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The *Exxon Valdez* Oil Spill and Chronic Psychological Stress

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Abstract.—We evaluated the long-term psychological impacts of the *Exxon Valdez* oil spill in terms of community structure and resource-based stress responses. Propositions and hypotheses that identify vulnerable communities and occupational groups were derived from an ecological–symbolic conceptualization of disaster impacts. Data collected from stratified random household samples in three Alaskan communities were used to empirically evaluate hypotheses. Chronic stress was documented for communities affected by the spill and for members of occupational groups most dependent on commercial fishing. These empirical findings support the need to recognize and evaluate stress in resource-dependent human communities when technological disasters, such as the *Exxon Valdez* oil spill, occur.

Over the last 25 years, the concept of disaster has been discussed, debated, and empirically studied in relation to an increasing variety of catastrophic events. As a result, the concept of "technological disaster" has emerged, bringing attention to the unique qualities and impacts of events that arise from failures of technology. The negative consequences of disasters stem from social responses to extreme stressors (Dynes 1993), yet some stress responses may vary according to the perceived source of the triggering event. For example, Tierney and Baisden (1979) identified greater long-term mental health impacts of the Buffalo Creek (West Virginia) dam collapse (a technological disaster) than of the Xenia (Ohio) tornado (a natural disaster). Researchers have extended this line of inquiry by investigating theoretical and applied issues related to the social and long-term psychological impacts of technological disasters (e.g., Erikson 1976, 1991, 1994; Titchener and Kapp 1976; Ahearn and Cohen 1984; Couch and Kroll-Smith 1985; Edelstein 1988; Bogard 1989; Kroll-Smith and Couch 1991a, 1993a, 1993b). In general, these studies consistently indicate that technological disasters produce chronic social and psychological impacts.

Research on well-publicized technological disasters at Three-Mile Island (Pennsylvania), Bhopal (India), Chernobyl (Russia), and Love Canal (New York) have documented a variety of initial and long-term psychosocial impacts (Brown and Harris 1979; Baum et al. 1982; 1983; Levine 1982; Shrivastava 1987; Houts et al. 1988; Bogard 1989; Davidson and Baum 1991; Weisaeth 1991; Baum and Fleming 1993). Furthermore, survey and case studies of less-publicized accidents involving toxic contamination and litigation in Livingston (Louisiana), Woburn (Massachusetts), and Legler (New Jersey) have shown prolonged community and neighborhood disruption as well as patterns of psychological stress and trauma (Picou 1984; Gill 1986; Edelstein 1988; Brown and Mikkelsen 1989; Gill and Picou 1991; Picou and Rosebrook 1993). Chronic stress resulting from technological disasters has been related to issues and perceptions of "uncertainty" regarding the extent and consequences of biophysical contamination (Vyner 1988; Davidson and Baum 1991; Erikson 1991) and protracted litigation (Brown and Mikkelsen 1989; Picou and Rosebrook 1993). Furthermore, technological disasters are characterized by a lack of finality which may result in the emergence of a "corrosive" or "abrasive" community context, and this, in turn, fosters the development of long-term stress and disruption (Freudenburg and Jones 1991; Kroll-Smith and Couch 1991b, 1993a).

This line of inquiry suggests that a paradigm shift is occurring in disaster research as a result of the persistent empirical anomaly presented by studies that consistently document long-term negative mental health outcomes for victims of tech-

nological disasters.[1] Such a pattern of chronic impacts is relatively rare for victims of "natural" disasters (Kreps 1980; Drabek 1986). This paradigm shift has led disaster researchers to propose alternative theoretical approaches (Kroll-Smith and Couch 1991a, 1993a) and to call for longitudinal research designs (Solomon 1989; Maser and Solomon 1990). Our study contributes to this line of inquiry by providing resource-based concepts of community stress response to evaluate hypotheses regarding long-term psychological stress resulting from the *Exxon Valdez* oil spill (EVOS).[2]

The *Exxon Valdez* Oil Spill

On 24 March 1989, the supertanker *Exxon Valdez* ran aground on Bligh Reef in Prince William Sound (PWS), Alaska, and released approximately 42 million liters of oil into several commercial fishing areas. Inadequate response to the spill exacerbated the situation and eventually over 1,900 km of rugged coastline were oiled (Skinner and Reilly 1989; Piper 1993). The EVOS occurred in the highly productive fishing grounds of PWS and spread to fishing grounds along the Kenai Peninsula, Cook Inlet, Kodiak Island, and the Alaska Peninsula. The spill occurred at the beginning of the most biologically active season and impacted ecosystem processes throughout the summer of 1989; havoc was wreaked through both contamination from oil and certain methods of cleanup (Hodgson 1989). Although the environmental disaster has been well documented and widely acknowledged, the human dimensions of the EVOS have been studied less and are perhaps most misunderstood.

The EVOS provides a case study of a technological disaster for evaluating emerging theoretical issues in disaster research. Social and organizational research on the EVOS has included studies of the political context and management of the accident, as well as cross-sectional analyses of initial social impacts (Impact Assessment, Inc. 1990; Browning and Shelter 1992; Clarke 1992; Gramling and Freudenburg 1992; Williams and Treadway 1992; Sellnow 1993). Studies conducted within the impacted region document that subsistence harvests by some groups of Alaskan Natives were severely disrupted (Fall 1990; Restoration Planning Work Group 1990) and that low harvest activities characterized "highly oiled" villages through 1991 (J. A. Fall, Alaska Department of Fish and Game, unpublished). Additional research suggests that social and cultural activities of Alaskan Natives were initially disrupted and threatened by the spill (Dyer et al. 1992; Dyer 1993). Furthermore, when compared to other ethnic groups, Alaskan Natives experienced relatively high levels of depression (Palinkas et al. 1992).

Studies of the economic impacts of the EVOS provide evidence that a dramatic increase in nonfishing wages characterized impacted regions immediately following the spill (Cohen 1993) and that losses incurred in 1989 and 1990 by commercial fishermen may have reached 155 million dollars (Cohen 1995). Furthermore, the influx of cleanup activity income in small Alaskan communities and Alaskan Native villages resulted in a variety of negative social impacts (Rodin et al. 1992). These impacts were associated with the destruction of the physical environment, the effects of the cleanup, and the organizational structure of Exxon and its subcontractor for the cleanup, VECO (Rodin, et al. 1992; Piper 1993).

Research findings also document the existence of a variety of initial negative mental health impacts resulting from the EVOS (Donald et al. 1990; Rodin et al. 1992; Palinkas et al. 1993). In terms of longitudinal data, one study found that patterns of disruption and stress persisted approximately 18 months following the spill (Picou et al. 1992). This research documented that high levels of intrusive stress and avoidance behavior characterized residents of an impacted fishing community (Cordova).[3] In addition, more personal, work, and community disruptions were found in Cordova than in a control community (Petersburg). These disruption trends were associated with stress levels in 1989 and 1990, suggesting the beginning of chronic psychological stress for the most threatened subpopulations (e.g., fishers, subsistence users) in impacted communities (Picou et al. 1992).

[1]The concept of paradigm shift identifies a reorientation of research questions in terms of alternative scientific explanations that incorporate recurring anomalies, or exceptions to traditional research (Kuhn 1962; McCann 1978). For examples of applications of this model of scientific development to sociology, see Wells and Picou (1981), Turk (1988), and Picou et al. (1990).

[2]We use EVOS to denote a range of activities associated with the *Exxon Valdez* oil spill, including the actual spill, the contamination, and cleanup activities.

[3]Intrusive stress and avoidance behavior are forms of psychological stress measured by the subscales of the impact of events scale (IES) (Horowitz 1974, 1976; Horowitz et al. 1979). The IES is listed as a component of the DSM-III criteria for post-traumatic stress disorder (Davidson et al. 1989; Shore et al. 1989).

Empirical documentation of the long-term impacts of technological disasters in general and the specific documentation of continuous social and psychological impacts resulting from the EVOS provide an opportunity to more fully examine long-term psychological impacts. In this paper, we report research that extends this line of inquiry: First, we develop the idea of a renewable resource community (RRC) to provide a theoretical basis for explaining chronic psychological stress. Next, we derive hypotheses regarding chronic stress from the conservation of resources (COR) stress model and empirically evaluate them from data collected 32 and 42 months following the EVOS. Finally, we discuss the results' theoretical and practical implications.

The Renewable Resource Community: An Ecological–Symbolic Approach

An RRC is a population of individuals who live within a bounded area and whose primary cultural, social, and economic existences are based on the harvest and use of renewable natural resources. The RRC perspective identifies direct links between seasonal ecosystem cycles and culturally-based community activities. Consistent with the ecological–symbolic approach to disasters, the RRC is a mediating social structure that organizes interpretive responses to the biophysical environment. The RRC contains a seasonal cycle for understanding community-ecosystem links through cultural and economic behaviors that occur at specific times during the year (Gill 1994).

A fundamental assumption of the RRC perspective is that, to varying degrees, all human communities are economically, socially, and culturally linked to biophysical resources. From the ecological–symbolic perspective, residents of an RRC exist in exchange relationships with their biophysical environment, and their collective interpretation of this relationship is essential for community equilibrium (Kroll-Smith and Couch 1991a; 1993a; 1993b).

The RRC is connected to the biophysical environment through resource harvests and uses. This connection can be economically structured on a cash or subsistence basis and socioculturally structured through behaviors, values, attitudes, and knowledge. Economic and sociocultural linkages are identifiable in terms of occupational and status roles associated with exchange networks of harvested resources. Further, sociocultural values found in subsistence activities provide a collective value set that links human conceptions of community culture to the biophysical environment. Consideration of the occupational nature of the RRC allows conceptualization of occupational behaviors that directly involve commercial harvests of renewable resources.

Cultural ecology provides a historical basis for understanding the early resource-dependent communities of the northwest coast of North America (Netting 1986). Direct links between culture, social organization, and resources have been identified by Jorgensen (1990:80–81) in his description of the "quintessential subsistence economy" once characteristic of Eskimo villages. Subsistence economics provide a cultural context for harvesting, consuming, exchanging, and maintaining renewable natural resources. With the absence of monetary capital, these communities are structured into relatively nonhierarchical systems in which the primary economic objectives are the maintenance of life, social organization, and culture (Jorgensen 1990).

The five communities in PWS all are small in population size and geographically isolated from each other. The Native Alaskan villages of Tatitlek and Chenega Bay are populated by fewer than 100 people and can be described as modern versions of traditional subsistence culture. Even though contemporary Native communities are far removed from traditional subsistence culture, subsistence still plays a vital role in terms of sociocultural structure and continuity with the past. The other three communities—Whittier, Valdez, and Cordova—have cash economies and predominantly non-Native (White) populations. To various degrees, these five communities are commercially and culturally linked to renewable natural resource harvests, particularly harvests of various fisheries in PWS.[4]

A 1993 social indicators study of Alaskan coastal villages (Anonymous 1993) classified PWS communities in terms of commercial fishing prevalence and transportation development. Prevalence of commercial fishing was based on the percentage of total community income derived from fishing related businesses. When cross-classified by the extent of transportation services, infrastructure, and social services, PWS communities can be delineated into

[4]Prince William Sound (PWS) is part of the "area E" commercial fishing region (Gill 1994). Of the three non-Native communities in PWS, Cordova best fits the renewable resource community concept. The character of Valdez is dominated by oil and the activities of the Aleyeska pipeline. Whittier's character is shaped by its historic role as a transportation and service center.

noncommercial fishing hubs, which are communities characterized by a fairly complex occupational division of labor and an "urban bias" afforded by transportation services, and commercial fishing periphery communities characterized by dependence on commercial fishing and a simpler division of labor.

The resource contamination that resulted from the EVOS simultaneously provided an immediate and a long-term threat to the commercial fishing industry in PWS. Cordova, the primary RRC in PWS, is an occupational community based on commercial fishing.[5] A wide variety of support occupations such as cannery packing, net mending, electronics repair, and boat repair are linked to and depend on commercial fishing. Limited cash revenues may be available to the RRC through tourism, harvests of nonrenewable resources, and government agencies. However, PWS communities dependent on renewable resources are geographically isolated, which severely restricts their economic diversification.

The Conservation of Resources Stress Model

Stress researchers have long noted the importance of social structure for understanding variations in stress responses (Kahn 1973; Pearlin 1989). The ecological–symbolic approach with the RRC perspective provides an understanding of community social structure in terms of threats posed by environmental contamination to renewable fishery resources. Environmental threats to human communities are stressors, and empirical studies clearly indicate that such stressors "cause measurable psychological problems" (Hallman and Wandersman 1992:114). The conservation of resources (COR) stress model (Hobfall 1988, 1989) takes an ecological perspective but recognizes that stress and coping occur within a social setting with characteristics that are as important as those of individuals. The COR stress model provides a more detailed specification of stress responses applicable to all types of disasters, and it is particularly appropriate for understanding the variations in stress response within an RRC.

The COR stress model integrates stress response approaches that have emphasized environmental and cognitive characteristics (Lazarus and Folkman 1984). A basic assumption of the COR explanation of stress "is that people strive to retain, protect and build resources and that what is threatening to them is the potential or actual loss of these valued resources" (Hobfall 1989:516). Stress occurs when people experience "(a) the threat of a net loss of resources, (b) the net loss of resources, or (c) a lack of resource gain following the investment of resources" (Hobfall 1989:516). Resources of direct concern for this model include "objects, personal characteristics, conditions, or energies" that have value and meanings for individuals (Hobfall 1989: 516).

In the context of the COR stress model, fisheries are "objective resources" that, within the EVOS impact area, are necessary for RRC economic, social, and cultural continuity. Residents of an RRC are directly linked to fishery resources through their social status (e.g., occupational role) and energy (time, money, skills, etc.). The threat to fishery resources posed by the EVOS is structurally linked to the social and energy resources of commercial fishers. Over time, this contamination threat to community-linked resources (i.e., objective resources) poses a threat to the economic infrastructure of RRCs in the impact region. For example, recent declines in PWS commercial harvests of pink salmon *Oncorhynchus gorbuscha* and the collapse of the fishery for Pacific herring *Clupea pallasi* provide an indicator of prolonged "objective" resource depletion (Ott 1992, 1994; Kizza 1993; Phillips 1993; Schneider 1993; Fried 1994; Steiner 1993). The actual and potential loss of fishery resources over time has, in part, been attributed to the EVOS. For this reason, the EVOS continues to be a source of actual and potential resource loss and continues to threaten the economic, social, and cultural structure of RRCs in the impact region.

Propositions and Hypothesis

Human impacts of the EVOS can be identified from a consideration of RRC dependency on renewable resources and in terms of the COR stress model. The EVOS threatened the essential economic, social, and cultural viability of RRCs in the impact region. No occupational group was more threatened by the EVOS than commercial fishers and those directly linked to commercial fishing. The oiled fishing grounds posed an immediate threat to the commercial fisheries and generated uncertainty regarding the long-term recovery of the resources. This threat and uncertainty were acute for individ-

[5]Oil spill damage to fisheries was not confined to Prince William Sound. In particular, Kodiak is a renewable resource community (RRC) that was impacted. However, the focus of our RRC analysis is Cordova.

uals in occupational roles related to commercial fishing.

Numerous types of losses are experienced as a result of any disaster (Dynes 1970). However, the loss or potential loss of renewable resources is a primary source of stress for victims of the EVOS. These renewable resources entail more than material values; they are important for establishing self-esteem and social standing as well as for transmitting cultural values and traditions. The uncertainty regarding the recovery and future use of renewable resources contributes to chronic stress. Furthermore, impacted communities and individuals have invested resources in litigation to recover damages and the lack of a timely final legal resolution further contributes to chronic stress (Gill 1994).

Occupational roles associated with commercial fishing link RRCs to the biophysical environment and establish direct socioeconomic consequences for deleterious effects of the EVOS. The theoretical conceptualization of the COR stress model and the RRC allows derivation of several propositions regarding environment-community linkages and impacts on humans in RRCs.

Proposition (1).—Renewable resource communities are directly linked to the biophysical environment by economic, social, and cultural structures.

Proposition (2).—The economic structure of RRCs consists of an occupational community built around commercial fishing.

Proposition (3).—The occupational role of commercial fishers structurally links the economic infrastructure of RRCs to resource harvest activities.

Proposition (4).—Contamination of fishing grounds is a direct threat to the economic viability of commercial fishing harvests in RRCs and is specifically a threat to occupational roles associated with fishing.

Proposition (5).—Real, potential, and perceived losses of resources resulting from contamination cause stress that becomes chronic as losses remain unresolved.

These propositions yield two general research hypotheses concerning the stress consequences of the EVOS. The first reflects that RRCs are more economically and culturally dependent than nonrenewable resource communities on fishing harvests.

Hypothesis (1).—Residents of RRCs will exhibit higher levels of oil-spill-related collective stress than residents of non-RRCs.

The second reflects that RRCs are structurally linked to the biophysical environment by the occupational role of commercial fishers.

Hypothesis (2).—People who work in commercial fishing occupations will exhibit higher levels of spill-related stress than people who work in nonfishing occupations.

These hypotheses provide a basis for assessing the validity of the RRC explanation of vulnerability to spill-related stress. As a group, occupations related to commercial fishing are seriously threatened by the spill and logically this occupational group becomes a focus for theoretically predicting empirical patterns of chronic stress impacts.

Methods

The strongest evidence concerning cause-and-effect relationships can be obtained when experimental designs are fully controlled and subjects are randomly assigned to treatment conditions manipulated directly by researchers (Campbell and Stanley 1963). However, environmental disasters cannot be manipulated directly by researchers, and subjects cannot be randomly assigned to treatment groups a priori. Instead, the community impacts of environmental disasters can only be assessed a posteriori with research designs and interview techniques adapted to the unique subject (Drabek 1970; Mileti 1987; Solomon 1989).

We relied on an ex post facto design (Spector 1981) in which the impacts of the EVOS were assessed by comparing communities and occupational groups that had experienced different potential adverse environmental impacts. Like most such field experiments, ours is subject to the criticism that preexisting group differences could account for the differences observed after the EVOS (Campbell and Stanley 1963; Spector 1981). However, the lack of prespill (baseline) data does not preclude evaluating theoretically based hypotheses within communities purposefully sampled in terms of conceptual and potential impact considerations. Using demographic and historical documents, we selected two communities within PWS and a third community from outside the EVOS impact region. Within PWS, Cordova was identified as an RRC and Valdez as a non-RRC. Petersburg was selected as an RRC outside the impact region.

Cordova: Impact Renewable Resource Community

Cordova was selected as an impact community because of its economic dependency on commercial fishing and its cultural heritage of subsistence. The community is at the southeastern edge of PWS, and it has remained geographically isolated since the

1964 earthquake (Janson 1975). Cordova has a cash economy derived primarily from commercial fishing (Anonymous 1993). Cordova fishers own 44% of all herring permits and 55% of all salmon fishery permits in the area E region (Stratton 1989). Approximately 50% of Cordova's labor force is employed in fisheries harvest and processing occupations (Fried 1994:1). The base population of 2,500 (18% Alaskan Natives) typically increases to over 4,500 during the summer commercial fishing season. Subsistence activities (harvesting and giving, or receiving fish, moose, deer, berries, etc.) characterize 90% of Cordova's households (Stratton 1989). Cordova can be classified as an RRC given the community's economic dependence on fishing grounds for commercial and subsistence harvests.

Although oil from the EVOS did not reach Cordova, many of the community's primary fishing areas were initially contaminated and closed, which severely disrupted the 1989 fishing season. Cordova was also a cleanup support community used by Exxon and its subcontractors. Some Cordova fishermen leased boats to assist in the cleanup and other residents were employed to clean beaches. During the first 3 years following the spill, residents experienced various disruptions in the fishing seasons and in their local economy as well as increased community conflict and segmentation (Gill 1994). Despite not being directly oiled, Cordova experienced significant shock, disruption, and uncertainty in the aftermath of the oil spill (Picou et al. 1992; Anonymous 1993).

Valdez: Impact Non-Renewable Resource Community

Valdez was selected as a second impact community. Prior to the 1964 earthquake, Valdez had little recorded history (Anonymous 1993). Following the total destruction and relocation of the community after the earthquake, Valdez experienced a modest economic boom from reconstruction activities. With the construction of the pipeline terminus in the 1970s, the Valdez population temporarily increased dramatically to over 9,000 residents. By the 1980s, however, the town's population had stabilized at approximately 3,500–3,900 residents (Anonymous 1993).

The Valdez economy is very different from the economy of Cordova. Valdez has three major employment sectors: transportation, primarily based on Alyeska's pipeline responsibilities; public sector employment; and seasonal tourism (Anonymous 1993). Valdez has a mixed economic infrastructure and is connected to other Alaskan communities by the Richardson highway. The economic significance of commercial fishing in Valdez is very small, accounting for less than 3% of employment and income (Anonymous 1993). Valdez was classified as a "hub, mixed" Alaskan community by Anonymous (1993). Thus Valdez is classified as a non-RRC in the impact region.

Petersburg: Control Renewable Resource Community

Petersburg was selected as the control community because it shares many economic, demographic, and geographical characteristics with Cordova. Petersburg is on an island in the southeastern part of the state. It is geographically isolated with no road connections outside of Mikoff Island. Petersburg has a population of 3,200, of which Alaskan Natives make up approximately 20%. Petersburg's economic base is commercial fishing, especially its $29.5 million salmon fishery. The community is home to a large commercial fishing fleet and various support businesses. Further, Petersburg residents engaged in subsistence activities at a rate similar to Cordova residents (Smythe 1988; Stratton 1989). These indicators provide a basis for classifying Petersburg as an RRC.

Although similar to Cordova in many ways, Petersburg has some distinctions. Petersburg has a distinct Norwegian heritage, whereas Cordova consists of an amalgamation of several European heritages. Petersburg is economically tied to Juneau (Alaska) and Seattle (Washington); Cordova's ties are to Anchorage (Alaska).

The most important distinction between these two communities, however, is that Petersburg experienced minimal direct impacts from the EVOS. The fishing grounds used by the vast majority of Petersburg's fishing fleet were not contaminated by the spill. Very few Petersburg fishers leased their boats during the cleanup and only a few own area E fishing permits. Thus, the use of Petersburg as a control community provided a very conservative standard for evaluating psychological consequences of the EVOS.

Data Collection

Data used in this analysis were collected in each of the three communities in 1991 and 1992. Data collection included face-to-face survey interviews, telephone interviews, and mail surveys. The research design in Cordova and Petersburg was based on an expansion of community research conducted

in August, 1989 (Picou et al. 1992).[6] The 1989 sample comprised 118 respondents from 102 households in Cordova and 73 respondents from 73 households in Petersburg. In 1991, we attempted to survey all individuals who had participated in the 1989 surveys and to systematically expand the samples. The 1991 Cordova sample was expanded by interviewing panel members' spouses who had not participated in 1989 and by interviewing adults from additional randomly selected households within the same geographical areas, exclusive of households selected in 1989 and identified Alaskan Native households. This procedure resulted in 228 respondents from 184 households. Random-digit-dialing telephone sampling was used to expand the original Petersburg sample. This resulted in 101 respondents from 101 households.[7]

In Valdez (1991), city maps of residential units were used to identify five geographical areas containing approximately the same number of households. Households within these geographical areas were randomly selected and adult members were asked to be interviewed. One hundred nineteen respondents from 100 households completed the survey.

Surveys in Cordova and Valdez were administered by a field team consisting of the researchers and select volunteers from the Earthwatch Center for Field Research. Volunteers participated in an intensive training program that sensitized them to the local ecology and culture and provided them with information on the oil spill and the nature of the research project. Volunteers also participated in interviewer training sessions patterned after one developed at the University of Michigan Institute for Social Research (Guenzel et al. 1983). In addition to learning how to conduct a survey, volunteers were given detailed explanations of the intent and purpose of each section of the survey. Each volunteer was given a mock interview test and only a limited number were permitted to conduct household surveys. Surveys were screened by the researchers daily. Screening consisted of a review of the survey to determine completeness and a debriefing period with each interviewer to discuss open-ended responses.

In 1992, a mailed survey was sent to all previous participants (original and expansion) in Cordova, Petersburg, and Valdez. The mail survey had three scheduled mailings and was augmented by telephone and personal contacts by researchers in each community. As a result, 163 surveys from 131 households were completed in Cordova, 61 surveys from 42 households were completed in Valdez, and 60 surveys were completed in Petersburg.

Response rates for the 2 years are provided in Table 1. Respondents who participated in the original 1989 household survey (O) are distinguished from those initially selected in the 1991 expansion (E). The highest response rates were in the impact region (70% in Cordova and 62% in Valdez, compared to 57% in Petersburg) and among participants from the original study.

The estimated sample error for Table 1 was based on the random selection of households in Cordova and Valdez and the random selection of telephone respondents among Petersburg households.[8] This sample error provides an estimate of the chances that the sample represents the actual population of each community. In Cordova, the 1991 sample error with a 95% band of confidence was 7.2% for a variable that showed 50% of the sample having some specific characteristic. Thus, if 50% of the Cordova sample were male, one would be 95% confident that the population figure of males is between 42.8% and 57.2%. With random sampling procedures being followed, 1 of 20 samples taken in this manner would be outside this band of confidence.

Sociodemographic Characteristics

Sociodemographic characteristics of the total sample and each community for both years are presented in Table 2. In general, the sample characteristics are similar to known population characteristics although some categories may be over- or underrepresented. For example, the Valdez and Cordova samples underrepresent males and the Petersburg sample overrepresents males. Nonmarried individuals are also underrepresented in all samples. However, differences in representation among demographic categories were not deemed large enough to warrant weighting of the data for this analysis.

[6]We attempted to exclude any purposeful bias in the activities that resulted in household selection. Selection of all households in Cordova was based on random procedures. Selection of households in Petersburg was based on random-digit-dialing techniques.

[7]We assumed that random digit dialing resulted in only one household being contacted.

[8]Sample error was estimated at the 95% confidence interval for a 50:50 binomial distribution and expressed in percentage points (plus or minus).

TABLE 1.—Response rates within original (O, 1989) and expansion (E) samples for the 1991 and 1992 household surveys in Cordova, Petersburg, and Valdez.

Measure	1991 O	1991 E	1992 O	1992 E	1992 O and E
Cordova					
Individual respondents					
Number (*N*)[a]	104	151	101	151	252
Completed	77	151	74	89	163
Not completed or returned	16	[b]	22	44	66
Refused	8	[b]	2	2	4
Deceased	1	[b]	1	0	1
Not found	2	[b]	2	16	18
Response rate	74.0%		73.3%	58.9%	64.7%
Adjusted response rate	76.3%		75.5%	65.9%	70.0%
Households					
Number (*N*)	95	116	92	119	208
Completed	72	116	67	72	139
Response rate	75.8%		72.8%	60.5%	66.8%
Estimated sample error[c]	7.2%				8.3%
Valdez[d]					
Individual respondents					
Number (*N*)		119		119	119
Completed		119		63	63
Not completed or returned		[b]		37	37
Refused		[b]		1	1
Deceased				[b]	[b]
Not found				18	18
Response rate				52.9%	52.9%
Adjusted response rate				62.4%	62.4%
Households					
Number (*N*)		100		100	100
Completed		100		42	42
Response rate				42.0%	42.0%
Estimated sample error[c]	9.8%				15.1%
Petersburg					
Individuals or households					
Number (*N*)[a]	67	68	66	68	134
Completed	34	68	43	16	59
Not completed or returned	20	[b]	21	22	43
Refused	12	[b]	2	0	2
Deceased	[b]		[b]	[b]	[b]
Not found	1		0	30	30
Response rate	50.7%		65.2%	23.5%	44.0%
Adjusted response rate	51.5%			42.1%	56.7%
Estimated sample error[c]	9.7%				12.8%

[a]Total number for original panel is adjusted for sample attrition. Those who died the previous year and those who were permanently lost (not found) were subtracted from the original number of respondents and households in Cordova (118,102) and Petersburg (73,73).
[b]Data are unavailable.
[c]Estimated sample error (alpha = 0.05) is reported for a 50:50 binomial distribution.
[d]Valdez was not part of the original 1989 study.

Indicators and Measures

Questionnaires containing similar indicators were used for data collection. Questionnaire items were selected because of their use in previous disaster research and their relevance to the EVOS. Our analysis focused on indicators of chronic stress, community type, and occupational role.

Psychological stress was measured by the intrusive stress subscale derived from the "impact of events scale" (IES). The IES consists of 15 items that elicit statements of potential responses to ex-

ing up the IES were originally derived from statements made by people who had experienced stressful life changes (Horowitz 1974, 1976; Horowitz et al. 1979). Responses to the instrument are anchored to a specific event as well as to time.[9]

[9]The exact wordings of the stem and the seven intrusive stress items were as follows. Stem: An accident like the *Exxon Valdez* oil spill can affect people in different ways. These effects may last long after the actual accident. Please read the following statements made by people after

TABLE 2.—Sociodemographic characteristics of 1991 and 1992 total and community samples. Percentages, means, and medians have been adjusted for missing data, and actual sample size may vary among characteristics.

Characteristic	1991 Total (N = 449)	1991 Cordova (N = 228)	1991 Petersburg (N = 102)	1991 Valdez (N = 119)	1992 Total (N = 285)	1992 Cordova (N = 163)	1992 Petersburg (N = 59)	1992 Valdez (N = 63)
Percent male	48.1	42.9	62.7	45.4	46.7	46.6	50.8	42.9
Percent married[a]	76.6	78.0	74.0	76.3	81.9	83.4	85.0	76.2
Percent white[a]	90.6	91.2	89.7	89.8	90.9	90.7	93.8	90.5
Percent commercial fishing	30.1	39.5	37.3	5.9	31.2	38.1	37.9	6.6
Percent commercial fishing households	44.6	59.0	45.1	16.8	44.8	52.8	55.9	13.1
Percent with household income $100,000 or more	14.0	15.1	2.8	19.8	13.3	11.7	6.1	23.6
Percent residing in single-family dwelling[a]	63.1	62.5	70.3	58.0	65.7	67.3	73.2	57.1
Mean age	44.2	44.4	46.3	42.1	45.8	45.0	48.3	45.4
Mean years in community[a]	18.5	20.0	22.5	12.2	19.2	19.7	26.6	12.9
Mean years of education[a]	13.7	13.6	13.9	13.7	13.7	13.5	14.1	13.8
Mean household size[a]	3.2	3.2	2.9	3.5	3.2	3.1	3.1	3.4
Median income category ($1,000s)	50–60	60–70	40–50	70–80	50–60	50–60	40–50	70–80

[a]1992 values are based on 1991 data.

The rationale underlying the development of the IES is that the more stressful an event, the more likely it is to have two consequences: (a) a high incidence of recurring, unbidden, and distressing thoughts and feelings; (b) a high incidence of deliberate attempts to suppress these feelings and avoid reminders of the incident. Each of these potential consequences is tapped by a subset of IES items. Seven questions that operationalize the intrusive stress subscale asked about the frequency of such spill-related occurrences.

Psychological stress as measured by the IES is associated with patterns of community post-traumatic stress disorder produced by disasters (Davidson et al. 1989; Shore et al. 1989). Nonetheless, this indicator may actually underestimate the wide variety of stress that characterizes communities experiencing disasters (Shore et al. 1989). The IES provides a valid and reliable indicator of event-related stress that has been used in previous disaster studies (Shore et al. 1989; Solomon 1989).

please indicate how often it was true for you *about the oil spill* during the past seven (7) days. It might not have happened at all during the past week, or during the past week, it might have occurred only *rarely*, *sometimes*, or *often*. Stress items: (1) I *thought about it* when I didn't mean to (the thought of the spill just popped into my mind). (2) Pictures about it popped into my mind. (3) Other things kept making me have *thoughts* about it (even when I didn't want to). (4) I had dreams about it. (5) I had *trouble falling asleep or staying asleep* because pictures or thoughts about it came into my mind. (6) I had waves of strong feelings about it (feelings about it just seemed to wash over me). (7) *Reminders* of it brought back feelings I first *felt* about it.

The intrusive stress subscale is the dependent variable for the statistical analysis. The seven-item scale ranges in summed scores from 0 to 35. The reliability of this subscale was assessed by Cronbach's alpha (Cronbach 1951). The alpha coefficients for 1991 and 1992 were 0.8725 and 0.8956, respectively, indicating a high degree of scale reliability. Independent variables are community type (impacted RRC–Cordova; impacted non-RRC–Valdez; nonimpacted RRC–Petersburg), and fishing–nonfishing occupations. Occupation was determined by an analysis of open-ended responses. Respondents who reported occupations such as commercial fisher (gillnetter, seiner, crabber, etc.), deck hand, net mender, marine mechanic, or cannery worker, were coded as fishing occupations. Nonfishing occupations included government employee, business owner, service worker, professional among others, and those with no stated occupation (e.g., retired, housewife, student, unemployed).

Levels of psychological stress were calculated for an impacted RRC (Cordova) and an impacted non-RRC (Valdez), and both impact communities were contrasted with the control RRC (Petersburg) for the years 1991–1992. Levels of psychological stress also were compared among fishing and nonfishing occupational groups both within and across communities for 1991–1992. Psychological stress was calculated from the intrusive subscale, and the Mann–Whitney U-statistic was used to test whether the comparison groups were selected from the same population (Siegel 1956).

TABLE 3.—Mann–Whitney *U*-tests of differences in intrusive stress between communities, 1991 and 1992.

Comparison	Mean	Mean rank	*Z*-score	*P*[a]	*N*	Direction
			1991 intrusive stress			
Cordova (C)	9.50	195.61			224	
Petersburg (P)	2.43	90.47	−9.459	0.0000	101	C > P
Valdez (V)	7.13	134.17			116	
Petersburg (P)	2.43	80.09	−6.666	0.0000	101	V > P
Cordova (C)	9.50	181.94			224	
Valdez (V)	7.13	148.40	−2.992	0.0014	116	C > V
			1992 intrusive stress			
Cordova (C)	8.51	121.97			160	
Petersburg (P)	2.79	72.60	−5.204	0.0000	57	C > P
Valdez (V)	5.98	70.83			61	
Petersburg (P)	2.79	47.38	−3.856	0.0001	57	V > P
Cordova (C)	8.51	115.21			160	
Valdez (V)	5.98	99.95	−1.599	0.0549	61	NS

[a]One-tailed probability.

Results

Community Comparisons

We first establish the logic of the RRC framework by comparing stress levels by region of impact. Next, we compare stress levels within the impact region for the RRC (Cordova) and the non-RRC (Valdez). The following hypotheses reflect these contrasts.

Hypothesis (1).—Residents of communities in the region of the EVOS will have higher levels of stress than residents from communities outside of the spill region.

Hypothesis (2).—Within the impact region of the EVOS, residents of renewable resource communities will have higher levels of stress than residents of nonrenewable resource communities.

Worded more specifically, hypothesis (1) is that spill-related stress is higher in Cordova and Valdez (impact communities) than in Petersburg (control community). Hypothesis (2) states that psychological stress is greater in Cordova than in Valdez.

Results of this analysis support both hypotheses (Table 3). In both 1991 and 1992, levels of intrusive stress were significantly higher in Cordova (impact) and Valdez (impact), than in Petersburg (control). These results suggest that communities in the impact region experienced chronic stress for at least 3.5 years following the EVOS. In both 1991 and 1992, Cordova had higher mean stress scores than Valdez; the difference was statistically significant in 1991 but not in 1992 at an alpha level of 0.05. The absolute difference between the mean stress levels in Cordova and Valdez increased from 1991 (2.37) to 1992 (2.53), and the probability of no real difference (0.0549) was only slightly greater than threshold in 1992. We believe that these results provide evidence consistent with the RRC perspective.

Occupational Group Comparisons

We extended the logic of the RRC framework to include the COR stress model for predicting differences in psychological stress by occupational group. The relevant hypothesis is as follows.

Hypothesis (3).—People who work in commercial fishing occupations will have higher levels of spill-related stress than people who work in other occupations.

The RRC model for understanding spill-related social psychological impacts was consistently supported by the data (Table 4). Between occupational groups in the total sample and the impact RRC (Cordova), commercial fishers had significantly higher levels of spill-related intrusive stress than nonfishers. Differences were not significant in the Petersburg samples, although they were directionally consistent with hypothesis (3), and the low mean scores for both occupational sectors indicate that (as expected) the Petersburg control community suffered no substantive negative psychological impacts 2.5–3.5 years after the EVOS.

Demographic Comparisons

It is possible that the inferred causal relationships between stress and RRC characteristics are spurious. To examine this possibility, we compared intrusive stress within demographic categories traditionally subject to differential stress responses (Mirowsky and Ross 1989; Kessler et al. 1994) for

TABLE 4.—Mann–Whitney *U*-tests of differences in intrusive stress between commercial fishing and nonfishing occupations, 1991 and 1992.[a]

Community and comparison	Mean	Mean rank	*Z*-score	*P*[b]	*N*	Direction
		1991 intrusive stress				
Total sample						
Fishing (F)	9.98	255.02			133	
Nonfishing (NF)	6.08	206.31	−3.730	0.0001	308	F > NF
Cordova						
Fishing (F)	12.39	131.64			88	
Nonfishing (NF)	7.63	100.11	−3.563	0.0002	136	F > NF
Petersburg						
Fishing (F)	3.16	55.71			38	
Nonfishing (NF)	1.98	48.16	−1.591	0.0558	63	NS
		1992 intrusive				
Total sample						
Fishing (F)	9.77	161.32			84	
Nonfishing (NF)	5.51	126.19	−3.451	0.0003	189	F > NF
Cordova						
Fishing (F)	11.92	95.32			59	
Nonfishing (NF)	6.59	69.17	−3.522	0.0002	98	F > NF
Petersburg						
Fishing (F)	3.68	30.98			22	
Nonfishing (NF)	2.29	26.90	−1.026	0.1526	34	NS

[a]The Valdez community sample was excluded because it included only seven commercial fishers.
[b]One-tailed probability.

each community and the total sample. Levels of intrusive stress did not vary significantly by age, education, ethnicity, and the presence or absence of dependent children (Table 5). The only significant community differences found (between genders and between marital groupings) were in Valdez, a non-RRC sample. These results provide evidence that the relationships observed in our analysis are not spurious.

Discussion

This research provides a conceptualization of social structure that, to varying degrees, characterizes communities located in the impact region of the EVOS. From an ecological–symbolic perspective, an RRC is defined in terms of economic, social, and cultural dependence on the biophysical environment. This dependence is reflected in role behaviors (e.g., commercial and subsistence harvesting) that were directly threatened by the EVOS. The COR stress model identified objective, personal, and social resources and corresponding losses of and threats to those resources as a context for understanding stress-related responses to the *Exxon Valdez* disaster. The resources and the corresponding human behaviors toward them are interpreted in terms of community social structure that is conditioned by its relationship with the biophysical environment.

The RRC perspective and the COR stress model provide a theoretical framework for deducing testable hypotheses regarding patterns of chronic psychological stress resulting from the EVOS. Postspill data collected in categorized communities in 1991 and 1992 provided the basis for an empirical eval-

TABLE 5.—Mann–Whitney two-tailed *U*-test probabilities of differences in demographic comparisons of intrusive stress for total and community samples, 1991. Directionality is shown parenthetically for significant differences (alpha = 0.05).

Demographic comparison	Total	Cordova	Petersburg	Valdez
Age (55 and over versus under 55)	0.1685	0.6719	0.7177	0.4480
Gender (female [F] versus male [M])	0.5980	0.7711	0.9040	0.0127 (F > M)
Marital status (nonmarried [NM] versus married [M])	0.0373 (NM > M)	0.1042	0.1626	0.0255 (NM > M)
Education (high school or less versus more than high school)	0.4978	0.3638	0.2813	0.6591
Ethnicity (White versus non-White)	0.4288	0.0865	0.3697	0.2728
Dependent children (no versus yes)	0.9048	0.3101	0.9648	0.3373

uation of the hypotheses. The data analysis indicated that the RRC model effectively differentiated the impacts of the EVOS on Alaskan communities. The COR stress model affirmed this differentiation and further showed that chronic patterns of psychological stress characterized groups occupationally tied to commercial fishing. These results provide evidence that the EVOS produced chronic patterns of psychological stress that differentially impacted communities and individuals. The COR stress model results suggest that the RRC classification captured, among other things, perceptions of vulnerability to and threats of future economic loss. The data analysis shows that, overall, mean levels of intrusive stress have been decreasing over time in the two PWS communities communities examined (Cordova and Valdez). However, for commercial fishing occupations in Cordova, high stress levels continued from 1991 to 1992, suggesting a chronic stress response based on resource depletion and continuing threats to fishery resources. Previous research on technological disasters and chronic stress has shown significant relationships between long-term psychological impairment and symptoms of post-traumatic stress disorder (Davidson and Baum 1986).

How should our findings of chronic psychological stress be interpreted? The intrusive stress subscale of the IES is an "... efficacious measure of post-traumatic adjustment in crime victims and other personal injury victims, combat veterans, and bereaved individuals" (Seidner et al. 1988:256). A longitudinal study of rape victims reported that initial intrusive stress scores of 20 and above signaled a need for clinical therapy and that intrusive stress scores averaged 11.40 two years after initial treatment (Seidner et al. 1988). In comparison, Cordova's commercial fishing occupations had a mean intrusive stress level of 12.39 in 1991 and 11.92 in 1992. The traumas of rape and oil spill are disparate, but the similarity in mean intrusive stress scores between these two cases is revealing: at least 2 years (rape) to 3.5 years (EVOS) after a destructive event, stress levels in the affected populations remain high.

The EVOS has had negative psychological impacts on communities affected by the oil spill and its aftermaths. Demographic comparisons convince us that our results are not spurious. As predicted from the RRC perspective, we observed consistent and statistically significant associations between intrusive stress, community type, and occupational groups. The attribution of "cause" is complex and, for many, an impossible task for social science (Cook and Campbell 1979). Nonetheless, causal inferences can be made when the criteria of rationale, temporal sequence, association, and nonspuriousness are met by social science (Labovitz and Hagedorn 1971). Our research design and analysis meets these criteria.

Our findings of elevated stress in RRC communities and within commercial fishing occupations are consistent with an ever-growing body of research on the long-term consequences of technological disasters (Baum and Fleming 1993; Kroll-Smith and Couch 1993a, 1993b). In addition, our results are consistent with other studies of the social and psychological impacts of the EVOS (Donald et al. 1990; Palinkas et al. 1992, 1993; Picou et al; 1992; Rodin et al. 1992). Although these studies have used various methodologies to collect data, all consistently identify social, psychological, and behavioral impacts resulting from the EVOS. These studies, combined with the present study, provide strong convergent evidence that the EVOS had negative social and psychological impacts on local communities. Although the empirical evidence in our study is limited to three communities, the theoretical basis for community selection allows our findings to be generalized in terms of renewable resource dependency and associated occupational roles.

The theoretical and methodological implications of this research are that the nature and significance of cultural and social links to the biophysical environment should be conceptually delineated and empirically evaluated in greater detail. We have considered only general measurement of RRC social structure and only one role linkage (commercial fishing) to the biophysical environment. The importance of social and cultural linkages for understanding negative impacts on traditional subsistence activities and behaviors, as well as on self-concept and belief systems, should be further developed and evaluated.

Longitudinal data collection is essential in extending this type of inquiry. However, the reality of litigation and the ability of adversarial parties to subpoena research documents virtually precludes this methodological strategy in the future (Marshall 1993). Alternatively, longitudinal studies of these events could be conducted under the auspices of a judicial court order (Picou and Rosebrook 1993) or if litigation were bypassed in mitigating negative impacts and resolving disputes.

Given the scientific findings on technological disasters in general and on the EVOS in particular, it is imperative to recognize legitimate long-term human impacts resulting from such events. It is impor-

tant to understand the sources of distress and to put this knowledge to use in mitigating negative social and psychological impacts. A tremendous amount of money and effort has gone into restoring the environmental damage caused by the EVOS (*Exxon Valdez* Oil Spill Trustee Council 1994). However, as this study indicates, true restoration must also include the reestablishment of a social equilibrium between the biophysical environment and the human community. We have empirically documented that an imbalance exists in impacted RRCs and among individuals occupationally linked to commercial fishing. Community restoration would be directly facilitated by mitigation strategies designed to resolve community conflict and uncertainty and reduce chronic psychological stress. Without mitigated human restoration, the persistent threat, uncertainty, and lack of economic and ecological resolution resulting from the EVOS will continue to produce patterns of chronic stress. In summary, the restoration of renewable resources must be accompanied by the restoration of the quality of life in communities negatively affected by the EVOS.

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