criterion (and review by reviewers that understand inter-disciplinarity).
  - o Identify problem that requires cross disciplinary/sector collaborations through community input.
  - o Have a job description that requires work across disciplines—"here are the kinds of expertise that we'd like to see reflected in a proposal."
- (At back-end) Focus on peer-review process. Having well-versed reviewers who understand the context and the complexity of what the sponsor is trying to accomplish.

7

Long-term Opportunities

BOX 7-1 Points Highlighted by Individual Speakers

- Transdisciplinary research to understand socioecological responses and recovery following disasters can inform the development of best management practices to promote sustainable and healthy communities (Blum).
- Ecosystem services have emerged as a means to characterize ecosystems and link their functions with human health and well-being. This concept can be used to characterize baseline health of ecosystems and measure impact of stressors (e.g., oil spills, climate change) (Sandifer).
- Consortia that support interdisciplinary traineeships and are connected to Gulf communities could enable students to work with specific populations (Sandifer).
- Members of communities who work with fisheries and other coastal ecosystems can grasp complex ideas quickly and are a valuable resource for researchers (Peterson).
- Because their livelihoods are at stake, people from communities have the drive and passion to create change (Peterson).
- A forum for information exchange between the Gulf Research Program and other relevant programs, such as the oceans and human health centers could make needed links between related programs (Stegeman).
- Dedicated funds that can be mobilized quickly to support immediate postevent research are lacking. The 30-year window of the Gulf Research Program provides a unique second opportunity to document baseline health indicators in communities living in disaster-prone areas (Lichtveld).
- Leadership development across sectors, disciplines, and communities is a key opportunity for building lasting impact (Lichtveld).

The final panel discussion at the workshop considered two broad questions relevant to long-term planning of the Gulf Research Program: (1) Given the Program's 30-year duration, what are some key opportunities to advance understanding of the connections between human health and the environment?, and (2) How can the Gulf Research Program support the development of health, scientific, community, and policy leaders who can address complex issues at the intersection between human and ecosystem health?

Presentations summarized in this chapter explore the possibility of funding a center in the Gulf region for integrative, cross-boundary research; identify opportunities to build upon important models and concepts that can drive cross-boundary approaches; and suggest funding mechanisms and other approaches that can help support the Gulf Research Program's strategic vision.

A GULF CENTER LINKING HEALTH, SOCIETY, AND THE ENVIRONMENT

New Orleans, the southeastern Louisiana coast, and the Gulf Coast in general provide many opportunities to better understand socioecological responses and recovery following catastrophic events, observed Michael Blum, Eugenie Schwartz Professor of River and Coastal Studies and director of the Tulane/Xavier Center for Bioenvironmental Research. Such research can advance understanding of post-trauma conditions and yield outcomes that promote sustainable and healthy communities. He characterized three broad categories of opportunity—synthesis, coordination, and pipelines—for the Gulf Research Program to contribute to this work.

Examining how communities responded to and recovered from events like Hurricane Katrina or the *DWH* incident provides an opportunity to understand the

processes and drivers that lead to or promote healthy and sustainable communities, said Blum. Because the Gulf region encompasses tightly coupled human and natural ecosystems, research on post-trauma conditions can yield critical and novel understanding of how economic outcomes are tightly linked to environmental integrity (i.e., ecosystem services) and how community resilience is linked to the resilience of natural systems (i.e., socioecological resilience). Such interactions are dynamic and can lead to emergent processes and properties, he said. Ultimately, such research can lead to the development of best management practices, like restoring damaged wetlands, that incorporate and enhance the value of endemic ecosystem services (e.g., storm protection and water filtration) provided by coastal environments.

Blum illustrated the impact of interacting human and natural systems by briefly discussing research on the distribution and prevalence of pathogens in post-Katrina New Orleans. A traditional linear perspective draws a line from land use change to pathogen prevalence to disease incidence, but this view is "very outdated," said Blum. A more realistic perspective is one that recognizes the coupled dynamic of human dimensions and natural dimensions and the processes that link those two categories. This kind of approach can also be applied to the *DWH* oil spill (Figure 7-1), where decisions made to remediate and restore coastal environments following the incident have influenced exposure pathways that put human and ecological communities at risk.

Developing this kind of perspective requires transdisciplinary research perspectives, which necessitates breaking out of disciplinary silos that are perpetuated by separate funding agencies with distinct missions. Providing support for transdisciplinary research through well-conceived grant competitions and supporting a center to encourage such cross-boundary work are distinctive opportunities for the Gulf Research Program. Existing national centers focused on oceans and human health probably come closest to filling this gap at present, but "There is no national center that effectively links health, society, and environment. The Gulf Research Program has the opportunity to do something unique here," he said. For example, he said, we currently have silos of environmental assessments conducted by EPA and environmental analyses funded by the NSF, but "It is very rare that health assessments are linked and integrated from the get-go with environmental assessments." This "strategic gap" is one that the Gulf Research Program could fill by providing support for integrative environmental and health assessments, he observed.

Blum urged the NAS to "step beyond its comfort zones" and look at opportunities other than its traditional workshops and consensus studies. For example, the Gulf Research Program could support leadership acad-

FIGURE 7-1 Opportunities for transdisciplinary research on socioecological responses and recovery following catastrophic events. SOURCE: Presented by Michael Blum on September 24, 2014; Image Credits: U.S. Coast Guard (upper right and left); Scott Zengel, RPI/NOAA (lower right and left).

emies that engage academics, community members, and others, or risk communication training for scientists, policy makers, and others. Such academies could offer training in community resilience and build awareness of human–environment interactions. These and other complementary activities, including the junior policy and senior research fellowships that have been created by the Gulf Research Program, could be centered on a new cross-boundary research center located in the Gulf.

The National Academies can succeed where others might fail because it is known for its transparency and trust, but it will have hurdles to overcome. For example, the organization is not an embedded member of the Gulf Coast community. Blum noted, "There needs to be a push for embedding the NAS into the community. The Gulf Research Program can play a strategic role in stewarding the community. It can provide guidance in ways that other institutions on the Gulf Coast haven't done yet … You have 30 years. That's a long period of time to become a rich and deep partner."

EVALUATING ECOSYSTEM SERVICES

Speaking in his personal capacity, Paul Sandifer, chief science advisor for NOAA's National Ocean Service, urged the Gulf Research Program to focus on ecosystem services and to quantify the values of these services to humans. Human health and well-being is the cumulative or ultimate ecosystem service, he said. Health and well-being result from a number of services provided by healthy ecosystems, many of which can be impacted by a variety of stressors (Figure 7-2) (Sandifer and Sutton-Grier 2014). For example, exposure to nature and biodiversity provides multiple health values to humans including a variety of psychological and physiological benefits, decreased inflammatory and other noninfectious diseases, tangible materials and resilience, and aesthetic, cultural, recreational, socioeconomic, and spiritual benefits. Thus, the loss of natural biodiversity may have important consequences for human health and well-being (Bernstein, 2014; Hough, 2014; Rook, 2013; Sandifer et al., 2015).

The mechanisms by which ecosystems provide these services are still poorly understood, said Sandifer, and present an important research opportunity for the Gulf Research Program. Specifically, he suggested four key foci for research:

- Determine ecological mechanisms by which natural biodiversity supports the production and delivery of ecosystem services in the Gulf of Mexico ecosystem.
- Increase understanding of the ways in which nature and biodiversity in the Gulf of Mexico ecosystem support human health, including biological mechanisms of action (e.g., effects on the human immune

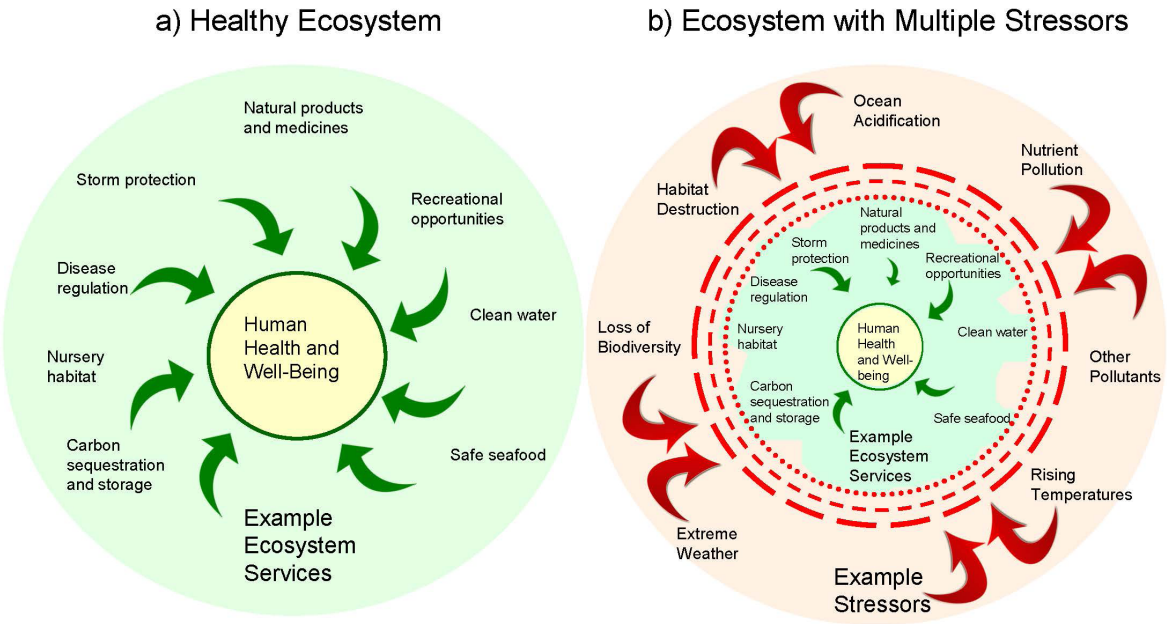

FIGURE 7-2 Conceptual representation of human health and well-being as the focal point of cumulative ecosystem services in healthy and heavily stressed ecosystems. In a healthy ecosystem (a), the area that provides optimal ecosystem services of all kinds for the support of human health and well-being is large, regular and more or less stable. In heavily stressed ecosystems (b), multiple stressors simultaneously and cumulatively impact numerous ecosystem services, resulting in reduced amount, quantity, and stability of services for humans. SOURCE: Sandifer and Sutton-Grier (2014). Presented by Paul Sandifer on September 24, 2014.

system and other physiological and psychological processes) as well as how natural infrastructure confers storm protection and other benefits.
- Quantify how intact ecosystems and habitats within ecosystems can assist in the adaptation or mitigation of the effects of climate change and extreme events and how stressed systems may exacerbate climate change effects.
- Invest in the development of environmental health early warning systems such as expanded ocean observations and ecological forecasting capabilities (Sandifer et al., 2013).

Such research is essential to establishing baselines for healthy ecosystems, he said. "If you do not understand what a healthy ecosystem is, and what that means in terms of ecosystem services, you cannot understand the impact of incidents such as *DWH* or sea-level rise." Over a 30-year period, the Gulf Research Program could significantly advance understanding by developing measurable and meaningful metrics for ecosystem services and the processes through which they affect human health and well-being.

Sandifer also discussed the Gulf Research Program's potential role in training. One extremely successful component of the former NOAA Oceans and Human Health Initiative was its support for competitively designated university consortia that funded interdisciplinary trainees at the master's, doctoral, and postdoctoral levels. Once trained in the ocean and health sciences, these trainees have gone on to work in academia; federal, state, and international agencies; nongovernmental organizations; and private business.

Sandifer suggested that the Gulf Research Program should support the development of similar interdisciplinary traineeship consortia, including social science and policy components. These traineeships should be connected to Gulf of Mexico communities to enable students to work with specific populations. In addition, support for a few internationally recognized distinguished scholars could help raise the visibility of the Gulf Research Program, provide role models and mentors for these students, and represent the Program's science in high-level, high-impact situations. These scholars could also draw community, congressional, philanthropic, and private business attention to needed investments, policies, and actions, Sandifer said.

TAPPING INTO THE KNOWLEDGE OF COMMUNITIES

The traditional ecological knowledge that can be found in local coastal communities is in fact a manifestation of complex systems thinking (Rihani, 2002), said Kristina Peterson, an anthropologist and community-engaged scholar at the Lowland Center and the University of New Orleans. In the Gulf, for instance, the ways in which communities work with fisheries and other coastal systems enable them to grasp complex ideas very quickly—"far more so than what I have found academics to be able to grasp, because academics are so siloed," Peterson said. "That's a gift that communities can give to this process over the next 30 years."

Another goal of communities is the conservation and comanagement of natural resources, said Peterson. Comanagement means that the community brings its local and traditional ecological knowledge into the discourse over resource management and resource recovery, as an equal partner. They have an equal voice in the oversight and protection of the "commons," she said (Berkes 1999, 2008; Berkes and Folke, 1998; Berkes et al., 2005, 2003). For example, many people in the Gulf region have knowledge both of the oil industry and the fishing industry. "They know the complexity between the two, and they understand the regime change and the challenges that [these interactions] present." Several examples of the community understanding include the participation of the expert commercial fishers in a state-funded research program carried out by University of New Orleans called Sci-TEK. The fishing community developed lesson plans that included fisheries, water flow, historic and proposed reclamation projects, and navigation. These lesson plans were part of the knowledge exchange that occurred between the fishers and state agency personnel that contributed to a new understanding of dynamic changing systems and restoration needs. Another instance that demonstrated the multidimensional understanding of oil and fisheries occurred after the BP oil disaster. The leaders of the "oiled" communities were quick to understand what potential impact the oil would have on estuaries; thus, they gathered fishers, political leaders, business owners, students, and others for investigative trips to the Prince William Sound Citizens Advisory Council. The exchange between the Alaskans and the coastal communities lead the Louisiana coastal communities to advocate for such an entity in the Gulf States region so there could be community-directed science that would address concerns communities see as present and potential risks between oil and the estuaries. The Gulf folks appreciated the science that has been and continues to be carried out for the Prince William Sound region through the Regional Citizens' Advisory Council (RCAC), Peterson said.

Communities are also actively contributing to research in such areas as phenology; ethnobotany; shoreline erosion; biomimicry; monitoring and sampling of air, land, and water; climate change; adaptation strategies; mitigation; and experimentation, she said (Koppel-Maldonado et al., 2013; Laska et al., 2015; Peterson, 2014; Peterson et al., 2014; Peterson and Maldonado, 2015).

Community members from the Louisiana parishes of Lafourche, Plaquemines, and Terrebonne, for example, contributed to the National Climate Assessment. In another example cited by Peterson, a Gulf community is doing experiments with mushrooms that can eat oil and clean soil. "These are things that communities have taken on, on their own and on their own dime, without academics coming in or supporting them."

In response to a question, Peterson noted that her organization has been studying how to effectively engage communities for more than 13 years. A key finding, she said, is that academics and representatives from state, local, and federal agencies learn more from community members when community members are peers at professional meetings, rather than when academics and agency representatives are "in the field," visiting communities. Financial support of participation of community members at professional meetings or other venues where decisions are being made would be helpful, she said, and training programs to support engagement are also needed. Agencies and academics often speak in very different languages, she said, and it is often entirely on the shoulders of communities to become "multilingual." Communication is a bridge that needs to be built, she said.

Because their lives and livelihoods are at stake, people from communities have the drive and passion to create change. "If they are not involved, you are missing a huge potential." Community members need to be equal partners in research and interventions, said Peterson, with equally funded and equally represented voices. Peterson suggested that RCAC is a potential model for integrating members of the community, academy, and leadership in a very innovative and adaptive way. This would be an incredible resource for the Gulf region, she concluded.

LINKAGES TO OCEANS AND HUMAN HEALTH PROGRAMS

The Oceans and Human Health (OHH) Program, which is funded by NIEHS and NSF, supports activities to understand how coastal water systems and human populations interact and influence one another. In his presentation, John Stegeman, director of the OHH Center at Woods Hole Oceanographic Institution (http://www.whoi.edu/whcohh), reviewed the breadth of activities the program has been involved in over the past 10 years (Laws et al., 2008), and suggested that these activities could inform the development of Gulf Research Program initiatives.

Oceans influence human health in a variety of ways (Figure 7-3), he said. In this complex system, drivers (e.g., environment and climate, biological and chemical risks) and targets (biodiversity, human physical and mental health) interact in complex ways that have both

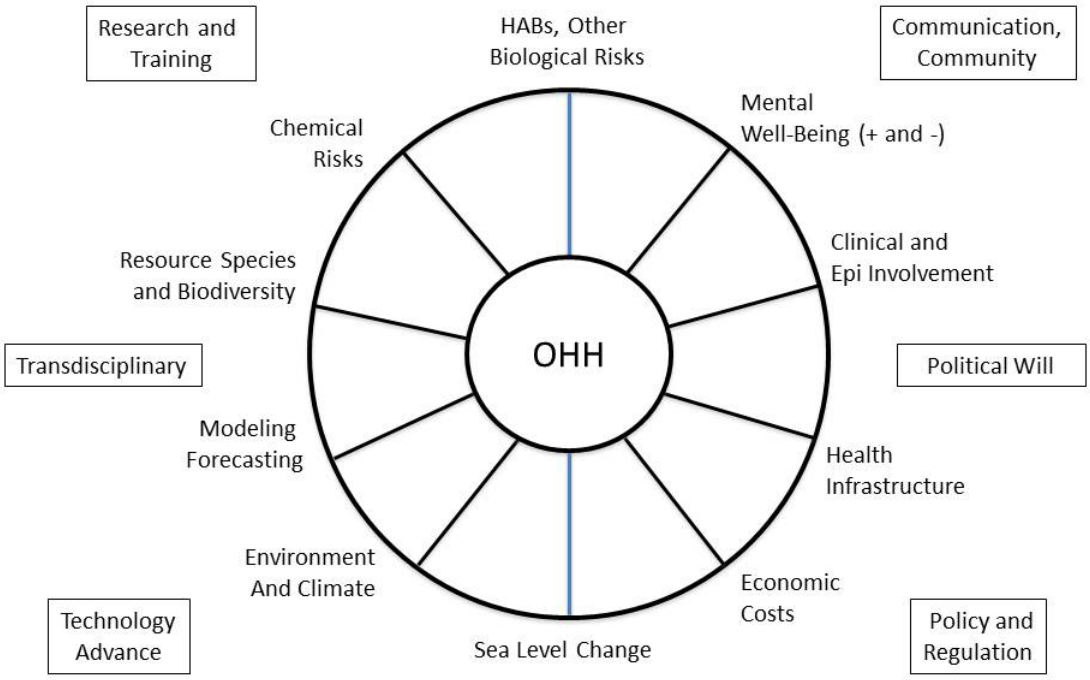

FIGURE 7-3 Spectrum of Oceans and Human Health Program activities (outside boxes) and focus areas. SOURCE: Presented by John Stegeman on September 24, 2014.

positive and negative outcomes for coastal populations and ecosystems (Bowen et al., 2006). OHH programs have developed models of some of these interactions that can be used to forecast outcomes and protect human health from negative influences, such as Harmful Algal Blooms (HABs), he said. Some outcomes are much harder to evaluate, he said, such as the positive health benefits of recreational activities near the ocean, though studies do support such benefits (White et al, 2013). Research on the linkages, outcomes, and forecasting are among important needs, he said. OHH research topics are necessarily transdisciplinary, involving oceanographers, physicists, economists, epidemiologists, and genomic scientists, among others. Another program strength is its focus on technological advances to improve methods for sampling, measuring, and modeling. Beyond research and development, OHH program activities include communications, community involvement, political will, and policies and regulations.

The Gulf Research Program should take advantage of the work of the OHH program and of similar centers that are beginning, worldwide, such as in the European Centre for Environment and Health , he said. Establishing a forum for information exchange with OHH programs and others, such as the NIEHS *DWH* consortia and divisions of the CDC, (the Agency for Toxic Substances and Disease Registry and the Division of Environmental Hazards and Health Effects in the National Centers for Environmental Health) could explore possible connections among programs and opportunities to build upon existing data and activities. Stegeman further suggested that a committee or a forum might be a useful mechanism for gathering and synthesizing information from these programs.

INVESTING IN PEOPLE, PELICANS, AND PUPILS

The Gulf Research Program can be seen as operating in a "sandbox" with many related programs, players, and portfolios of research, said Maureen Lichtveld, professor and chair in the Department of Global Environmental Health Sciences at the Tulane University School of Public Health and Tropical Medicine. In her presentation, she reviewed elements of the existing landscape and lessons learned, and offered suggestions for the Gulf Research Program to consider as it develops its research portfolio, approaches to research conduct and funding, and training and education programs.

Lichtveld began by matching topics from the current workshop with the objectives and recommendations drawn from a recent conference hosted by the Gulf of Mexico Research Initiative (GOMRI):[1]

Objective 1: Health and resilience
- Strengthen the science of resilience.

Objective 2: Disaster and ecosystem change management
- Assess baseline health status of different target communities.

Objective 3: Environmental health risks
- Characterize background exposure levels in communities to examine health status trends over time.
- Design a new generation of cumulative exposure models.
- Promote the use of locally collected data to inform the risk assessment decision-making process.
- Prioritize inter- and transgenerational health studies in at-risk communities.

Objective 4: Innovation and partnerships
- Invest in cross-disciplinary partnerships.
- Develop effective methods to advance environmental health literacy.

Some of these recommendations have come up in the workshop, Lichtveld pointed out, but some have not and should be included in the Program's research portfolio. She emphasized the need to prioritize taking advantage of "the work that is going on, but will end, such as the continuation of existing cohort studies." Cohorts of pregnant women and their infants could support inter- and transgenerational studies, she said, and "We can't miss that opportunity; it will be a crime to let those cohorts go."

In addition, the research portfolio could include the development and testing of a recently proposed resilience activation network framework, which suggests that resilience can arise through community or individual resilience attributes or through exposure to harm, which in turn affects the mental health of individuals (Abramson et al., 2014). This framework is a potential resource to guide practice. For example, social indicators of community resilience could be developed, as described by Ross (2014), and used to guide responses.

Lichtveld also identified critical challenges hampering human health research design, implementation, and translation into meaningful, actionable findings benefiting vulnerable communities. For example, from a design perspective, environmental epidemiological investigations require baseline indicators to determine risk levels and ascertain how exposures potentially adversely affect a specific outcome or disease condition over time. Obtaining baseline measures soon after an event or exposure to chemical and nonchemical stressors is not feasible unless an "off the shelf," field-ready approved research protocol can be activated. Efforts

[1] 2014 Gulf of Mexico Oil Spill and Ecosystem Science Conference. See http://2014.gulfofmexicoconference.org/wp-content/uploads/2014_GulfConferenceReport.pdf.

currently underway by the Department of Health and Human Services and the National Library of Medicine may assist in overcoming this challenge. An equally important challenge is the lack of dedicated funds that could be mobilized in days rather than months or years to support immediate postevent research. The 30-year window of the Gulf Research Program provides a unique second opportunity to document baseline health indicators in communities living in disaster-prone areas. Disasters have four phases, Lichtveld explained: pre, during, post, and inter. The last phase, interdisaster, is the one that needs the most attention, she contended. For example, she pointed to seven factors that influence disaster readiness and capabilities:

- Density of predisaster populations
- Levels of isolation versus proximity to large metropolitan areas
- Extent of local infrastructure strength
- Robustness of local economy
- Availability of public transportation
- Consistent access to health and basic services
- Special population needs addressed

All seven—and especially the needs of special populations—are considerations in the interdisaster phase. Funding interdisaster research can provide a reasonable health status baseline upon which studies in the postevent response phase can build. Timing, Lichtveld indicated, not only affects the scientific yield of a disaster-related study but equally importantly also affects the establishment of viable, trust-based community–academic partnerships (Lichtveld, 2014). Engaging community partners at the earliest possible time, ideally not during or after, but in between disasters not only gives the partnerships time to mature but also creates a greater likelihood that communities are engaged in the research from design to translation and dissemination.

Because of its 30-year duration, the Gulf Research Program should carefully consider which activities need to be initiated early in its lifetime, she said. In her view, the Gulf Research Program should prioritize developing a transdisciplinary pipeline, across industry, policy, community, and academic spheres. There are many models that could guide the development of this pipeline, such as programs that embed college students in middle schools[2] (service learning), support "emerging scholars" that are junior and seniors in high school,[3] training to link research with practice skills, link training with research funding, support bi-directional policy scholars—to bring science to policy makers and policy makers to the academic setting—and developing a leadership academy to develop "research navigators." The Gulf Research Program could support innovations by building on such existing programs through new projects funded under its education and training theme or providing opportunities to embed such pipeline projects as part of career development within both the human health research and ecosystem monitoring portfolios.

The Gulf Research Program should also carefully consider a funding strategy that is holistic and transdisciplinary in nature and deliberately designed to maximize the return on investment in a synergistic fashion, she said. For example, early rounds of funding could take advantage of the interdisaster period by supporting the development of tools to expedite comprehensive immediate postdisaster research (e.g., from a research capacity-building perspective, tools to accelerate field-ready protocols, predictive risk models, community-based participatory research, and environmental health literacy). Another urgent need, particularly suited for intramural exploration through a workshop, is to define, measure, and communicate about "exposure." The yield of such interdisaster projects sets the stage for comprehensive human health research including inter- and transgenerational studies in future funding rounds.

Lichtveld concluded with a proposed paradigm for the Gulf Research Program based on science, policy, and practice (Figure 7-4). The Program could focus on the linkages among these three components through gap analysis and risk reduction, translation into applications, and implementation and monitoring.

CLIMATE CHANGE AND SEA LEVEL RISE

During the discussion period, several participants noted the anticipated impact that climate change and sea level rise will have on the Gulf region. Paul Sandifer noted that "[health and environmental] baselines will be affected by changing climate, so this should be an issue that cross-cuts the Gulf Research Program's activities." Cornelis Elferink, University of Texas Medical Branch, agreed, noting that "a 30-year period is probably long enough to start seeing those impacts in the most vulnerable coastal areas around the Gulf of Mexico." Both remedial and preventive measures will be needed to deal with the problem, he said. Stegeman agreed,

> Thirty years will be long enough. We'll know a fair amount about the degree to which this will be a disaster in the making and how strong of a disaster it will be … If there is a 3-foot increase in the next 15, 20, 30 years, you're going have to rebuild a lot of the coast. A lot of the infrastructure that you now live with will not be livable. There will be an accommodation to a slow and progressive change that will adversely impact all communities and all of the mental health and community resilience features that have been spoken about.

[2] See http://tulane.edu/cps/students/servicelearningcourses.cfm.

[3] See http://www.tulaneemergingscholars.com.

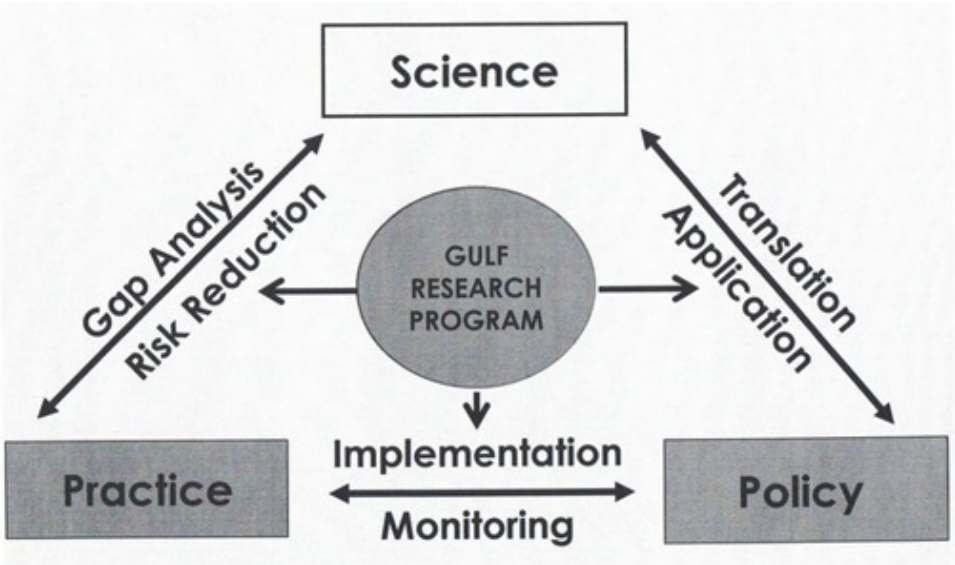

FIGURE 7-4 A possible paradigm for the Gulf Research Program would be to mediate the linkages among science, policy, and practice. SOURCE: Presented by Maureen Lichtveld on September 24, 2014.

COMMUNITY ENGAGEMENT

The remarks of the presenters in the final panel led to an extended discussion of community engagement, which also came up many other times in the workshop.

As Lichtveld pointed out, community engagement can mean different things. To inform is to provide balanced and objective information. To consult is to obtain feedback on analysis, alternatives, and/or decisions. To involve is to work with the public to understand and consider issues and concerns. To collaborate is to work together to develop alternatives and identify solutions. And to empower is to place the final decision in the hands of the public. All of these approaches require funding, she observed, and this funding needs to be in hand before rather than after a disaster if it is to be fully effective in building sustainable community–academic partnerships.

Bernard Goldstein, University of Pittsburgh, pointed to a similar three-tiered approach to community engagement. One level is letting the community know before they read in the newspapers about research results derived from the community. A second level is hiring community people and setting up community advisory committees to help with the research. And a third level is meaningful community involvement in setting the research agenda. This takes a lot of time to develop relationships with community members, he said, especially because it needs to be done before a disaster occurs rather than after a disaster strikes.

Sharon Gauthé, executive director of Bayou Interfaith Shared Community Organizing in Louisiana, argued for the most inclusive option possible, treating communities as "a partner rather than as a subject." When they are partners rather than subjects, communities can identify the gatekeepers in a community. "What we know, we want to share," she said. "We want to be considered as equal partners in addressing the situation, and we want to learn and teach all of our community how to be successful." Along those lines, Kim Anderson, Oregon State University, noted that she had sometimes worked with communities that owned the data generated in a research project, rather than having the data reside solely with a research team (Harding et al., 2012).

As Lynn Goldman and others pointed out, disaster research has shown that people who are more recently arrived in a community are the least likely to understand the things that need to be done in the case of disaster. Many communities around the Gulf Coast are relatively new and filled with people who have not lived in the area a long time, along with "snowbirds" who live in the Gulf region for just part of each year.

Several participants, pointed to the need for research that demonstrates the value of community engagement. "We need data to show how outcomes from disasters are better if people participate in the development of plans and other policy documents," said Jennifer Horney, Texas A&M University. Aubrey Miller, NIEHS, raised the possibility of conducting research to understand the effect of participation in a participatory research program on a community's response to a disaster. This is critical to understand, he said, but it is not currently studied using systematized or standardized approaches.

Finally, LaDon Swann, Mississippi-Alabama Sea Grant Consortium, referenced a seven-part test developed by the Kellogg Commission on the Future of State and Land-Grant Universities (Kellogg Commission, 2001) and noted that "understanding engagement isn't that difficult for those who work with it on a daily basis," such as those engaged in extension programs. These programs are always concerned about workforce development within the water-dependent industries they serve, which provides an important leveraging opportunity for the Gulf Research Program.

LEADERSHIP DEVELOPMENT

At many points during the workshop, several participants highlighted the need to develop cross-sector leaders who are able to address complex issues at the intersection of health and the environment.

Paul Sandifer underscored the need for a long-term investment strategy to develop academic leaders, who are "much more capable than most of us have been, in working across disciplines." Linda McCauley, Emory University, observed that such leadership and education development programs need to be linked to research funding. "We have the responsibility to provide a funding pathway that can support trained individuals to do this work after they graduate," she said. The Gulf Research Program cannot encourage individuals to think across boundaries but expect them to obtain funding from agencies that have specific missions, she said.

Several workshop participants emphasized the need for researchers to engage policy makers as well as communities. Maintaining a connection between research and policy makers makes it more likely that research recommendations will be implemented. And, as with communities, such engagement can transform outreach to dialogue. Linda Usdin, of SwampLily, suggested the need to better understand the process of decision making and how to include community members in ways that are meaningful. "I think we all know that policy makers, politicians, and community members can have the best information available." But it is having the tools to make sure that information is used in decision making that matters.

Several participants suggested the creation of a leadership academy in the Gulf region to support cross-boundary education, training, and interactions for academics, policy makers, and community members. Michael Blum, Tulane University, noted that there are models of disaster resilience leadership academies, but that they are generally focused on educating policy makers; the Gulf Research Program could build upon these models and develop a curriculum that could be extended to a broader constituency.

PROGRAM SUSTAINABILITY

Several participants also discussed the need to think about how to sustain the Program over the long term. Stegeman observed that the Gulf Research Program has the opportunity to put something in place that will help communities rebound successfully from disasters. However, he observed, the need for resiliency is more than a 30-year problem, and the Gulf Research Program needs to also begin to put things in place to ensure that the important aspects of the program can be sustained after 30 years. Stegeman also challenged the audience to think more broadly: "Can we develop something that enhances human health and the environment in the Gulf that also pertains to other communities, national and globally? Let's figure out how to do research that creates something that is of lasting importance, well beyond 30 years."

8

Lasting Benefit

In the wake of the largest offshore oil spill in U.S. history, the potential health impacts of the *DWH* explosion and oil spill have been widely discussed. Yet, as noted by Lynn Goldman of George Washington University, many existing and emerging factors will influence community resilience and health in the Gulf region over the next 30 years. From chronic factors—such as health disparities, environmental pollution, and the ever present threat of natural disasters—to the impacts of emerging threats, such as rising sea levels and ecosystem change, the Gulf region presents a complex and dynamic set of challenges to the health and resilience of its coastal communities. The workshop brought together individuals from academic institutions, federal, state, and local agencies, and community-based organizations to discuss opportunities to prepare for and respond to this complex set of challenges.

Supporting the development of healthy and resilient Gulf communities by improving understanding of the links between coastal communities and the ecosystems in which they live, is one of the three goals of the Gulf Research Program, she said (see Box 1-1). The funds the Program received, "seem like a large amount of money" she continued, but it is important to remember that the Gulf Research Program has a very broad mandate, well beyond the topics discussed at this meeting, and that the funds will be expended over 30 years. "The Program must use its resources as a catalyst," she said, to spark important work across its three categories of activity: Research and Development; Education and Training, and Environmental Monitoring. The Gulf Research Program's key challenges in the coming year are to identify focus areas for investment and opportunities to leverage its limited funds for maximum impact, she said.

Many questions need to be answered in formulating the Gulf Research Program's plans, she said: What can the Program cause to happen that would not have happened otherwise? What activities will inspire innovative, integrated thinking about how to address the challenges faced by people along the Gulf Coast? How can the Program take advantage of the role of the National Academies as an independent adviser to the nation in areas of science, engineering, and health?

Over the course of the 2-day workshop, individual participants offered their ideas for needs, challenges and opportunities that should be considered as the Gulf Research Program expands its portfolio of activities. These ideas were reviewed by a breakout discussion group tasked with identifying the ideas discussed at the meeting which held the greatest potential to produce lasting benefits for the Gulf region. As a summary of the breakout discussion, Linda McCauley, Emory University, presented the list, below, to all workshop participants. This list summarizes items suggested by individual and multiple participants during the breakout discussion as potential areas for future exploration. It should not be seen as the consensus recommendations of the workshop participants; nor are they necessarily actions that the Gulf Research Program should undertake.

- **Foster creation of a "central hub" in the Gulf to support transdisciplinary research, education, and training and to link research to practice.**
  - o A center is a means to focus needed attention on health, social, and environmental issues relevant to coastal populations. It could also drive the use of common measures and information sharing across disciplines and sectors.
  - o Could serve as a coordinating hub that links existing networks and organizations within the Gulf region that are engaged in relevant work (e.g., research on health and ecosystem impacts, disaster response, monitoring, restoration).
  - o Could engage the public sector, private sector, communities, and academics, perhaps through a regional citizens' advisory council-type of governing body.
  - o Could be designed with transparency, sustainability, trust, and community embeddedness as core values.
  - o Need innovative thinking about the structure and funding. Rather than being housed at a single university, it could be a consortium of institutions, supporting multiple working groups around different priorities. Funding mechanism could require invest-

ment from others (e.g., communities, philanthropy, businesses, states).

- **Focus on transdisciplinary leadership development.**

o Support sustainable career paths by linking cross-boundary education and training programs with research opportunities and funding.

o Develop education and training programs for students at different levels, not just at the graduate level.

- **Advance the science of resilience and identify effective practices for building and sustaining the resilience of communities.**

o Support cross-sector work to develop a common framework for resilience.

o Develop a common platform for sharing data, methods, instruments, and analytical approaches (and funding to encourage the use of these resources) to support the development of comparable data and the use of best practices.

- **Explore opportunities to support longitudinal studies.**

o Identify metrics that are useful and meaningful to communities and researchers.

o Take advantage of cohort studies (e.g., clean-up workers, babies) that have been developed in the Gulf region, where the funding will likely disappear in the near future.

o Support the development of "science first responders".

o Identify challenges (e.g., obtaining IRB approvals) and opportunities to contribute to the efforts of NIEHS and other organizations to develop teams of researchers and others that can be deployed to collect data during disasters and to assess health impacts of disasters.

o Identify needs, challenges, and opportunities to better engage communities as part of a disaster research response.

- **Focus on mental health impacts of disasters.**

o Identify data and research needs for understanding the effects of disasters on mental health and developing approaches to reduce stigma and mitigate impacts.

o Explore opportunities to integrate prevention or mitigation strategies into response and recovery.

- **Explore opportunities to improve how communities are involved and engaged in scientific research.**

o Assess the impact of different models for engaging communities.

o Collaborate with funders that effectively use these approaches.

o Educate peer-reviewers about the methodology of community based participatory research and the importance of this approach to achieving Gulf Research Program goals.

- **Advance human health and environmental monitoring technologies.**

o Invest in the development of new instruments and tools that are easy to deploy and use in the field.

o Develop consensus on biomonitoring approaches.

- **Explore opportunities to leverage the Gulf Research Program funds and extend the longevity of its activities.**

o Identify funding approaches and partnerships that leverage the Gulf Research Program's funds and lead to the development of activities that will be sustained beyond the Program's duration.

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A

Workshop Agenda

Community Resilience and Health Opportunity Analysis Workshop

September 22–23, 2014

Hotel Monteleone
New Orleans, Louisiana

Workshop Objectives:

1. Explore needs, challenges, and opportunities to improve the health and resilience of Gulf communities.
2. Identify opportunities to improve how Gulf communities anticipate, prepare for, and recover from disasters and environmental change.
3. Identify opportunities to improve detection, assessment, management, and communication about environmental health risks.
4. Explore how the Gulf Research Program can encourage innovation and collaboration and ensure that its activities engage and benefit communities.

MONDAY, SEPTEMBER 22, 2014

8:00 a.m. Breakfast

8:30 a.m. Welcome
LeighAnne Olsen, Senior Program Officer, Gulf Research Program

8:35 a.m. Overview of the Gulf Research Program and Meeting Objectives
Linda McCauley, Emory University, Advisory Group Member

8:50 a.m. KEYNOTE: Human Health, Public Health Practice, and Community Resilience
Bernard Goldstein, University of Pittsburgh, Advisory Group Member

9:30 a.m. **SESSION 1: Community Resilience, Health, and Well-Being**
Panel Discussion

Discussion questions (5–7 minutes for prepared comments; followed by a moderated conversation):

- What examples illustrate how health, socioeconomic, and environmental factors intersect and affect the resilience of communities?
- What are some key challenges and opportunities for the Program to improve the resilience of communities in the Gulf region?
- What opportunities are best aligned with the strengths of the Academies and the Program's 30-year duration?

Moderator: LaDon Swann, MS-AL Sea Grant Consortium/Auburn University, Advisory Group Member
- J. Steven Picou, University of South Alabama, Advisory Group Member
- Rex H. Caffey, Louisiana Sea Grant and Louisiana State University
- Craig Colten, Louisiana State University and The Water Institute of the Gulf
- Anita Chandra, RAND Corporation

10:30 a.m. BREAK

10:45 a.m. **SESSION 2: Reducing Risk and Strengthening Resilience**
Panel 1

Discussion questions (3–5 minutes for prepared comments; followed by open discussion):
- What are some important lessons learned about the long-term impacts of disasters on community health and well-being?
- How might research, monitoring, education, or training activities help reduce these impacts and strengthen the resilience of Gulf communities to future disasters?

Moderator: Linda McCauley, Emory University, Advisory Group Member
- Eric T. Baumgartner, Louisiana Public Health Institute
- Richard Powers, University of Alabama at Birmingham
- Angela Grajeda, American Red Cross–Mississippi Region
- Joe Banta, Prince William Sound Regional Citizens' Advisory Council
- Jennifer Horney, Texas A&M University

12:15 p.m. Lunch

1:15 p.m. *Panel 2*

Discussion questions (3–5 minutes for prepared comments; followed by open discussion):
- How can efforts to strengthen the resilience of communities to disasters and environmental change also improve health and well-being?
- What are some key opportunities for the Gulf Research Program to support these efforts and to extend the benefits of resilience-building activities to other communities in the Gulf region?

Moderator: James Ziglar, Van Ness Feldman LL, Advisory Group Member
- Alexandra Nolan, University of Texas Medical Branch
- Umair A. Shah, Harris County Public Health & Environmental Services
- Tracie Sempier, Mississippi-Alabama Sea Grant Consortium and Gulf of Mexico Alliance
- Shirley Laska, University of New Orleans, Center for Hazards Assessment, Response and Technology
- John Hosey, Gulf Coast Restoration Corps (former South Mississippi Volunteer Organizations Active in Disaster)

2:45 p.m. BREAKOUT SESSION INSTRUCTIONS/BREAK

Each group will have 1.5 hours for discussion of one of the following questions:

Breakout group 1 (Moderator: LaDon Swann | Rapporteur: LeighAnne Olsen)
- What research (basic and translational) or monitoring system investments could significantly advance understanding of factors that support and enhance resilience of communities in the Gulf region?

Breakout group 2 (Moderator: Bernard Goldstein | Rapporteur: Chris Elfring)
- What activities could reduce long-term impacts of disasters and strengthen the resilience of Gulf communities?

Breakout group 3 (Moderator: Steve Picou | Rapporteur: Evonne Tang)
- How can the Gulf Research Program ensure that its programs effectively engage and benefit communities? And, how can the Program extend the benefits of resilience building activities to other communities in the Gulf region?

Breakout group 4 (Moderator: Linda McCauley | Rapporteur: Maggie Walser)
- What types of collaborative, educational, or training activities could significantly enhance current efforts to improve how Gulf communities anticipate, prepare for, and recover from disasters and environmental change?

3:00 p.m. BREAKOUT DISCUSSION SESSIONS

4:30 p.m. Report back from breakout sessions and discussion

5:30 p.m. Reception for Attendees

TUESDAY, SEPTEMBER 23, 2014

8:00 a.m. Breakfast

8:30 a.m. Opening Comments
Lynn Goldman, George Washington University, Advisory Board Member

8:45 a.m. **SESSION 3: Detecting, Assessing, and Improving Understanding of Environmental Health Risks**
Panel Discussion

Discussion questions (3–5 minutes for prepared comments; followed by open discussion):
- What are some key needs and opportunities for improving detection, assessment, and management of environmental health risks associated with disasters?
- What is needed for more effective communication about environmental health risks (chronic and episodic) between residents, policy makers, and researchers?

Moderator: Lynn Goldman, George Washington University
- Robert Dickey, University of Texas Marine Science Institute
- Andy Kane, University of Florida
- Bruce Brackin, Mississippi State Department of Health
- Kim Anderson, Oregon State University
- Aubrey Miller, National Institute of Environmental Health Sciences
- Ann Hayward Walker, SEA Consulting Group

10:15 a.m. BREAK

10:30 a.m. **SESSION 4: Long-Term Opportunities for the Gulf Research Program**
Panel Discussion

Discussion questions (3–5 minutes for prepared comments, followed by open discussion):
- Given the Program's 30-year duration, what are some key opportunities to advance understanding of the connections between human health and the environment?
- How can the Program support the development of health, scientific, community, and policy leaders that can address complex issues at the intersection between human and ecosystem health?

Moderator: Bernard Goldstein, University of Pittsburgh, Advisory Board Member
- John Stegeman, Woods Hole Oceanographic Institution
- Maureen Y. Lichtveld, Tulane University
- Paul Sandifer, National Oceanic and Atmospheric Administration
- Kristina Peterson, Lowlander Center
- Michael Blum, Tulane/Xavier Center for Bioenvironmental Research

12:00 p.m. Lunch

12:30 p.m. BREAKOUT DISCUSSION SESSIONS

Each group will have 1.5 hours for discussion of one of the following questions:

Breakout group 1 (Moderator: LaDon Swann | Rapporteur: Chris Elfring)
- How can the Program encourage needed collaboration across disciplines, sectors, and regions to improve understanding and communication about environmental health risks? What are some key opportunities for collaboration?

Breakout group 2 (Moderator: Bernard Goldstein | Rapporteur: LeighAnne Olsen)
- How can the Program improve understanding of the role of baseline community health status in affecting the health impacts of acute disasters?

Breakout group 3 (Moderator: Lynn Goldman | Rapporteur: Evonne Tang)
- What research (basic and translational) or monitoring system investments could significantly improve current capacity to detect, assess, and manage environmental health risks associated with disasters?

Breakout group 4 (Moderator: Linda McCauley | Rapporteur: Maggie Walser)
- What ideas discussed at this meeting need additional exploration, but hold the potential to produce lasting benefits for the Gulf region?

2:15 p.m. Report back from breakout sessions and discussion

3:15 p.m. Closing comments by AG members

3:30 p.m. Adjourn

B

Statement of Task

The Gulf Research Program proposes to convene three information-gathering workshops to identify opportunities in three focus areas: (a) environmental monitoring, (b) education and training, and (c) human health in the Gulf Region. Each workshop is intended to be an in-depth discussion with selected stakeholders where participants will explore (per area) what activities are currently being done, what plans exist, and what short- and long-term opportunities might suit the Gulf Research Program. The workshops are not intended to be series of presentations but rather be forums to discuss perceived needs and potential opportunities. In general the workshops will provide opportunities to:

1. Discuss the purpose of the workshop, context, and definition of terms;
2. Discuss the perceived gaps between what is being done (in the workshop focus area) or is planned, perceived needs, and opportunities that might be addressed by the Gulf Research Program, especially in areas of that might benefit most from the long time horizon.

Individually authored workshop summaries of the presentations and discussions at the workshops will be prepared by a designated rapporteur in accordance with institutional policies and procedures.

C

Speaker Biographies

KIM ANDERSON is a professor in the Department of Environmental and Molecular Toxicology and Director of the Food Safety and Environmental Stewardship program, both at Oregon State University. Dr. Anderson's research focuses on environmental exposure of contaminants, mixtures, and development of novel bio-analytical technologies for assessing bioavailability in multicontaminant environments. Dr. Anderson is the project leader in the Superfund Research Program, NIEHS, titled Biological Response Indicator Devices for Gauging Environmental Stressors. Dr. Anderson was recruited by the UN Food and Agriculture Organization in collaboration with the Global Environmental Fund to develop a new program of international scope, to design bio-analytical technologies to conduct environmental assessment for use in setting of protective standards for human and environmental health. Current research is also focused on development of personal passive samplers, a silicone-based device structured as a wristband or lapel pin, which has the potential to greatly expand the possibilities for developing quantitative measures of exposures in humans. Dr. Anderson has more than 70 referred articles and holds 4 patents. Dr. Anderson is currently World Council Member for Society of Environmental Toxicology and Chemistry (SETAC), past member of the Board of Directors for SETAC North America, and founding member of the Chemistry Advisory Group.

JOE BANTA is a senior project manager for the Prince William Sound Regional Citizens' Advisory Council (Council). The Council, perhaps the most radical innovation to come out of the *Exxon Valdez* oil spill, is a permanent, industry-funded citizens' council for the *Exxon Valdez* oil spill affected area designed to oversee both the oil transportation industry and its government regulators. As one of the first staff members of the Council, Mr. Banta provides the Council with long-time institutional knowledge and expertise based on his experience with the *Exxon Valdez* oil spill and his project management for the Council's Scientific Advisory Committee and its Oil Spill Prevention and Response Committee. His current project management areas include environmental monitoring, hydrocarbon toxicity, dispersants, science planning, and invasive species to name a few. Mr. Banta has a background in fishing and fisheries and grew up in Cordova, Alaska. He has a B.S. degree in Biology and an M.A.T. from the University of Alaska, Anchorage.

ERIC BAUMGARTNER is a career public health physician engaged in a variety of community and national activities focused on issues of population health and access to care. Currently he serves as Policy and Program Planning Director for the Louisiana Public Health Institute, as a member of the Georgia Health Policy Center Technical Assistance Program team for HRSA's Rural Health Network Development grantees, and as Coaching Faculty for the National Leadership Academy for the Public's Health directed by the Public Health Institute. In addition, Dr. Baumgartner continues to engage in public speaking, facilitation, and community coaching for access to care initiatives nationally. Formerly, Dr. Baumgartner served as the Director of the Community Access and State Planning Programs of the federal Health Resources and Services Administration in Rockville, Maryland. Prior to that position, he served in a variety of posts in state public health agencies in the states of Mississippi, Hawaii, Texas, and Louisiana. While in Louisiana, he served as the State Health Officer for 3 years. In Texas, he served as the Chief of the Bureau of Managed Care of the Texas Department of Health where he shared in the responsibility for converting Medicaid to managed care. Dr. Baumgartner received his Medical Degree from Louisiana State University School of Medicine and his Masters of Public Health from Tulane University School of Public Health and Tropical Medicine. He completed a residency in general pediatrics at the University of Arkansas and completed a second residency in general preventive medicine at Tulane. He is board certified by the American Board of Preventive Medicine and by the American Board of Pediatrics.

MICHAEL BLUM is the Eugenie Schwartz Professor of River & Coastal Studies and Associate Professor of Ecology and Evolutionary Biology. Mike earned a B.S. in Integrative Biology at the University of California, Berkeley,

and a Ph.D. from Duke University. He then completed a 4-year postdoctoral fellowship in the Office of Research and Development of the U.S. Environmental Protection Agency before joining the Tulane faculty in 2007. Mike's expertise is in molecular population genetics, molecular ecology, and the ecology of river and coastal ecosystems. He is well known for his work on the development of genetic methods for assessing the condition of aquatic environments, responses of coastal marsh ecosystems to global environmental change, and aquatic biological invasions. While serving as the Arnold Early Career Professor in Earth and Ecological Science, Mike worked closely with academic, government, and industry partners to advance coastal remediation and recovery following the *Deepwater Horizon* oil spill. Mike also has collaborated on National Science Foundation-funded projects with colleagues at Tulane and partner institutions to develop New Orleans as an urban long-term research area to understand socioeconomic and human health drivers of biological diversity. As Director of the Tulane/Xavier Center for Bioenvironmental Research, Mike has led an initiative to establish a new riverfront campus and center of excellence for cross-cutting scholarship on energy, environment, and sustainability to enrich cross-university commitments to public service. His work has been featured by media outlets including *The Times-Picayune, The New York Times, CNN, Fox News, NPR, BBC, The Daily Show,* and *The Colbert Report*.

BRUCE BRACKIN is a consulting environmental epidemiologist at the Mississippi State Department of Health. Previous to this he served as an epidemiologist at the Mississippi Agromedicine Program of the University of Mississippi Medical Center and as deputy state epidemiologist at the Mississippi State Department of Health. Mr. Brackin serves a board member of the Pearl River Basin Development District and the Pearl River Water Supply District. He received his M.P.H. in epidemiology and biostatistics from the University of Oklahoma School of Public Health.

AYANNA BUCKNER is the principal of Community Health Cooperative (communityhealthcooperative.com), a health consulting firm that assists organizations, academic institutions, and other groups with the design, implementation, and evaluation of community-based health programming. Dr. Buckner also serves as chairperson of the Gulf Region Health Outreach Program Coordinating Committee, which coordinates a series of integrated, 5-year projects developed as part of the Deepwater Horizon Medical Settlement and designed to strengthen healthcare in Gulf Coast communities in Louisiana, Mississippi, Alabama, and the Florida Panhandle. Dr. Buckner formerly served as director of the Regional Coordinating Center for Hurricane Response at Morehouse School of Medicine, through which she managed multistate projects to assist with rebuilding health systems in the Gulf Region after Hurricanes Katrina and Rita.

REX CAFFEY is a Professor of Natural Resource Economics at Louisiana State University. For more than 20 years he has conducted applied research and extension programming related to the socioeconomics challenges of resource-dependent coastal communities. In 2011, he was named director of the Marine Extension Project (MEP) for the Louisiana Sea Grant College Program. This network of 18 agents and specialists has provided the primary extension liaison for coastal and marine research in Louisiana for more than 40 years. He is also founding director of the LSU Center for Natural Resource Economics and Policy (CNREP). Established in 2003, CNREP fosters the interaction of social science researchers to address natural resource management challenges at the state and regional level. In the past decade CNREP has expanded to 28 cooperators at 8 institutions and obtained more than $12 million in extramural research funds from 46 public and private entities. Through his MEP and CNREP activities, Dr. Caffey provides socioeconomic expertise to state and federal agencies in the northern U.S. Gulf of Mexico.

ANITA CHANDRA is a senior policy researcher and director of RAND Justice, Infrastructure, and Environment at the RAND Corporation. Her background is in public health, child and adolescent development, and community-based participatory research and evaluation. She currently leads or co-leads studies on community well-being; deployment and military families; community resilience and long-term disaster recovery; and child health and development. Throughout her career, Chandra has engaged government and nongovernmental partners to consider cross-sector solutions for improving child and community well-being and to build systems and evaluation capacity. This work has taken many forms including engaging with the Department of Health and Human Services and local government agencies on building systems for emergency preparedness and resilience both in the United States and globally; partnering with private-sector organizations to build the science base around child systems; and collaborating with city governments and foundations to measure well-being, sustainability, and health transformation. She has also partnered with community organizations to conduct broad-scale health needs assessments, to examine the integration of health and human service systems, and to determine how to address the needs of historically vulnerable populations in health and social services. These projects have occurred in partnership with local health systems, foundations, and other community organizations. Dr. Chandra earned a Dr.P.H. in population and family health sciences from the Johns Hopkins Bloomberg School of Public Health.

CRAIG COLTEN is the Carl O. Sauer Professor of Geography at LSU and the Director of Human Dimensions at the Water Institute of the Gulf. Since he earned his Ph.D. at Syracuse University, he worked in government service and the private sector before returning to the academy. He has been engaged in community resilience research since 2007 with funding from the Community and Regional Resilience Institute and the National Institute of Environmental Health Sciences. LSU Press recently released his new book titled *Southern Waters: Limits to Abundance*.

ROBERT DICKEY is Director of the University of Texas at Austin, Marine Science Institute (UTMSI) and Chair of the Department of Marine Science, College of Natural Sciences. Robert joined UTMSI in 2013 as the Nancy Lee and Perry R. Bass Regents Chair in Marine Science after serving 28 years with the U.S. Food and Drug Administration's seafood safety-related marine science programs. His research interests are in the areas of marine natural toxins, xenobiotics in aquatic systems, toxicology, and analytical methods development. Robert leads the UTMSI, a center for higher education and research with global reach. The Institute is dedicated to advancing knowledge of estuarine, coastal, and blue water oceans through objective inquiry and research; training future generations of marine science professionals through inspired teaching and mentorship; and raising ocean literacy of the general public and societal leaders through diverse education outreach programs.

CORNELIS ELFERINK obtained his Ph.D. in Biochemistry from the University of Adelaide, Australia, and conducted a Postdoctoral Fellowship at Stanford University before initially joining the faculty at Wayne State University, and subsequently the Department of Pharmacology and Toxicology at UTMB where he is currently Professor and the Mary Gibbs Jones Distinguished Chair in Environmental Toxicology, and the Director of the Sealy Center for Environmental Health and Medicine. Dr. Elferink's long-term research objective is to understand the role of the aryl hydrocarbon receptor (AhR) in liver homeostasis and liver regeneration following hepatic injury. These studies hold the promise of identifying new therapeutic targets for the treatment of various liver diseases such as hepatitis, cirrhosis, and hepatocellular carcinoma (HCC). In related translational research, the laboratory is actively seeking to identify serum biomarkers for early detection of HCC in Hepatitis C virus (HCV) infected patients at risk for developing HCC. The approach involves proteomic strategies based on 2D difference in gel electrophoresis and stable isotope labeling coupled to mass spectrometry, and multiplexed selected reaction monitoring for use in validation studies. Successful development of serum biomarkers will enhance surveillance of millions who are HCV positive and at risk of developing HCC. In addition, Dr. Elferink also oversees a NIEHS-funded Core Center and a separate consortium engaged in community-based participatory research examining the human health concerns of the Gulf of Mexico coastal fishing communities impacted by the *Deepwater Horizon* oil spill in 2010.

SHARON GAUTHÉ is the Executive Director of Bayou Interfaith Shared Community Organizing (BISCO) and served on the BISCO Board of Directors for 5 years. Her previous employment was as the Region 3 Office of Public Health's Healthy Communities Coordinator. She represented the State of Louisiana as one of five persons to attend the South Central Public Health Leadership Institute. This unique leadership training, developed by Tulane University for OPH state employees selected from five southern states, allowed Mrs. Gauthe' to participate in a multistate task group to develop the first Internet site for all five states to study and share information on bioterrorism. Prior to this, Mrs. Gauthé was employed by the Louisiana Office of Mental Health as a Social Services Counselor. She has also worked for the State Department of Public Welfare, for the Lafourche Parish Council as a Juvenile Probation Officer, and for the Lafourche Parish School Board, where she served as a Social Services Counselor at South Lafourche High School. Mrs. Gauthé graduated from Nicholls State University with a BS in Family and Consumer Sciences. She received the honor of "Another Success Story"–Top 50 Outstanding Graduates of Nicholls State during their 50–year celebration in 2000. Mrs. Gauthé has also completed and received certificates in many trainings including the Tulane University School of Public Health and Tropical Medicine's "Disaster Navigation Training." She also received Organizer and Director's training in the PICO National Organization in Community Organizing and participated in the Rockwell Leadership Institute where she is an Alumnus of their Art of Leadership for Southern Leaders. Mrs. Gauthé is a lifelong resident of Lafourche Parish.

ANGELA GRAJEDA is the Disaster Program Manager, South MS Chapter, of the American Red Cross. Graduating with a degree in Social Work from Ball State University in 1996, Angela has dedicated her work to improving the resources available to social service agencies and the surrounding communities. Angela has worked with American Red Cross since 2007, initially as part of the Hurricane Katrina Recovery team in Biloxi, Mississippi, and transitioning to the role of Program Manager with Community Preparedness and Resilience Services through National Headquarters in 2011. In this role, she has helped to develop and implement a nationwide strategy for building community resilience and preparedness using community-based networks. Angela continues to contribute to the work of building resilience and preparing communities through her current position as Disaster Program Manager and association with the LA/MS Coastal Resilience Network.

JENNIFER HORNEY is an associate professor of Epidemiology and Biostatistics at the Texas A&M University Health Science Center School of Public Health and a faculty fellow of the Hazard Reduction and Recovery Center at the Texas A&M College of Architecture. At Texas A&M, Dr. Horney's research focuses on measuring the health impacts of disasters, as well as the linkages between disaster planning and household actions related to preparedness, response, and recovery. Dr. Horney received her Ph.D. and M.P.H. from the University of North Carolina at Chapel Hill, where her research focused on the role of social factors in decision making during disasters. She serves as a member of the Center for Disease Control and Prevention's Disaster Epidemiology Community of Practice and was a member of a team of public health practitioners who responded to Hurricanes Isabel, Charley, Katrina, Wilma, and Irene, where she conducted rapid assessments of disaster impact on the public health of individuals and communities. She has also provided technical assistance to public health agencies globally around disasters, infectious disease outbreaks, and pandemic influenza planning and response.

JOHN HOSEY joined The Corps Network staff in December 2013 as the Gulf Coast Restoration Corps Director of Development. His responsibilities include conducting research and identifying potential government and non-governmental partners to develop local workforce development opportunities for youth and veterans. The focus of the GCRC Program is to provide a trained and qualified local workforce that will participate in and contribute to conservation and restoration projects as recommended by the Restore Act Council. Additionally, he will be assisting local communities with the long-term development of community-based conservation corps programs. These programs will provide resources and support for starting sustainable programs that are focused on education, workforce development, and leadership components. In the end, the goal is to assist local communities to produce long–term Corps resources that provide conservation/restoration skills-based jobs and education for young adults and veterans. In his previous assignment he served as Director of United Way's Volunteer South Mississippi and as the Board President for the South Mississippi Voluntary Organizations Active in Disaster. He was actively involved in several projects related to expanding volunteerism across the state and building collaborative partnerships to address both current and future needs related to improving community resiliency. Since 2007, John has assisted in regional research projects with several universities. As a result he has co-published articles and served as both Investigator and Co-Investigator on grants related to these projects. The programs focused on collaborative community partnership development, disaster mental health interventions, and crisis response efforts following disasters (e.g., Hurricanes Katrina, Gustav and the Gulf Oil Spill). He also serves as a volunteer on the Gulf Coast Community Health Workers Training Program Advisory Board and the MS Gulf Coast Regional Planning Subcommittee on Resiliency.

ANDREW KANE is Associate Professor of Environmental and Global Health in the College of Public Health and Health Professions at the University of Florida. Dr. Kane received his B.S. degree from Cornell University (Aquatic & Marine Sciences), his M.S. degree from The Ohio State University (Aquatic Toxicology with minor in Fisheries Management), and his Ph.D. degree from University of Maryland School of Medicine (Aquatic Pathobiology). Dr. Kane directs the UF Emerging Pathogens Institute's Aquatic Pathobiology Laboratories, and he is the Graduate Program Director for One Health and Environmental & Global Health masters and doctoral programs at UF. Dr. Kane's research interests span environmental pathology and toxicology, and include application of aquatic models for environmental and public health studies, effects of contaminant and water quality stressors on host/pathogen/parasite interactions, and scientific communications. Research projects focusing on environmental health in the Gulf of Mexico include: Seafood Safety and Coastal Community Health Following the *Deepwater Horizon* Oil Spill (NIEHS); Oyster Health and Environmental Monitoring in Apalachicola Bay (UF Oyster Recovery Team); and Research, Communications and Community Engagement Support for Apalachicola Bay Oyster Restoration and Management (NFWF/Florida FWC; Florida Sea Grant).

BARBARA KIRKPATRICK serves on the Gulf of Mexico Coastal Ocean Observing System (GCOOS) Board of Directors and Executive Committee and has been a GCOOS member since 2005. She started her career as a Respiratory Care Supervisor at Duke University Medical Center before going on to receive a master's degree from North Carolina State University and a doctorate in Educational Leadership from the University of Sarasota. After finishing her graduate program, Dr. Kirkpatrick served as an Associate Professor at Manatee Community College in Bradenton, Florida, where she continued her research interests in human respiratory health and assessing clinical teaching effectiveness. In 1999, Dr. Kirkpatrick started with Mote Marine Laboratory as a staff scientist and shifted her research focus to environmental human health, specifically studying the effects of harmful algal blooms on human respiratory health. She is currently a senior scientist and program manager at Mote and her recent research efforts focus on harmful algal blooms and human health effects, specifically the development of tools to report beach conditions in Florida and the respiratory effects of red tide toxins.

SHIRLEY LASKA is Professor Emerita of Sociology at the University of New Orleans where in 2002 she created the Center for Hazards Assessment, Response and Technology (UNO-CHART) (www.uno.edu/chart), a center that has developed collaborative approaches to reduce communities' vulnerability to natural and technological risks and trained more than 175 masters and Ph.D. students in such community engagement. Recently she co-founded the Lowlander Center (lowlandercenter.org), a nonprofit organization that helps coastal Louisiana communities and their residents build capacity and resilience for place and people in the context of challenges such as climate change, coastal land loss, and technological hazards such as the BP oil spill. Author and co-author since Hurricane Katrina of more than 20 peer-reviewed journal articles and a book, her work on the BP spill has focused on the question of community corrosiveness engendered by the spill and the impact on residents and their families of the layering of the various disasters, especially the spill, on recovery from each and long-term resiliency. She currently serves on the NAS Committee on the Affordability of NFIP Premiums and the Science and Engineering Advisory Committee (SEAC) of the Water Institute of the Gulf.

MAUREEN LICHTVELD has 35 years of experience in environmental public health and currently is Professor and Chair, Department of Global Environmental Health Sciences, Tulane University, School of Public Health and Tropical Medicine. Her research focuses on environmentally induced disease, including asthma and cancer, health disparities, environmental health policy, disaster preparedness, and public health systems. She holds an endowed chair in environmental policy and is Associate Director, Population Sciences, Louisiana Cancer Research Consortium. Dr. Lichtveld has a track record in community-based participatory research with a special emphasis on persistent environmental health threats affecting health disparate communities living in disaster prone areas. As Director of the Center for Gulf Coast Environmental Health Research, Leadership, and Strategic Initiatives, Dr. Lichtveld serves as Principal Investigator of several Gulf Coast-associated environmental health research and capacity-building projects ascertaining the potential impact of the Gulf of Mexico Oil spill: the NIH-funded Transdisciplinary Research Consortium for Gulf Resilience On Women's Health, addressing potential post-oil spill effects on vulnerable pregnant and nonpregnant women; "Risk and Resilience in Environmental Health," a project designed to implement rapidly deployable community-based research, outreach, and education; and the Gulf Region Health Outreach Program's Environmental Health Capacity and Literacy Project, aimed at strengthening individual and community resilience through an environmental health clinical referral network, emerging scholars, and trained community health workers navigating frontline health services. Dr. Lichtveld was elected President of the Hispanic Serving Health Professions Schools. She was honored as CDC's Environmental Health Scientist of the Year and twice named Woman of the Year by the City of New Orleans.

KEN LINDEMANN is a physician-scientist with more than 20 years of professional support and leadership to the global oil and gas industry. Prior to his retirement from ExxonMobil in 2011, Dr. Lindemann had oversight for the strategic health management of new exploration ventures, mega-project development, and oil and gas production operations in areas of the world challenged by public health concerns and limited medical infrastructure. Since 2011, Dr. Lindemann has been providing consulting advice on global community and public health issues.

SUSAN LOVELACE is the assistant director for development and extension at the South Carolina Sea Grant Consortium. Previously she was manager of the Human Dimensions Research Program at the National Oceanic and Atmospheric Administration (NOAA) Hollings Marine Laboratory. She leads the Consortium's Sea Grant Extension Program, working with the executive director on program development efforts and assists with overall management of the agency. Dr. Lovelace earned her Ph.D. in coastal resource management and a B.S. in science education at East Carolina University. She also holds a B.S. in zoology from North Carolina State University. For over 2 decades, she has sought to understand the role of natural resources in public well-being as well as the complexity of information flow in local resource decision making. Her work at the Consortium includes assessing the information needs of the agency's diverse stakeholders, and providing them with science-based information, tools and guidance to inform their decision making.

BRIAN MAYER is an associate professor in the School of Sociology at the University of Arizona. His research interests focus on the social production of environmental health risks and the contestations that emerge around environmental problems in the areas of science, policy, and medicine. His work in environmental sociology has examined the role of community activism and participation in the identification and management of potential environmental health risks. Recent research projects include a National Institute of Environmental Health Sciences funded project to examine the long-term psychosocial and community health impacts of the BP Oil Spill in the Gulf of Mexico, an investigation of the use of community-based science in social movement organizations, and a project funded by the National Science Foundation to explore the interactions of labor and environmental social movement organizations in the United States. Through his qualitative research methodology, Dr. Mayer often makes use of community-based participatory research to engage local stakeholders in the research process.

AUBREY K. MILLER is a board-certified physician in Occupational and Environmental Medicine. He is currently the Senior Medical Advisor to the Director the National Institute of Environmental Health Sciences (NIEHS), National Institutes of Health (NIH). He has responsibility for strategic planning and coordination of environmental health issues and activities among U.S. federal agencies, academia, and other stakeholders. Dr. Miller has longstanding experience, publications, and contributions to a wide range of occupational and environmental health issues and policies. He has had extensive involvement in the Gulf oil spill response providing testimonies before U.S. Senate and House Committees regarding health concerns and research needs. Other focus areas include asbestos issues and hazardous mineral fibers, hydraulic fracturing, and disaster responses (e.g., Hurricane Sandy, H1N1 pandemic influenza, anthrax attacks, Hurricane Katrina, and the World Trade Center attack). Dr. Miller's previous positions include leadership, chief medical, and research activities with the U.S. Food and Drug Administration (FDA), the U.S. Environmental Protection Agency (EPA), the U.S. Department of Health and Human Services, and the U.S. Centers for Disease Control and Prevention (CDC).

ALEXANDRA (LEXI) BAMBAS NOLEN serves as the Director of the Center to Eliminate Health Disparities and Associate Director of the Coordinating Center for Global Health at UTMB Health in Galveston, Texas. She is also an Assistant Professor in the Departments of Family Medicine, Preventive Medicine & Community Health, and Internal Medicine, and Associate Faculty in the Institute for the Medical Humanities. Under her leadership, the Center to Eliminate Health Disparities is engaged in research, training, and community action in four program areas: Health Systems Solutions, Solutions through Social Determinants of Health, Leadership Development for Social Change in Health, and Global Health. Dr. Nolen has experience in coordination of community-based research and interventions as well as policy development on issues of health equity and public health. Her work also encompasses issues of social determinants of health and intersectoral action, health information systems, advocacy strategies for health equity, health systems development, the impact of globalization and trade on health in Africa, environmental justice, and development of training materials on health equity. Dr. Nolen served on the Secretariat of the WHO Commission on Social Determinants of Health between 2005 and 2007. Previously she was the Coordinator of the Global Equity Gauge Alliance, a South Africa-based nongovernmental organization focused on health equity initiatives in Latin America, Africa, and Asia. Under the Division of Health and Human Development at the Pan American Health Organization (1999–2002), she helped to advance research and programming on issues of health equity for the organization. Dr. Nolen serves on the Executive Board of the International Society for Equity and Health; on the National Advisory Committee for the National Association of City and County Health Officials/Centers for Disease Control project The Roots of Health Inequity; on the National Advisory Panel for the Department of Housing and Urban Development's Healthy Communities Transformation Initiative, and on the Coordinating Committee for the Houston-Galveston Area Council Sustainability Planning Grant, among other committees.

KRISTINA PETERSON currently facilitates The Lowlander Center, a nonprofit organization that helps create solutions through education, research, and advocacy, beginning at the community level, for Lowland people and places in the bayous of Louisiana. Social and environmental justice is at the core of the Center's work. Through the Center, Lowlanders seek solutions to living with an ever-changing coastline and land loss, while visioning a future that builds capacity and resilience for place and people. Peterson's 30 years of postdisaster community redevelopment experience help communities to envision futures that mitigate vulnerabilities, to enhance existing systems, or to develop new systems to serve the public. Dr. Peterson was a founding board member of the National Hazards Mitigation Association, collaborator with FEMA's Project Impact, and national coordinator with Church World Service Disaster Services. She is an anthropologist who holds a Ph.D. in Urban and Regional Planning from the University of New Orleans, a Master of Sacred Theology and a Master of Divinity from United Theological Seminary, and a Bachelor of Arts in Urban Studies-Ethnic Studies, University of Puget Sound. She was made a fellow in the Society of Applied Anthropology in 1998, received the Prince Award for outstanding dissertation, the William Gibson Environmental Award in 2010, the Rural Sociology Society's 2014 Service to Rural Communities Award, and a citation from the State of Maryland for work on social and economic justice. She serves on the advisory board of the Thriving Earth Exchange, TEX, of the American Geophysical Union.

RICHARD POWERS is a psychiatrist and neuropathologist who received his medical degree from the University of Kentucky in 1976, and he completed his Internal Medicine internship at Butterworth Hospital in Grand Rapids, Michigan. He served for 3 years in the U.S. Army as a Squadron Surgeon and Clinic Director. He completed an Anatomical Pathology Residency at the University of Kentucky. He completed a psychiatry residency and neuropathology fellowship at Johns Hopkins Hospital. He practiced psychiatry and neuropathology at the University of Alabama School of Medicine where he held the rank of Professor prior to retirement in 2011. While at UAB, Dr. Powers also served as the Medical Director for the Ala-

bama Department of Mental Health and assisted with creating the geriatric mental health system for the state of Alabama as well as providing psychiatric services to persons with intellectual disability. He has subsequently practiced within the Veteran's Administration Health Care system as an Associate Chief of Staff for Geriatrics and Extended Care as well as in the Outpatient Mental Health Clinic caring for veterans with PTSD. He continues to remain active in teaching at the university as an Adjunct Professor in the departments of pathology and psychiatry. Dr. Powers has been involved in numerous public policy initiatives at the local, state, and national levels. He was one of the founding members of the Alzheimer's Foundation of America, and he has assisted with numerous advocacy programs on behalf of persons with dementia and their family caregivers. Dr. Powers is the recipient of numerous awards including his induction into the Alabama Health Care Hall of Fame and the Nathan Davis Award presented by the AMA in 2011 for public service provided at the state level. He is the author of numerous book chapters, scholarly publications, and consumer education programs that focus on neurodegenerative diseases or neuropsychiatric disorders.

ASHLEY ROSS is an Assistant Professor of Political Science at Sam Houston State University. She received a M.A. from Louisiana State University and a Ph.D. from Texas A&M University. Her research interests focus on comparative public policy with an emphasis on local governments. Her most recent work examined disaster resilience from the perspective of Gulf Coast emergency managers and municipal elected officials. This project was funded by the Department of Homeland Security, and the findings of this research are presented in the book *Local Disaster Resilience: Administrative and Political Perspectives*, recently published by Routledge.

PAUL SANDIFER is the Chief Science Advisor for NOAA's National Ocean Service (NOS). He oversees an agency-wide effort in ecological forecasting, leads NOAA's health strategy, is involved in the NOAA RESTORE Science Program and coastal ecosystem science. Previously he led NOAA's Oceans and Human Health Initiative and served as Senior Science Advisor to the NOAA Administrator. He is a member of the NAS Roundtable on Science and Technology for Sustainability and the IOM Roundtable on Environmental Health Science, Research and Medicine. He was a member of the U.S. Commission on Ocean Policy, and served on the Marine Board of the NRC, U.S. National Committee for the Census of Marine Life, and on numerous other boards and committees including the Founding Board of Directors of the South Carolina Aquarium. He is an Honorary Life Member of the World Aquaculture Society, a Fellow of the AAAS, a NOAA Research Fellow, and a recipient of South Carolina's highest civilian award, the Order of the Palmetto. Prior to coming to NOAA, Dr. Sandifer had a 31-year career with the South Carolina Department of Natural Resources, including service as agency director. He is a member of the graduate faculty at the College of Charleston.

MICHAEL SCHAFFER is the Division Director for Harris County Public Health and Environmental Services (HCPHES) Environmental Public Health Division, the local environmental public health department for approximately 1.9 million people. Mr. Schaffer applies a broad range of academic, private-sector employment, and consulting experience to meet the diverse environmental and public health challenges of today. Mr. Schaffer graduated with his M.B.A. from the University of Wyoming. He has spent 13 years in the electric energy industry working in both the thermal and wind divisions for PacifiCorp Energy. As his role of Director he had obtained extensive operations, business process, project management, and finance experience. Prior to entering the energy industry, Schaffer spent over 5 years managing various food establishments. As Division Director of Environmental Public Health for over 4 years, Mr. Schaffer manages a group of dynamic people to protect the public health by ensuring the integrity of the food supply, clean drinking water, neighborhood cleanliness (unsafe structures, environments that lead to harboring disease carrying pests), along with safe pools to swim in and working to minimize lead-based paint in homes. Mr. Schaffer has recently taken on a new and exciting lead role around community health and the built environment, which includes conducting health impact assessments. This program intersects the notion of public health with community planning, merging the worlds of community design, land use, and public planning along with public health.

TRACIE SEMPIER is the Coastal Storms Outreach Coordinator for the Mississippi-Alabama Sea Grant Consortium (MASGC). Her responsibilities include designing a Coastal Storms outreach and education program that will introduce people to storms tools, information, and partnerships. Dr. Sempier works with local communities, state and federal agencies, nonprofit organizations, port authorities, emergency and floodplain managers, residents, and other audiences to try and decrease the negative impacts of coastal storms on families, communities, the environment, natural resources, and property. Dr. Sempier is also the Regional Program Manager for the Gulf of Mexico Alliance (GOMA). Her position is a shared position between MASGC and GOMA. Her responsibilities include providing support to the six GOMA Priority Issue Teams for grants management (contracting and reporting), team calls, in-person meetings, and joint projects. Dr. Sempier is one of the authors of the Coastal Community Resilience Index that was pilot tested in 16 communities throughout the Gulf. She has trained over 70 facilitators to implement the tool, and a total of 45 communities

have completed the Index. This has given her a unique perspective on the challenges facing local governments and the types of information they need to address vulnerabilities and improve future land use decisions.

UMAIR SHAH is the Executive Director of Harris County Public Health & Environmental Services (HCPHES) and the Local Health Authority for Harris County, Texas—the third most populous county in the United States. Previously, Dr. Shah had served as HCPHES Deputy Director and its Director of Disease Control & Clinical Prevention since 2004. Prior to joining HCPHES, he was Chief Medical Officer at Galveston County Health District and since 1999 an emergency department physician at Houston's Michael E. DeBakey VA Medical Center. He earned his B.A. (philosophy) from Vanderbilt University; M.D. from the University of Toledo Health Science Center; before completing Internal Medicine residency, a Primary Care/General Medicine fellowship, and his M.P.H. (management & policy sciences) at The University of Texas Health Science Center. In addition to completing an international health policy internship at the World Health Organization in Geneva, he has provided leadership through the American Public Health Association, the Centers for Disease Control and Prevention, the Institute of Medicine of the National Academies, and the National Association of County and City Health Officials (NACCHO). Dr. Shah currently serves on NACCHO's board of directors. His numerous large-scale emergency response roles have involved Tropical Storm Allison; Hurricanes Katrina, Rita, and Ike; novel H1N1; and earthquakes in Kashmir and Haiti. His focus areas include population health, wellness, and prevention; health "innovation" technology; health care management; global/refugee health; health equity; and community/stakeholder engagement. He remains engaged in clinical patient care, academic teaching, and is actively involved in the local community.

CHRISTINA SIMONIELLO received a B.S. in Biological Sciences and Certificate in Marine Science from Florida International University. She has conducted herpetological studies in Everglades National Park, worked in analytical chemistry for the Drinking Water Research Center, Miami, and researched bears, birds, seals, and otters for the Fish and Wildlife Service, Alaska, following the Exxon Valdez oil spill. Completing her Ph.D. in Biological Oceanography at the University of South Florida, she has conducted research in the oceanic Gulf of Mexico, Florida Keys, Exumas, and Southern Ocean. Following 5 years developing programs for the Southeast Atlantic Coastal Ocean Observing System as faculty in the University of Florida Sea Grant College Program, she presently directs Outreach and Education activities for the Gulf of Mexico Coastal Ocean Observing System Regional Association (GCOOS-RA). Areas of special interest include using interdisciplinary skills to develop products and programs that benefit society by bridging the gap between research and applications. Current leadership roles include Chair, U.S. Integrated Ocean Observing System Association Education and Outreach Committee; Steering Committee and past-chair, Gulf of Mexico Alliance Environmental Education Network; Steering Committee Member, NOAA Gulf of Mexico Regional Collaboration Team; and Advisory Board, National Hurricane Museum and Science Center Development Team.

JOHN STEGEMAN received a Ph.D. in biochemistry from Northwestern University, and was awarded a D.Sc. (honoris causa) from Gothenburg University in Sweden. He has been studying hydrocarbon and other pollutant chemical metabolism and effects, primarily in aquatic species, for more than 30 years focusing on structure, function, regulation, and evolution of the cytochrome P450 (CYP) genes and enzymes involved in metabolism of chemicals and hormones. Dr. Stegeman has authored or co-authored over 200 publications, including studies of molecular biomarkers of chemical exposure in fish, birds, whales, and humans, and the mechanisms involved in chemical effects, including carcinogenesis, cardiovascular defects, and neurobehavioral disorders. He has served as journal editor and on several editorial boards, on NIH review groups, and on Advisory Boards of several NIH Centers. Dr. Stegeman chaired the Science Advisory Board of the National Toxicology Program, and served on and chaired committees for the National Research Council and the Institute of Medicine. He is a Lifetime National Associate of the National Academies. Dr. Stegeman was Chair of the Biology Department at Woods Hole Oceanographic Institution and is Director of the NSF/NIEHS Woods Hole Center for Oceans and Human Health.

GREGORY STEYER is a wetland ecologist who serves as branch chief for the USGS National Wetlands Research Center, Coastal Restoration Assessment Branch. He received his B.S. from the University of Maryland in 1985, M.S. in 1988 from the University of Louisiana at Lafayette, and Ph.D. at Louisiana State University in the Department of Oceanography and Coastal Studies in 2008. His research is focused on developing ecological indicators, adaptive management approaches, and ecological and landscape models for use in natural resource decision support. For over 20 years he has worked for State and Federal governments developing and implementing wetland mitigation plans, wetland restoration projects, and monitoring and research programs for the evaluation of wetland restoration projects and programs. Dr. Steyer has developed over 80 project-specific monitoring plans under the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) and a comprehensive wetland monitoring network for CWPPRA called the Coastwide Reference Monitoring System, that allows evaluation of the cumulative effects of restoration and protection efforts at hydrologic basin and coastwide scales. Dr.

Steyer has also developed desktop models for the Louisiana Coastal Area (LCA) and State Master Plan that project over 50 years how wetland vegetation communities and coastal geomorphology will change with and without restoration and protection efforts. His current research investigates the effects of disturbance events, primarily hurricanes, and sea level rise on coastal landscape change and resilience.

BILL VOCKE is a U.S. Coast Guard Environmental Protection Specialist with extensive and wide-ranging experience in environmental impact analysis, environmental regulatory development and compliance, and emergency preparedness. He currently serves as the Executive Director of the Interagency Coordinating Committee on Oil Pollution Research (ICCOPR). His background includes more than 6 years as an Environmental Engineer with the U.S. EPA, and 28 years providing consulting services on environmental and emergency management issues. Mr. Vocke has worked with federal, state, and local public health agencies to identify response and recovery issues associated with potential health emergencies such as waterborne illnesses, Marburg viral hemorrhagic fever, plague (Yersinia pestis) events, pandemic influenza, and bovine spongiform encephalopathy (mad cow disease). Mr. Vocke received a B.S. degree in Environmental Resource Management from Penn State University and an M.S. degree in Environmental Engineering from George Washington University.

ANN HAYWARD WALKER, president of SEA Consulting Group, has over 30 years of experience in applying knowledge from academic researchers, agency and industry practitioners, and other sources to enable timely and credible decision making around risks, especially those related to oil spills, dispersants, and liquid natural gas. Before founding SEA she was a coastal zone researcher at the Virginia Institute of Marine Science, College of William and Mary, and the University of Hawaii. She has responded to over 250 coastal spills during her career, most often in support of the U.S. Coast Guard and EPA, including the *Exxon Valdez* (EVOS) and *Deepwater Horizon* (*DWH*) incidents. Her special interests and experience include risk communication, stakeholder engagement at the local and state levels, fishers and seafood safety, and transdisciplinary risk assessment and management approaches involving the natural, health, and psychosocial sciences. She was the PI for a UNH Coastal Response Research Center grant on "Response Risk Communication Tools for Dispersants and Oil Spills." Onsite experience with the EVOS and *DWH* spills has led her to focus on human health risk perceptions associated with oil spills and dispersants and to develop institutional solutions to improve how we address these issues in the future.

CHUCK WILSON is a distinguished scientist and academic leader. He has held faculty and administrative posts at Louisiana State University (LSU) where he joined the faculty in 1984 as an assistant professor in the Department of Oceanography and Coastal Sciences. Since then, he has risen through the academic ranks to full professor and department chairman. Most recently, he has served as Executive Director of the Louisiana Sea Grant College Program, and prior to that as the Vice Provost for Academic Affairs. During his tenure at LSU, Dr. Wilson has received more than $15,000,000 in private, state, and federal funding for research and education programs, and has authored or co-authored more than 100 scientific publications.

STEVE WOLFE is a marine biologist, biological oceanographer, and environmental toxicologist who has been coordinating the efforts of the GOMA Water Quality Team for the past 8 years. The team's focus areas include coastal pathogens, harmful algal blooms, mercury in seafood, and water-quality monitoring. He earlier staffed the Florida Oceans and Coastal Council after spending more than a decade as a biologist, manager, and then administrator of the Central Biology Laboratory for the Florida Department of Environmental Protection. His experience includes program manager for a private company carrying out spiny lobster mariculture research and as technical writer for a series of USFWS Ecological Characterizations for portions of Florida's Gulf coast. His varied past also includes stints as deckhand on an oceanographic research vessel and as a certified auto mechanic, a few years building custom sailboats, and a period building diving bells, miniature dry submarines, and other commercial diving equipment.

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Workshop Attendees

Speakers and Guests

Kim Anderson
Oregon State University

Joe Banta
Prince William Sound Regional Citizens' Advisory Council

Eric Baumgartner
Louisiana Public Health Institute

Michael Blum
Tulane/Xavier Center for Bioenvironmental Research

Bruce Brackin
Mississippi State Department of Health

Ayanna Buckner
Community Health Cooperative

Rex Caffey
Louisiana Sea Grant and Louisiana State University

Anita Chandra
RAND Corporation

Craig Colten
Louisiana State University and The Water Institute of the Gulf

Robert Dickey
UT Marine Science Institute

Cornelis Elferink
University of Texas Medical Branch

David Gauthé
Bayou Interfaith Shared Community Organizing

Sharon Gauthé
Bayou Interfaith Shared Community Organizing

Angela Grajeda
American Red Cross–MS Region

Jennifer Horney
Texas A&M University

John Hosey
Gulf Coast Restoration Corps

Andrew Kane
University of Florida

Barbara Kirkpatrick
GoM Coastal Ocean Observing System (GCOOS)

Shirley Laska
University of New Orleans

Maureen Lichtveld
Tulane University

Susan Lovelace
South Carolina Sea Grant Consortium

Brian Mayer
University of Arizona

Aubrey Miller
National Institute of Environmental Health Sciences

Alexandra Nolen
University of Texas Medical Branch and Episcopal Health Foundation

Kristina Peterson
Lowlander Center

Troy Pierce
U.S. EPA Gulf of Mexico Program

Richard Powers
University of Alabama at Birmingham

Ashley Ross
Sam Houston State University

Paul Sandifer
National Oceanic and Atmospheric Administration

Michael Schaffer
Harris County Public Health and Environmental Services

Tracie Sempier
Mississippi-Alabama Sea Grant Consortium and Gulf of Mexico Alliance

Umair Shah
Harris County Public Health and Environmental Services

Christina Simoniello
GoM Coastal Ocean Observing System and GOMA Environmental Education Network

John Stegeman
Woods Hole Oceanographic Institution

Greg Steyer
U.S. Geological Survey

Linda Usdin
Swamplily, LLC

William Vocke
Interagency Coordinating Committee on Oil Pollution Research

Ann Hayward Walker
SEA Consulting Group

Chuck Wilson
Gulf of Mexico Research Initiative

Steven Wolfe
Florida Institute of Oceanography

Workshop Planning Committee/Advisory Group Members

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George Washington University

Bernard Goldstein
University of Pittsburgh

Linda McCauley
Emory University

J. Stephen Picou
University of South Alabama

LaDon Swann
Mississippi-Alabama Sea Grant Consortium/Auburn University

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Teri Thorowgood
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Maggie Walser
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E

Related Funding Programs

ORGANIZATION	SOURCE	FUNDING
Deepwater Horizon Oil Spill Trust, managed by the Gulf Coast Claims Facility (GCCF)	BP	$20 billion, $5 billion per year paid by BP
GoMRI (Gulf of Mexico Research Initiative)	BP	$500 million to be disbursed over 10 years
GRHOP (Gulf Region Health Outreach Program)	BP as part of the Deepwater Horizon Medical Benefits Class Action Settlement	$105 million to be paid over 5 years
NAS (National Academy of Sciences) Gulf Research Program	BP ($350 million) and Transocean ($150 million)	$500 million received from 2013 to 2018, and disbursed over 30 years
NAWCF (North American Wetlands Conservation Fund) managed by the U.S. Fish and Wildlife Service (FWS), the North American Wetlands Conservation Council (NAWCC), and the Migratory Bird Conservation Commission (MBCC)	BP fine for violations of the Migratory Bird Treaty Act	$100 million received from 2014 to 2019, and disbursed: $20 million within 60 days of sentencing (on January 29, 2013), $20 million within 1 year, $20 million within 2 years, $12 million within 3 years, $12 million within 4 years, and $16 million within 5 years
NFWF (National Fish and Wildlife Foundation)	BP ($2.394 billion) and Transocean ($150 million) from criminal settlements	$2.544 billion received from 2013 to 2018 and disbursed over 5 years
NIEHS (National Institute of Environmental Health Studies) *DWH* Research Consortium	NIH	$25.2 million over 5 years to the following universities and their community partners: University of Florida; Louisiana State University Health Sciences Center, New Orleans; Tulane University; and The University of Texas Medical Branch at Galveston
NRDA (National Resource Damage Assessment)		BP
OSLTF (Oil Spill Liability Trust Fund) managed by the U.S. Coast Guard National Pollution Funds Center		MOEX ($45 million from civil penalties); Transocean ($100 million from criminal penalties, $200 million from civil penalties); BP ($1.15 billion from criminal penalties)
RTF (Restoration Trust Fund) created by the RESTORE Act and managed by the Department of the Treasury		Transocean ($800 million) and BP (amount TBD) for civil Clean Water Act liabilities

SOURCES: Environmental Law Institute and Tulane Institute on Water Resources Law and Policy (2014); The BP Claims Fund website (accessed May 2014); Gulf of Mexico Research Initiative website (accessed May 2014); National Institute of Environmental Health Sciences website (accessed May 2014); and Louisiana Public Health Institute Primary Care Capacity Project, Gulf Region Health Outreach Program website (accessed May 2014).

PURPOSE	SPECIFIC ALLOCATIONS
Compensate for natural resource damages, state and local response costs, and individual financial damage.	
Fund research projects and consortia to understand, respond to, and mitigate the impacts of petroleum pollution and related stressors of the marine and coastal ecosystems, with an emphasis on the Gulf of Mexico.	
Inform residents of the Gulf region about their own health and facilitate access, now and in the future, to skilled frontline health care providers supported by networks of specialists knowledgeable in addressing physical, behavioral, and mental health needs.	$50 million to the Primary Care Capacity Project; $36 million to the Mental and Behavioral Health Capacity Project; $4 million to the Community Health Workers Training Project; and $15 million to the Environmental Health Capacity and Literacy Project
Establish a new research program focused on human health and environmental protection in the Gulf of Mexico and on the U.S. outer continental shelf, including issues relating to offshore oil drilling and hydrocarbon production and transportation.	For work in three program areas: oil system safety, human health, and environmental resources using three approaches: research and development, education and training, and environmental monitoring. Allocation among program areas and approaches were not specified.
Fund wetlands restoration and conservation projects located in states bordering the Gulf of Mexico or otherwise designated to benefit migratory bird species and other wildlife and habitat affected by the oil spill.	
Remedy harm and eliminate or reduce the risk of future harm to Gulf Coast natural resources that were adversely affected by the *DWH* explosion and oil spill.	$1.272 billion for barrier island and river diversion projects in LA; $356 million for natural resource projects in each of AL, FL, and MS; $203 million for projects in TX.
Create community–university partnerships to examine the long-term impact from the oil spill on the health of Gulf Coast residents and communities. This NIEHS research initiative and other related programs help communities and institutions in the Gulf and around the country understand how to be prepared for disasters and limit negative health effects related to disasters.	
Restore natural resources impacted by the spill to the condition they would have been in had the spill not occurred.	NOAA and the Department of the Interior (DOI) will each receive $100 million for projects to restore federal trust resources. The trustees for each Gulf State will receive $100 million; $300 million will be used for restoration projects that the state trustees suggest, and that NOAA and DOI select.
Fund federal agencies to administer the Oil Pollution Act (OPA), respond to future oil spills, and support research and development.	$50 million for the Emergency Fund, used for spill response and to initiate natural resource damage assessments. The rest is for the Principal Fund used to compensate those harmed by an oil spill when responsible parties cannot pay and, when appropriated by Congress to cover the costs of administering provisions of the OPA.
Varies with the process, but generally for restoration and protection of the natural resources, ecosystems, and economies of the Gulf Coast.	35% of the fund goes directly to the five Gulf States in equal shares; 30% goes to a regional Gulf Coast Ecosystem Restoration Council; 30% goes to the five Gulf States based on a formula that considers their respective disturbance from the *DWH* oil spill; 2.5% will support a NOAA-led Gulf Coast Ecosystem Restoration Science, Observation, Monitoring, and Technology program; 2.5% will sustain a competitive grant program to establish Centers of Excellence to conduct Gulf Coast research.