A Conceptual Framework for Understanding the Mental Health Impacts of Oil Spills: Lessons from the *Exxon Valdez* Oil Spill

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This paper introduces a conceptual framework for understanding and responding to the currently unfolding social and psychological impacts of the *Deepwater Horizon* oil spill. Drawing from the concept of corrosive communities and its relationship to theories of conservation of resources, cognitive activation, and risk and resilience, the conceptual model identifies three levels or tiers of impacts: biopsychosocial impacts that are direct consequences of the contamination of the physical environment; interpersonal impacts that are direct consequences of the biopsychosocial impacts; and intrapersonal or psychological impacts that are consequences of both the biopsychosocial and the interpersonal impacts. The model is then evaluated in light of research conducted in the aftermath of the *Exxon Valdez* oil spill as well as studies of other manmade disasters, and offers a set of testable hypotheses that predict likely impacts of the *Deepwater Horizon* oil spill. The conceptual framework may be used to identify strategies to develop community resilience and target specific services to prevent and mitigate these adverse effects.

The largest oil spill in the history of the United States began on April 20, 2010, with the explosion of the *Deepwater Horizon* drilling rig located 41 miles off the coast of Louisiana in the Gulf of Mexico. The explosion left 11 workers dead and another 17 workers seriously injured, and it resulted in a leakage of oil from the ocean floor 5000 feet from the surface. By April 30, the oil slick covered approximately 3,850 square miles of ocean surface, as well as islands and beaches on the coasts of Louisiana, Mississippi, Alabama, and Florida (CBS News, 2010). Before it was successfully capped on July 14, 2010, an estimated 4.9 million barrels, or 185 million gallons of crude oil, had been released from the leaking well (Robertson & Krauss, 2010). However, it was not until September 19, 2010, that the federal government declared the well to be "effectively dead." Estimates of the amount of oil remaining on or under the surface of the water vary widely (Camilli et al., 2010).

Despite the efforts of over 54,000 cleanup workers, the oil spill resulted in untold damage to the region's physical and

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social environments. The National Oceanic and Atmospheric Administration closed 86,985 square miles to commercial and recreational fishing and declared a fisheries disaster for the states of Alabama, Mississippi, and Louisiana, resulting in an initial loss of $2.5 billion in commercial fishing revenue (Walsh, 2010) and a rise in wholesale seafood prices nationwide (Jones, 2010). The economic impact on tourism in the region was believed to be even greater, resulting in an estimated loss of $23 billion over the next three years (Oxford Economics, 2010). In response to the spill, the federal government enacted a 6-month moratorium on further offshore drilling, jeopardizing the jobs of 58,000 oil industry workers and 260,000 others who work in oil-related businesses in Louisiana alone (Sasser, 2010).

Since the oil spill began, there have been widespread reports of distress and anxiety among residents of local communities related to the destruction of the ecosystem, the loss of employment in the fishing and tourism industries as well as businesses dependent on income derived from these industries, and the uncertainty over the long-term health effects of the oil and chemical dispersants. Although the long-term health effects of the oil spill have yet to be determined, there has been growing concern about the short- and long-term effects on the psychological health of the Gulf region (Institute of Medicine, 2010a; Solomon & Janssen, 2010; Yun, Lurie, & Hyde, 2010). A recent Institute of Medicine (IOM) report identified research on the psychological and behavioral health effects as a top priority (IOM, 2010b). These assessments were based primarily on preliminary evidence from the Gulf of Mexico (IOM, 2010a) and studies of the social and psychological effects of previous oil spill disasters (Palinkas, 2009; Picou, Gill & Cohen, 1997; Sabucedo, Arce, Senra, Seoane, & Vázquez, 2010).

There exist several different conceptual frameworks for understanding and responding to natural and technological disasters and acts of terrorism (Benight, Cieslak & Waldrep, 2009; Bolin, 1993; Kaniasty & Norris, 1993; Norris, 2006; Shalav, 2006; Ursano, McCaughey, & Fullerton, 1994). However, oil spills are unlike natural disasters and even other technological disasters in that there is no immediate loss of human life and the acute phase of the event usually unfolds over a much longer period of time. Nevertheless, oil spills have been found to produce significant impacts to the psychological health and social well-being of residents living in affected communities. Understanding these impacts requires the development and testing of a conceptual framework that is specific to this type of disaster. This paper introduces a conceptual framework for understanding and potentially mitigating the mental health impacts of the *Deepwater Horizon* and other future oil spills. It then evaluates this model in light of the results of studies conducted in the aftermath of the *Exxon Valdez* oil spill and other technological disasters.

THE CONCEPTUAL FRAMEWORK

In developing a conceptual framework for understanding the mental health effects of oil spills, it is important to consider how such events are similar to and different from other types of disasters. The mental health impacts of oil spills are in many ways similar to those of natural disasters, other technological disasters, and acts of terrorism. However, there are also two distinct characteristics of oil spills that are not always present in other types of catastrophic events. The first characteristic is that the acute or active phase of oil spills usually has a much longer *duration* than other types of disasters. It is during this phase that the event unfolds, in contrast to a subsequent phase or phases in which the destruction is remediated (recovery) or achieves a steady state (maintenance). Unlike a terrorist act that can occur over a span of seconds or minutes or a natural disaster in which destruction of the natural environment occurs within a matter of minutes, hours, or

days, the dispersion of oil itself may occur over a period of weeks and months. This longer duration is more likely to result in a prolonged period of acute stress.

The second characteristic is that such events are more likely to result in the disruption of social relations and less likely to result in a mobilization of social support. Communities affected by oil spills often meet the definition of a toxic or corrosive community. The notion of a toxic or corrosive community traces its origins to sociological studies of environmental hazards and technological disasters (Bolin, 1985; Edelstein, 1988; Freudenberg, 1997; Freudenberg & Jones, 1991; Kroll-Smith & Couch, 1990). In contrast to other communities impacted by disaster, corrosive communities are characterized by the following: a prolonged and pervasive exposure to the disaster event (i.e., longer duration of acute phase) (Baum & Fleming, 1993; Bolin, 1985; Brown & Mikkelsen, 1997); increased social conflict and competition for limited resources (Kreps, 1985), frequently accompanied by litigation to seek compensation for damages (Picou, Marshall & Gill, 2004); a loss of social connection and a sense of separation from other people (Erikson, 1976); and increased uncertainty about long-term outcomes (Baum & Fleming, 1993) and diminished trust in the ability of public officials and institutions to mitigate these outcomes or prevent future disasters (Couch, 1996; Erikson, 1994; Freudenberg, 1993).

The relevance of the concept of the corrosive or toxic community to understanding the mental health impacts of oil spills can be illustrated by examining its implications for three theoretical traditions within the field of disaster mental health. The first theoretical tradition is grounded in the loss or threatened loss of resources that occurs during and after a disaster. Hobfoll (1988) defines psychological stress as a reaction to the environment in which there is a net loss or threat of a net loss of resources—objects, personal characteristics, conditions, or energies that are valued by the individual. According to this Conservation of Resources (COR) model (Hobfoll, 1989), environmental circumstances may threaten people's status, position, economic stability, loved ones, basic beliefs, or self-esteem. Disasters in particular threaten resources such as housing and infrastructure, a sense of optimism and safety, employment and social relationships, and money and free time (Hobfoll, 2001). The actual or threatened loss of these resources is important because they have symbolic value as well as instrumental value in that they help to define for people who they are.

A second theoretical tradition in disaster mental health builds on the concept of risk and resilience (Bonnano, 2004; Raphael & Maguire, 2009; Yehuda & Flory, 2007). It is well known that some individuals are more vulnerable to traumatic events like disasters than others. Previous exposure to a traumatic event, for instance, increases the risk of an adverse reaction to a subsequent traumatic event (Robins et al., 1986). Individuals may be more or less susceptible to the mental health consequences of disasters based on the experience of pre-disaster psychiatric disorders (McFarlane, 1989; Nolen-Hoeksema & Morrow, 1991; North et al., 1999), age (Bromet, Parkinson, Shulberg, Dunn, & Gondek, 1982), gender (North et al., 1999), ethnicity (Norris, 1992), and socioeconomic status (Brewin, Andrews, & Valentine., 2000; Galea et al., 2007; Hawkins, Zinzow, Amstadter, Danielson, & Ruggiero, 2009; Norris, Friedman, & Watson, 2002). Similarly, individuals may be resilient to these consequences due to the availability and use of social and psychological resources, including perceived and received social support (Madakasira & O'Brien, 1987; Norris & Kaniasty, 1996), sense of coherence (Antonovsky, 1979), coping self-efficacy (Benight & Bandura, 2004), hardiness (Kobasa, Maddi, & Kahn, 1982), and internal locus of control (Baum, Cohen, & Hall, 1993). Both risk and resilience characteristics are believed to mediate or moder-

ate the impact of exposure to the disaster on physical and mental health outcomes.

The third theoretical tradition of disaster mental health builds on the relationship between cognition and affect. Disasters generate a great deal of uncertainty in affected communities, especially those that have never experienced a similar catastrophe. As Baum and colleagues (1983) noted, technological disasters create more uncertainty than natural disasters because they produce a perceived loss of control in contrast to the perceived lack of control over natural disasters. Consistent with the cognitive activation theory of stress (Ursin & Eriksen, 2004), the stress response is a general alarm in a homeostatic system, producing general and unspecified neurophysiological activation from one level of arousal to more arousal. The level of alarm depends on expectancy of the outcome of stimuli and the specific responses available for coping. Uncertainty produces high arousal. Because they are relatively uncommon events—even more so than natural disasters such as hurricanes, earthquakes, floods, and tornadoes—there is limited expectancy associated with the outcomes of oil spills, particularly the economic, environmental, and health outcomes.

Central to each of these three theoretical traditions is the social dimension of oil spills. Such events are associated with a loss of social resources due to the dispersion of populations as some residents of affected communities move away to seek employment elsewhere or are separated from family and friends while employed in cleanup activities. Oil spills may also result in a loss of natural resources that have social significance, as in the case of resources used for recreational or subsistence activities that bring social groups together. The unequal distribution of economic impacts and availability of cleanup employment or other resources during and after an oil spill leads to social disparities within a community or region, leading to the increased social conflict and reduced social support that characterizes a corrosive community. In such communities, the social connectedness, cohesion, and capital that may otherwise be mobilized in the aftermath of a catastrophic event to both obtain support from those with instrumental resources or affective capacity and to provide support to those in need (Bolin, 1982; Kaniasty & Norris, 1995; Mawson, 2005; Nakagawa & Shaw, 2004; Norris & Kaniasty, 1996), are largely absent. Finally, expectancies of the outcomes of oil spills are distributed and shared within and across social groups, representing a social cognition of shared understanding of outcomes and appropriate and effective means of coping (Hutchins, 1994; Wallace, Fullilove, Fullilove, & Wallace, 2007. In corrosive communities, the likelihood of sharing is minimized by the uncommon occurrence of such an event and the social conflicts that limit exchange of information or expectancies about oil spill economic, environmental, and health outcomes. Expectancies are further diminished by the lack of trust in public officials and institutions, another important source of information about disaster risk and outcomes. In the absence of such expectancies, fear and anxiety increase, leading to adverse psychological and psychophysiological outcomes.

The conceptual framework linking all three of these theoretical traditions is presented in Figure 1. Oil spills are associated with three groups or tiers of impacts. In the first group are five specific types of impacts that are direct consequences of the contamination of the physical environment: impacts on economic (e.g., fishing and other forms of resource harvesting, tourism, and recreation) and cultural (e.g., subsistence, recreation) activities, generation of cleanup related employment, generation of litigation to compensate victims, and short-term (e.g., respiratory and dermatologic conditions) and long-term (e.g., carcinogenic) impacts on health related to direct contact with the oil or dispersants. These are referred to as environmental or Tier I impacts. These impacts, in turn, are associated with a reduction in levels of social support, an increase in levels of social tension and conflict, and an increase

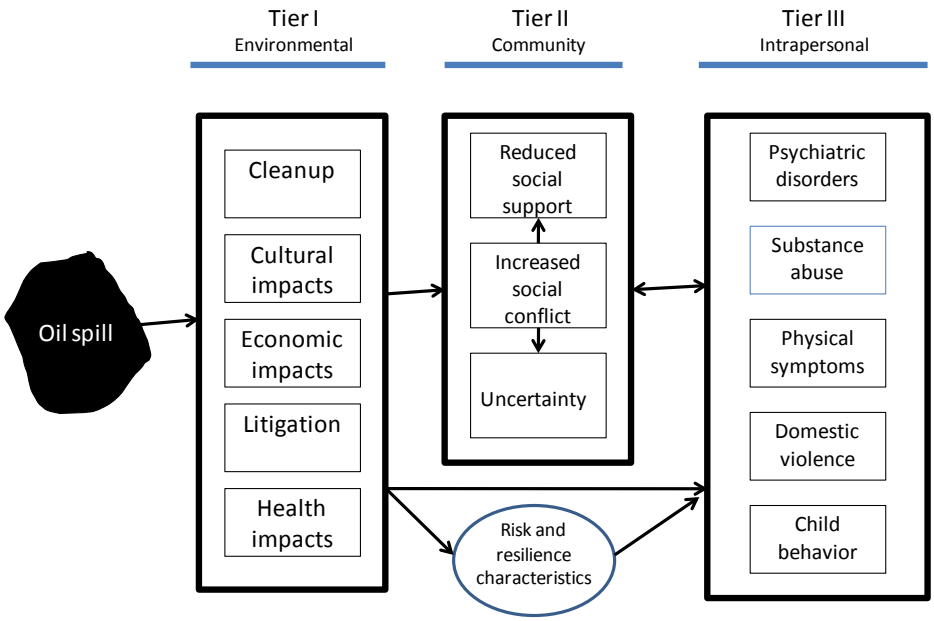

FIGURE 1. Conceptual Model of Mental Health Impacts of Oil Spills

in community-level uncertainty as to the long-term impacts of the spill. These are referred to as interpersonal or Tier II impacts. An increase in social conflict characteristics of toxic or corrosive communities may further reduce levels of social support and increase levels of uncertainty. These impacts, in turn, are associated with increases in the prevalence of posttraumatic stress disorder, depressive and anxiety disorders, drug and alcohol abuse, stress-related physical symptoms, domestic violence, and disruptions in child behavior. These are referred to as intrapersonal or Tier III impacts. Tier III impacts are also hypothesized to be significantly associated with increased levels of Tier I impacts. Combined with individual characteristics (i.e., social-demographic characteristics, pre-disaster psychopathology, past exposure to other traumatic events, individual coping styles and strategies) that serve as moderators, community-level impacts are hypothesized to mediate the association between Tier I environmental impacts and Tier III individual or intrapersonal impacts.

Data collected in the aftermath of the *Exxon Valdez* oil spill provide an opportunity to evaluate this conceptual model and identify its strengths and limitations in understanding the mental health impacts of oil spills. It is to these data that we now turn.

LESSONS LEARNED FROM THE *EXXON VALDEZ* DISASTER

What had been the largest oil spill in the United States prior to the *Deepwater Horizon* disaster began on March 24, 1989, when the supertanker *Exxon Valdez* ran aground on Bligh Reef (about 25 miles from the city of Valdez, Alaska), spilling over 11 million gallons (260,000 barrels) of crude oil into Prince William Sound. The oil spread more than 470 miles to the southwest along the Kenai Peninsula, Kodiak Archipelago, and the Alaska Peninsula. Cleanup efforts involved the hiring of thousands of local residents from nearby communities and outsiders seeking employment in jobs that paid $17.65 an hour.

TABLE 1. Impacts Identified from Exxon Valdez Oil Spill Studies by Tier and Tier Associations

Impact Tier	Variables		Reference
	Independent	Dependent	
	Combined*	Decline in subsistence activities	Palinkas, Downs et al., 1993
	Community	Decline in subsistence activities	Gill & Picou, 1997; Impact Assessment, 1990
		Property damage; Damage to commercial fishing; Economic losses; Cleanup participation	Impact Assessment, 1990
Tier 2 only	Community	Decline in social relations	Picou et al., 1992
Tier 3 only	Community	Intrusive stress/avoidance behavior	Donald et al., 1990; Picou et al., 1992; Picou & Gill, 1996
1 → 2	Combined*	Decline in social relations	Palinkas, Downs et al., 1993; Russell et al., 1996; McLees-Palinkas, 1994
	Combined	More fighting in community	Palinkas, Downs et al., 1993; Russell et al., 1996
	Combined	Social disruption	Palinkas, 2009
	Litigation involvement	Trust and perceived risk	Picou et al., 2004
2 → 3	Decline in social relations	Depressive symptoms	Arata et al., 2000; Palinkas et al., 1993
		Anxiety; PTSD; Intrusive stress/avoidance	Arata et al., 2000; Picou et al., 1992
	Social disruption	PTSD	Palinkas et al., 2004
	Uncertainty	Intrusive stress	Picou et al., 2004
1 → 3	Combined	Depressive symptoms	Palinkas et al., 1992; Palinkas, Downs et al., 1993; Palinkas, Petterson et al., 1993; Russell et al., 1996
		Generalized Anxiety Disorder	Palinkas, Downs et al., 1993; Palinkas, Petterson et al., 1993; Russell et al., 1996
		PTSD	Palinkas, Downs et al., 1993; Palinkas, Petterson et al., 1993; Palinkas et al., 2004, Russell et al., 1996
		Substance abuse	Palinkas, Downs et al., 1993; Russell et al., 1996
		Physical health symptoms	Palinkas, Downs et al., 1993; Impact Assessment, 1990
		Domestic violence	McLees-Palinkas, 1994
		Child development and behavior	McLees-Palinkas, 1994
	Litigation involvement	Depressive symptoms PTSD	Arata et al., 2000
		Intrusive stress	Picou et al., 2004
	Cleanup participation	PTSD symptoms	Donald et al., 1990

		Depressive symptoms; Generalized Anxiety Disorder; PTSD	Palinkas, 2009
	Decline in subsistence activities	PTSD	Palinkas et al., 2004
	Economic losses	Depressive symptoms; Anxiety; PTSD symptoms	Arata et al., 2000
		PTSD	Palinkas et al., 2004
1 → 2 → 3	Combined × family support	Depressive symptoms	Palinkas et al., 1992
	Litigation involvement × perceived risk	Intrusive stress	Picou et al., 2004
1 → moderators/mediators → 3	Combined × ethnicity	PTSD	Palinkas, Downs et al., 1993; Palinkas et al., 2004; Russell et al., 1996
		Depressive symptoms	Palinkas, Petterson et al., 1992
	Cleanup participation × ethnicity	Depressive symptoms; PTSD	Palinkas et al., 1992; Palinkas et al., 2004
	Property damage × ethnicity	PTSD	Palinkas et al., 2004
	Damage to commercial fishing areas × ethnicity	Depressive symptoms; PTSD	Palinkas et al., 1992; Palinkas et al., 2004
	Combined × age	Depressive symptoms; Generalized Anxiety Disorder	Palinkas, Downs et al., 1993; Russell et al., 1996
	Combined × gender	Depressive symptoms; PTSD	Palinkas, Downs et al., 1993; Russell et al., 1996
	Combined × parent status	Depressive symptoms; Generalized Anxiety Disorder; PTSD	McLees-Palinkas, 1994
	Combined x parent psychiatric status	Child Development and behavior	McLees-Palinkas, 1994
2 → moderators/mediators → 3	Social disruption × ethnicity		
Social support × ethnicity	PTSD	Palinkas et al., 2004	

Note. *Combined impacts include: participation in cleanup activities, damage to commercial fishing areas, damage to areas used for subsistence, property damaged, and other contact with the oil.

Tier I Impacts

The extent to which the natural environment was damaged by the *Exxon Valdez* oil spill remains the subject of considerable debate (Neff et al., 2006; Peterson et al., 2003). Nevertheless, during the year after the spill, commercial fishing and subsistence activities of local residents were significantly reduced because of the closure of certain areas to resource harvesting by state fish and game officials and the widespread fear that many commercial and subsistence foods were contaminated by the oil. In addition, Exxon provided cleanup employment opportunities at high wages to local residents in an attempt to offset the loss of commercial fishing income. However, these activities effectively removed individuals from their communities for long periods of time and prevented them from engaging in subsistence production and distribution activities (Palinkas, Downs, Petterson, & Russell, 1993). Interruption of the cycle of activity associated with subsistence has important symbolic significance for continuity in maintaining Alaska Native culture because such activities are fundamentally social in nature (Jorgensen, 1990), and because they provide an important linkage between self and social identities (Palinkas, 1987).

Table 1 summarizes the psychosocial impacts of the *Exxon Valdez* oil spill by tier and by associations between tiers. Reports of Tier I impacts were included in several studies conducted in the aftermath of the oil spill. In the Oiled Mayors Study (Impact Assessment, 1990), for instance, 8.2% of household survey participants reported property damage, 44% reported damage to areas used for commercial fishing, and 51.9% reported damage to areas used for subsistence fishing. One out of every four respondents (24.7%) participated in cleanup activities. In the mail survey received from 1,400 businesses in the North Gulf Coast region, gross business income for all respondents declined by 5% from 1988 to 1989 despite gains of approximately 13% attributable to 1989 oil spill cleanup earnings. Twenty-two percent of businesses reported a large decrease in net income. Spill-related expenditures for 14 selected communities exceeded $6.7 million (Impact Assessment, 1990).

In addition to the economic impacts, the oil spill also resulted in a decline in subsistence activities. In the Oiled Mayors Study household survey, 47% of respondents reported a decline in time normally spent hunting, fishing, and gathering; 41% reported a decline in time normally spent with people from other households engaging in these activities; 40% reported a decline in the amount of harvested food shared with others; 31% reported a decline in the amount of harvested foods received from others; 32% reported a decline in the number of household members engaged in subsistence activities; and 25% reported a decline in opportunities for children to learn hunting, fishing, and gathering skills. Each of these activities was significantly associated with level of exposure to the oil spill and cleanup (Palinkas, Downs et al., 1993). Gill and Picou (1997) also reported differences in the decline of subsistence activity by geographic proximity to the spill.

As described by Hirsch (1996), within days if not hours of the spill, seemingly hundreds of lawyers descended on small towns and villages throughout Alaska. In 1994, an Anchorage jury awarded $287 million for actual damages and $5 billion for punitive damages to a group of plaintiffs that included 32,000 fisherman, Alaska Natives, landowners, and others whose livelihoods were gravely affected by the disaster. After several appeals by Exxon, the punitive damages award was eventually reduced to $2.4 billion in 2006. In June 2008, the U.S. Supreme Court further reduced the damage settlement to $507.5 million. Moreover, claims by Alaska Natives that the oil spill had irreparably damaged their traditional culture, largely through the destruction of local subsistence resources, were dismissed by the court on the grounds that such losses could not be quantified in monetary terms, leading

to their further victimization by the oil spill (Gill & Picou, 1997).

Although there were anecdotal reports of cleanup workers experiencing headaches and blood in their urine associated with contact with chemical dispersants (Davidson, 1990), there were no systematic studies conducted of the short-term or long-term health impacts associated with exposure to the oil itself or the chemicals used in cleanup activities. Nevertheless, studies of other oil spills have documented both short-term and long-term health impacts, including throat, skin, and eye irritations, nausea and headaches, respiratory problems, as well as neuroendocrine function and genotoxicity (Aguilera, Méndez, Pásaro, & Laffon, 2010). In the Oiled Mayors Study, 37.8% of the household survey participants reported coming into contact with the oil (Impact Assessment, 1990).

Tier II Impacts

The oil spill also had a number of adverse effects on social relations both within and outside the household. Picou and colleagues (1992) reported that 38% of participants in the community of Cordova reported a change in relations with family members in 1989, compared to 8% in the control community of Petersburg ($p < 0.0001$). In the Oiled Mayors Study, exposure to the oil spill and cleanup was significantly associated with reported declines in social relations with relatives not in the home, friends and neighbors, coworkers, and residents of other communities, compared to the same period in 1988 (Palinkas, Downs et al., 1993; Russell, Downs, Petterson, & Palinkas, 1996). Individuals in the high-exposed group were also significantly more likely to report a conflict with outsiders and with friends since the spill than individuals in the not-exposed group. A measure of social disruption (Palinkas, Petterson, Downs, & Russell, 2004) that included relations both within and outside the household was 4.6 times greater in high-exposed individuals than in not-exposed individuals, and 2.8 times greater in low-exposed individuals than in not-exposed individuals (Palinkas, 2009).

The Oiled Mayors Study also found a significant impact of the oil spill and subsequent cleanup on social relations within the family. Due to spill-related disruptions, there was a reported decrease in time respondents spent visiting with other household members. In several native communities with high rates of cleanup involvement, 45% to 65% reported such decreases (Russell et al., 1996). Forty-five percent of those who worked on the cleanup reported less time spent with other household members, compared to 16% of those who did not work on the spill. Similarly, from 10% to 30% of the respondents in each of the affected communities indicated less time available for family vacations as a result of spill-related activities (Russell et al., 1996). Individuals in the high-exposed group were significantly more likely to report declines in socializing with other household members; sharing food, money, and other resources with family members; and overall household time together since the spill than individuals in the not-exposed group (McLees-Palinkas, 1994; Russell et al., 1996).

The loss of social resources because of cleanup employment opportunities was perceived by many to be distributed unevenly throughout the region. Some communities had a larger percentage of residents employed in such activities than other communities. Even within a community, some kin groups had a larger percentage of members employed in such activities than other kin groups. This led to conflict within and between members of families, extended kin groups and entire communities, effectively isolating individuals from actual or potential social resources (Palinkas, Downs et al. 1993).

Measures of expectancy (trust in public officials and institutions and perceived risk) were assessed in a study of litigation stress by Picou, Marshall, and Gill (2004). This

study found that participation in litigation after the oil spill was a significant predictor of "recreancy" (institutional trust) and oil spill risk. In the Oiled Mayors Study, 66.4% of household survey respondents stated that a future oil spill was "somewhat likely" to "almost certainly likely" to occur; 74.1% felt the effects of the spill were permanent, or at least would be present for the rest of their lives; and 50% said the spill would still be having negative effects on their families in five years (Impact Assessment, 1990).

Tier III Impacts

Several studies reported increased rates of posttraumatic stress symptoms in individual communities in the aftermath of the *Exxon Valdez* oil spill (Donald, Cook, Bixby, Benda, & Wolf, 1990; Picou et al., 1992; Picou & Gill, 1996). The Oiled Mayors Study found that exposure to the oil spill and subsequent cleanup was significantly associated with the post-spill prevalence of Generalized Anxiety Disorder (GAD), PTSD, and depressive symptoms (Palinkas, Downs et al., 1993; Palinkas et al., 2004; Palinkas, Russell, Downs, & Petterson, 1992; Russell et al., 1996). When age, sex, and ethnicity were controlled, members of the high-exposed group were 3.7 times (95% C.I. 2.0–7.0) as likely to have GAD, 2.6 times (95% C.I. = 1.2–5.7) as likely to have PTSD, and 2.1 times (95% C.I. = 1.0–4.5) as likely to have a CES-D score of 18 and above as were members of the unexposed group (Palinkas, Petterson, Russell, & Downs, 1993).

The oil spill also resulted in a significant increase in alcohol and drug abuse, as perceived by the respondents of the household survey. Individuals in the high-exposed group were significantly more likely to report an increase in alcohol and drug abuse in their community and among family and friends than individuals in the not-exposed group (Palinkas, Downs et al., 1993; Russell et al., 1996). In addition to a perceived increase in these activities, individuals in the high-exposed group were significantly more likely to report an increase in problems associated with alcohol and drug abuse in their community and among family and friends than individuals in the not-exposed group (Palinkas, Downs et al., 1993; Russell et al., 1996).

The Oiled Mayors Study also found a significant decline in health status associated with the oil spill. Level of exposure was significantly associated with a decline in perceived health status and an increase in both self-report and physician-verified post-spill physical health symptoms, including heart disease, high blood pressure, diabetes, thyroid problems, cancer, asthma, ulcers, bronchitis, chronic coughs, and skin rashes (Impact Assessment, 1990; Palinkas, Downs et al., 1993).

Exposure to the oil spill and subsequent cleanup efforts was also significantly associated with reports of domestic and interpersonal violence within the family. Analysis of the Oiled Mayors Study household survey data by McLees-Palinkas (1994) revealed that 49% of high-exposed households with children reported more fighting within the family than the year before the spill, compared to 15.3% of low-exposed households and 17.1% of not-exposed households ($p < 0.001$). A significant association between level of exposure to the spill and reports of more fighting within households compared to the year prior to the spill was also observed in households with children.

The household survey data and ethnographic interviews obtained from the Oiled Mayors Study also found that increasing exposure to the oil spill event was significantly associated with several child outcomes, including: a decline in children's relations with other children in the community, an increase in sleep disturbances, a decline in grades in school, becoming upset when someone talked about the spill, bedwetting, fear of being left alone, fighting with other children, and difficulty getting along with parents and sib-

lings (McLees-Palinkas, 1994). Exposure to the oil spill was also significantly associated with the two global measures of children's behavioral dysfunction: parent's assessment that the oil spill had an effect on their children, and scores on an index of children's behavioral disruption. These associations were independent of the gender, ethnicity, and age of the parent and the structure of the family.

Participation in litigation was also significantly associated with symptoms of depression and PTSD (Arata et al., 2000). Picou and colleagues (2004) found that litigant status and litigation stress were significant predictors of intrusive stress three and a half years after the oil spill.

Individuals involved in cleanup activities were especially vulnerable to adverse behavioral health outcomes for a number of reasons. These individuals were most exposed to the devastation resulting from the spill to the natural environment. They were able to observe firsthand the extent of the environmental damage resulting from the spread of oil and to grasp the significance of this damage in terms of its impact on their traditional way of life. They were also involved in the handling of remains of countless birds, otters, and other animals that were victims of the oil spread. They worked long hours attempting to halt the spread of oil and remove it from affected shorelines and beaches. Despite the lucrative salaries offered by Exxon's contractor, VECO, the pace and intensity of work led to fatigue and increased stress in many of those involved in cleanup activities. For many of those living in the communities directly exposed to the spread of oil, participation in cleanup activities often required spending long periods away from the community and the family, the suspension of subsistence pursuits that otherwise form the basis for many important social ties and obligations, and separation of parents from their children. The unequal distribution of cleanup jobs within and between communities led to feelings of bitterness and discontent such that cleanup workers were often subjected to criticism for having "sold out" to Exxon. In some instances, those who accepted these positions ran the risk of becoming social pariahs within the community and even within the family (Palinkas, Downs et al., 1993).

Participating in cleanup activities was associated with significantly increased rates of psychiatric disorder, a perceived decline in health status, increases in reported substance abuse and domestic violence within their communities and among families and friends as well as increased problems associated with these activities, and a decline in social relations and an increase in levels of social conflict. When age, sex, and ethnicity were controlled, Oiled Mayors Study household survey respondents who participated in cleanup activities were 2.3 times (95% C.I. = 1.5-3.7) as likely to have GAD, 1.8 times (< 1.0–3.4) as likely to have PTSD, and 1.9 times (1.1–3.2) as likely to have a CES-D score of 18 and above as were members of the unexposed group (Palinkas, 2009). The Valdez Counseling Center study found that respondents who earned the most money from oil spill cleanup activities in Cordova also were most likely to experience symptoms of PTSD (Donald et al., 1990).

Individuals who reported loss of important economic, cultural, and social resources experienced significantly higher levels of psychological symptoms and prevalence of psychiatric disorders. In the Oiled Mayors Study, 54.8% of Alaska Natives and 45.2% of Non-Natives reported a decline in subsistence activities compared to the same period one year before the spill (Palinkas et al., 2004). In both groups, a decline in subsistence activities was significantly associated with a significantly higher rate of PTSD. Similarly, 47.9% of Alaska Natives and 35.3% of Non-Natives participating in the household survey reported that the spill damaged commercial fishing areas they had used (Palinkas, Russell, Downs, & Petterson, 1992).

The prevalence of post-spill PTSD was also significantly higher in Alaska Natives and Non-Natives who reported damage to commercial fishing areas (19.8% and 14.3%, respectively) than their counterparts who reported no such damage (5.2% and 6.4%, respectively) (Palinkas et al., 2004). Individuals who experienced loss of income, despite taking on additional jobs to avoid loss, experienced significantly higher levels of depression, anxiety, and PTSD symptomatology (Arata et al., 2000). Picou and Gill (1996) found that measures of spill-related intrusive stress were significantly higher in the renewable resource community of Cordova than in the nonrenewable resource community of Valdez. Further, this study found significantly higher levels of intrusive stress among commercial fishermen than people who worked in other occupations in Cordova.

Direct and Indirect Effects

Tier II impacts of the disruption of social relations and/or low levels of social support were found to have direct influences on certain Tier III impacts. For instance, Palinkas and colleagues (2004) found that the prevalence of PTSD was independently associated with the amount of social disruption. This was especially true for Alaska Natives; those with high levels of social disruption were 14 times as likely (95%, C.I. = 1.2–163.3) to have a current diagnosis of PTSD as those with low levels of social disruption. A low level of family support was also a significant independent predictor of a PTSD diagnosis among Alaska Natives. Arata and colleagues (2000) found significantly higher levels of depression, anxiety, and PTSD symptoms to be independently associated with perceived negative changes in relations with family and nonrelatives. Palinkas and colleagues (1992) found high levels of social support to moderate the effect of Tier I exposure impacts on depressive symptoms.

Another Tier II impact of uncertainty was also found to mediate the association between Tier I and Tier III impacts. A study by Picou and colleagues (2004) found that the effect of litigant status on intrusive stress was mediated by work disruption, litigation stress, and perceived risk of future oil spills.

While the oil spill affected Alaska Natives and Non-Natives alike, the former were especially vulnerable to many of the psychosocial impacts described above. In the Oiled Mayors Study, 38.3% of the 189 Alaska Native participants reported participating in cleanup activities, compared to 19.1% of the 405 Non-Native participants ($p < 0.001$) (Palinkas et al., 1992). Alaska Natives were also significantly more likely than Non-Natives to report damage to commercial fishing areas (47.9% versus 35.3%, $p < 0.01$) and effects on hunting, fishing, and gathering (48.4% versus 28.3%, $p < 0.001$). Natives were particularly vulnerable to the effects of exposure on the prevalence of CES-D scores of 16 and above (O.R. = 1.3, 95% C.I. = 1.1–1.5) (Palinkas, Petterson, et al., 1993) and the effects of participation in cleanup and change in household income on mean CESD scores (Palinkas et al., 1992). Participation in spill cleanup activities, property damage, damage to commercial fishing areas, and a decline in subsistence activities were significantly associated with PTSD in Alaska Natives but not in Euro-Americans (Palinkas et al., 2004). On the other hand, damage to commercial fishing areas was significantly associated with higher levels of depressive symptoms in Non-Natives but not in Natives (Palinkas et al., 1992).

In the Oiled Mayors Study, additional differences in risk of Tier III impacts were observed by other social and demographic characteristics, suggesting a moderating effect, although no formal tests for moderation were conducted. For instance, a significant association between exposure to the spill and depressive symptoms and PTSD was observed for women but not for men (Palinkas, Downs et al., 1993; Russell et al., 1996). Similarly, a significant association was observed between exposure and depressive symptoms

and Generalized Anxiety Disorder in 18–44 year old adults, but not in older adults (Palinkas, Downs et al., 1993; Russell et al., 1996). The post-spill prevalence of GAD, PTSD, and CES-D scores of 16 and above was significantly associated with exposure to the oil spill among parents but not among other adults (McLees-Palinkas, 1994). Parents reporting changes in the behavior of their children were more likely to have a psychiatric disorder than parents reporting no changes. The post-spill prevalence of GAD and PTSD and the prevalence of depressive symptoms were all significantly associated with reports of the following: children having problems sleeping, children getting upset when someone talked about the oil spill, bedwetting as a new problem for children in household, children's fear of being left alone, children in household fighting more with other children, and children in household fighting more with parents since the oil spill.

OTHER TECHNOLOGICAL DISASTERS

Studies of other technological disasters have documented Tier I, II, and III impacts, although we could identify no study that examined all three simultaneously. Studies of the Chernobyl disaster documented increased risk of certain Tier III impacts, including depression, anxiety, posttraumatic stress, somatic symptoms, and self-reported poor health in subjects exposed to radiation compared to controls (Bromet & Havennar, 2009). Effects of the disaster on children's cognitive and emotional status were mixed. Mediating and moderating variables included female gender, perception of risk and level of uncertainty, relocation, low social support (not having a partner), low socioeconomic status (financial inadequacy), and having young children. However, apart from studies of mental health of cleanup workers (e.g., Rahu, Rahu, Tekkel, & Bromet, 2006), no studies appear to have been conducted on the effects of Tier I impacts on Tier III impacts, and no studies appear to have been conducted on Tier II impacts and their association with Tier I or Tier III impacts.

Studies of the Three Mile Island disaster also documented a host of Tier III impacts relating to exposure (proximity to the power plant), including symptoms of depression, anxiety, posttraumatic stress, high blood pressure, neuroendocrine markers, suppressed immune function, and stress-induced cancer (Baum & Fleming, 1993). Mediating variables identified included social support, loss of control, and coping style. Although these Tier III impacts were believed to be related to the loss of trust in public officials and institutions as sources of information, like the Chernobyl disaster, no studies appear to have been conducted on the effects of Tier I impacts on Tier III impacts, and no studies appear to have been conducted on Tier II impacts and their association with Tier I or Tier III impacts.

Studies of other technological disasters related to exposure to toxic chemicals, such as occurred at Love Canal (Fowlkes & Miller, 1982) or Times Beach (Smith, Robins, Pryzbeck, Goldring, & Solomon, 1986), transportation accidents (Bromet, Havennar, Glutzman, & Tintle, 2005), plant explosions (Van der Velden, Yzerman, & Grievink, 2009), or floods due to collapsing dams (Tichener, Kapp & Winget, 1976) have all documented various Tier III impacts, but no Tier I impacts and, with some exceptions (e.g., Erikson, 1976), no Tier II impacts or the relationship between Tier II and Tier III impacts. This is in spite of the fact that, like oil spills, other technological disasters frequently involve economic losses, litigation, hiring of cleanup workers, and both short-term and long-term health impacts. Unlike oil spills, however, other technological disasters rarely result in long-term impacts on cultural activities related to resource extraction (i.e., subsistence).

PARALLELS TO *DEEPWATER HORIZON*

As noted in the introduction, several of the Tier I impacts were observed during the acute phase of the *Deepwater Horizon* oil spill, including substantive economic damages inflicted on the region's seafood and recreation industries, and employment of over 75,000 local residents in cleanup activities. Despite BP's establishment of a $20 billion fund to compensate disaster victims, soon after the explosion of the *Deepwater Horizon* drilling platform on April 20, 2010, a series of lawsuits, most of which were class actions, were filed seeking compensation for financial losses covered by the Oil Spill Protection Act. Claimants include fishermen, recreation-related businesses, landowners, and seafood processors. As of April 2011, there were 510 active cases that have been filed seeking damages from the oil spill, according to the Environmental Law Institute (2011).

As with the *Exxon Valdez* oil spill, there is also evidence that the *Deepwater Horizon* oil spill was perceived by residents of the affected regions along the Gulf of Mexico as threatening their way of life. For instance, one story profiled a Gulf resident who was one of many seeking mental health support as a result of the spill. On June 9—Day 51 of the oil spill—the resident checked himself into the hospital after experiencing what he referred to as a nervous breakdown. "I feel like everything's been taken from me, you know? Not just my livelihood—my life…" (Rose, 2010). Just as the *Exxon Valdez* oil spill impacted cultural activities rooted in the subsistence harvesting of marine resources, the *Deepwater Horizon* oil spill adversely affected cultural activities rooted in the subsistence and recreational activities of Gulf residents (Benjamin, 2010).

Evidence of Type II impacts thus far has been largely anecdotal and focused on reports of social conflict and uncertainty. For instance, an Associated Press report on the spill mentioned the following:

> "Everybody's acting strange," said Robin, 56. "Real angry, frustrated, stressed out, fighting brothers and sisters and mamas and family." Fishing families, the backbone of the coastal economy, are especially hard-pressed as the waters that make up their livelihood are sporadically closed because of fears the oil will taint fish, oysters and shrimp….Oil field workers, whose salaries are among the best the region can offer, worry about their industry's long-term future. (McConnaghey & Stacy, 2010)

Qualitative interviews and focus groups with fishermen and community stakeholders conducted a few months after the oil spill found evidence of "increased suspiciousness and mistrust; the beginnings of dissent within communities; uncertainty about the future…and increased fighting and domestic violence" (Osofsky, Palinkas, & Galloway, 2010, p. 274).

Conflict over the unequal distribution of cleanup jobs, a Tier II impact, is another characteristic of the two oil spills that are similar in nature. In the Gulf of Mexico, commercial fishermen complained of being excluded from the Vessels of Opportunity Program initiated by British Petroleum to provide employment opportunities in cleanup activities to local residents affected by the closure of the commercial fisheries. BP was accused of hiring owners of recreational boats, part-time fishermen, and boat owners who lived outside the region (Schaper, 2010).

Evidence of Type III impacts also has been largely anecdotal. The qualitative studies of residents living on the Gulf coast reported instances of "anger, anxiety, symptoms of generalized anxiety disorder, acute stress reactions with early symptoms of posttraumatic stress disorder; increased use of alcohol, drugs, and cigarettes; more impatience and, at times, harsher behavior toward children…" (Osofsky et al., 2010, p. 274).

In June 2010, the suicide of 55-year-old William Allen "Rookie" Kruse, a charter boat captain, gained national attention. "Friends and families say that he was stressed out over his livelihood, had lost 30 pounds and wasn't sleeping" (Hennessey-Fiske, 2010).

CONCLUSION

Although evidence for the various components of the conceptual model introduced in this article and the linkages between these components can be supported from studies after the *Exxon Valdez* oil spill, as well as studies of other technological disasters, it is clear that no one study to date has provided a comprehensive examination of the entire model. Each study provides an important piece to the puzzle of what factors contribute to a mental health problem in the aftermath of an oil spill or other technological disaster and who is most vulnerable to these problems. However, efforts to prevent and mitigate such events are likely to require an understanding of the entire puzzle in order to effectively target selected interventions and programs to address specific impacts and segments of the population (Berren, Beigel, & Barker, 1982). The conceptual model offers one strategy for organizing the evidence obtained from individual studies to provide such a comprehensive mental health perspective on both process and outcomes of oil spills and other technological disasters that produce corrosive communities. However, definitive evidence to support certain elements, including the short-term and long-term health impacts at the Tier I level and the mediating influences of Tier II impacts of social support, social conflict, and collective uncertainty, remains to be obtained.

Ultimately, the validity and utility of the conceptual model will be determined on the basis of whether it accurately predicts the mental health impacts of the *Deepwater Horizon* oil spill and future oil spills. This will require longitudinal assessments of changes in employment and income, changes in cultural activities, cleanup participation duration, litigation participation, and indicators of short-term and long-term health status; measures of social support and conflict, measures of trust, risk perception, and uncertainty; and data on the number of individuals who meet criteria for a mental disorder, exhibit somatic symptoms or stress-related illnesses, are victims of domestic violence, abuse, or are dependent on drugs and alcohol, or children who exhibit behavioral problems. The Gulf Long Term Follow-Up Study (GuLF STUDY), under the direction of the National Institute of Environmental Health Sciences, has been initiated to learn about the possible health effects by studying over 55,000 cleanup workers and volunteers over a 10-year period. Use of structural equation modeling or hierarchical linear modeling is recommended to examine the multiplicity of direct associations and the influence of potential mediators and moderators of the associations between each of the three tiers. Longitudinal studies are recommended to elucidate the direction of causality between Tier II and Tier III impacts, as outcomes at the intrapersonal level may adversely affect patterns of social relations and support at the community level.

Even with the increase in efforts to find alternative sources of energy, the demand for oil continues to grow and will likely continue to do so into the distant future. One of the unfortunate consequences of this increased demand is the increased likelihood of oil spills on the scale of the *Exxon Valdez* and *Deepwater Horizon* disasters. Apart from the inevitable damage to the physical environment, the *Exxon Valdez* experience suggests that the spill of oil is equally likely to contaminate the social environment with wide-ranging mental health consequences. Understanding how this contamination occurs and how it affects mental health and well-being is critical to developing and implementing interventions designed to prevent and/or treat these mental health impacts. What we learn from the *Deepwater Horizon*

disaster as it continues to unfold will undoubtedly inform the response to future oil spills, but in order to learn anything from the present disaster, we must apply the knowledge gained from the lessons of the past. The lessons of the *Exxon Valdez* disaster provide the foundation for a conceptual framework that can inform the development and testing of hypotheses specific to the course and consequences of oil spills, hypotheses that will allow for more effective forms of mitigation of mental health impacts now and into the future.

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