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PUTTING RESPONSE AND NATURAL RESOURCE DAMAGE COSTS IN PERSPECTIVE[1]

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ABSTRACT

The total private and social cost of oil spills is of great interest to industry, responders, and regulators, but relatively few incidents have been examined in detail. Furthermore, publicly available cost data are often limited to State and Federal response costs and natural resource damage settlements. Significant categories of costs, such as private response costs, third party claims, and vessel or facility repair costs, are often not publicly available. Failure to consider these additional cost categories may result in erroneous conclusions regarding the total cost of spills and the relative significance of any one cost category. In this paper we update our previous analysis (Helton et al., 1997) on the various categories of costs that may result from spill incidents. We present and discuss the costs for a number of incidents representing a range of spill volumes and locations. Our data show that, contrary to the perception, costs for natural resource damages and assessment comprise only a small portion of total liability from an oil spill.

[1] This article expresses the views of the authors and does not necessarily reflect the views of NOAA.

BACKGROUND

In the aftermath of the *Exxon Valdez* spill in Alaska's Prince William Sound, Congress enacted tougher legislation, the Oil Pollution Act of 1990 (OPA), which expanded the oil spill prevention, preparedness, and response responsibilities of both the federal government and industry. Industry has voiced concern about the costs associated with their responsibilities under OPA, including the potential liability for damages to natural resources. The publicity associated with the natural resource damage assessment (NRDA) settlement[2] for the *Exxon Valdez* spill created a false public perception that these claims comprise the major portion of the overall cost of spills. In testimony before Congress and through comments on the Federal NRDA regulations, industry and trade groups have asserted that NRDA costs comprise a major portion of the overall cost of spills (Miller, 1996) and that these costs threaten industry viability (for example, see Kramer, 1995 and Hobbie, 1996).

However, to date, the financial costs of few incidents have been examined in great detail, thus there is incomplete information on the composition of spill costs (NAS, 1991). Publicly available cost information is often limited to State and Federal response costs, fines and penalties, and natural resource damage settlements. Other cost components, including private response costs, third party claims, and loss of (or damage to) cargo and vessels are often confidential. Failure to consider these additional cost categories because of unavailable data may result in erroneous conclusions regarding the total cost of spills and the significance of any one category.

[2] The reference to NRDA cost throughout this paper includes natural resource damage claims and assessment costs.

Our data show that in cases with NRDA claims, the *Exxon Valdez* included, NRDA costs generally represent only a small proportion of total liability from an oil spill. Most cases, however, do not contain natural resource damages. According to the USCG Office of Investigations and Analysis, there are between 5,000 and 10,000 oil spills reported annually in the US coastal zone. Natural resource trustees conduct damage assessments in fewer than 1 percent of these cases. Thus, our data set substantially overstates the prevalence of NRDA claims in oil spill incidents.

THE DATA SET

We collected data on spill incidents from a variety of sources, including settlement consent decrees, the U.S. Coast Guard National Pollution Fund Center, the U.S. Department of Justice, the Office of Pipeline Safety, Minerals Management Service, Golobs Oil Pollution Bulletin, the Oil Spill Intelligence Report and the Oil Spill U.S. Law Report. For each incident, we attempted to obtain cost information on: 1) responsible party response costs; 2) federal and state response costs; 3) assessment costs; 4) natural resource damages; 5) third party claims; 6) penalties; and 7) other costs, including salvage and repair costs, delay and additional operating costs, and lost or damaged cargo costs.

We obtained cost data on 48 spill incidents across the U.S. These incidents occurred between 1984 and 1997, and ranged in size from 0 (the threat of a release) to 11 million gallons. The cases were selected based on the availability of cost data, and do not reflect a statistically valid subset of spills: the database is skewed towards larger incidents with natural resource damage claims.

RESULTS

Complete cost information was not possible to obtain since many categories of cost are not routinely made public. As a result, we excluded spill incidents with minimal cost information. Even among the included cases (see Table 1), cost information was not complete. When cost estimates are reported, they should be considered partial and spill volumes should be viewed with some skepticism.

Cost breakdowns for incidents in our data set are summarized in Table 2.[3] Because of the incomplete nature of the data, we present the component proportions, for each case, as a percentage of total known costs. This of course overstates the share of components with complete information. To further the discussion, we outline the cost categories and then provide a sample of case histories. The detail in the case summaries illustrates the effect of spill context on the make-up and magnitude of costs.

COST CATEGORIES

Under the "polluter pays" principle of U.S. law, a responsible party (RP) may face an array of costs following a spill.[4] We summarize some of the major cost categories, but refer the reader to Etkin (1994, 1998) for a more thorough discussion of RP liability following an oil spill.

[3] The costs in the table are presented in 1997 dollars. Adjusting costs to a standard year's value requires knowing the year that each individual cost is incurred. This is not always known and instead one may only know the year of the settlement or the year of the spill. Therefore, the costs of a spill in 1997 dollars in Table 2 should be considered estimates.

[4] 33 U.S.C. § 2702.

Response

Response costs may include, but are not limited to, labor and equipment costs necessary for salvage and lightering, containment and protection of sensitive areas, recovery, shoreline cleanup, waste disposal, and wildlife rehabilitation. Under OPA, the party responsible for the spill is liable for cleaning up the incident under supervision of Federal and State response agencies.[5] Occasionally when the responsible party is unknown, or financially or otherwise incapable of adequately responding, the Federal and State agencies take over the response to the incident and seek to recover their costs from the RP at a later date. Overall, we found response costs to be the largest cost category, averaging just less than half of the known costs for the incidents. The average response cost across spills is understated, however, because our data set contains incomplete information on response costs (in the calculation of the average percent response cost, cases with unknown response costs were treated as though they had no response cost). In addition, to facilitate settlement negotiations, Federal and State response costs are sometimes dropped from a case.[6] Thus, the response costs do not in all cases reflect true costs.

Natural resource damages and assessment

Responsible party liabilities for natural resource damages include the costs of restoring injured resources to baseline, compensating for interim losses, and assessing natural resource damages. NRDA actions following a spill include determining the extent of impacts, development of an appropriately-scaled and publicly-reviewed restoration plan, determination of

[5] In most cases, these supervisory costs are ultimately covered by the responsible party.

[6] Other Federal and State costs may also be dropped, for example fines and penalties. The General Accounting Office estimated that the Federal Government was not reimbursed for 20 percent of its costs in the *Valdez* spill.

the costs to implement that plan, settlement or litigation with the RP, and then implementation of the restoration. Restoration actions may range from natural recovery to aggressive habitat or ecosystem manipulations. NRDA is broadly focused on the injuries and lost uses that result from the "incident." Thus, while most of the focus may be on the impacts resulting from the released contaminant, the trustees may also evaluate the effects of the vessel grounding and response-related impacts (e.g., closure of a beach to stage equipment, etc.).

Since NRDA costs are the only category for which we had complete data, the estimated share of NRDA cost is biased upwards by lack of data for other cost categories. Further, this sample overstates the significance of NRDA costs because all of the incidents but one contained assessments of natural resource damages. For the population of spills, however, fewer than 1 percent contained natural resource damage assessments.

As noted above, one component of NRDA is assessment costs. The Oil Pollution Act allows trustees to recover their reasonable assessment costs, including the costs of conducting studies and designing restoration projects, and coordination costs. Critics of NRDA have charged that trustee agencies routinely conduct expensive and excessive studies. We found that assessment costs are typically 3 percent of the overall costs of the incidents. Again, since we had complete data on this category, the cost share of assessment costs is skewed upwards.

As with response costs, publicly available NRDA costs may underestimate the true costs of a spill. Agencies may not be able to track all of the assessment and restoration costs that were incurred, and certain costs may be waived to facilitate settlement. Agency enforcement costs, including litigation costs incurred by the trustee agencies and the U.S. Department of Justice, are typically not recovered. Finally, trustees may underestimate the total cost of the restoration projects and be forced to use other funds to complete the project.

Third party claims

Third party costs refer to claims for lost profits, property damage, or personal injury, for example, claims by fishermen and hotel and tourist operations to recover lost revenue or replace equipment damaged as a result of a spill. The data are difficult to obtain since most of these claims are settled out of court between private parties and insurers are often unwilling to publicize the settlement terms. We found partial third party data for thirteen of the cases. Among these cases, third party claims ranged from less than 1 percent (*Tenyo Maru*) to 95 percent (*Glacier Bay*) of the known costs. Third party claims have the potential to be the largest financial liability against a RP. To illustrate, in the *Exxon Valdez* incident, which contained the most complete third party cost data, third party claims totaled at least $5.3 billion, including $5 billion (OSIR, 1996) in punitive damages,[7] almost twice the estimated response costs and more than five times the NRDA settlement. The *Glacier Bay* spill and *Jupiter* incident also had significant third party costs due to fishing closures and personal injury settlements, respectively.

Federal and state penalties

Depending on the jurisdiction and nature of the incident, RPs may face a variety of penalties resulting in a significant cost. We found penalty data for seventeen of the incidents. In some cases penalties were a significant fraction of the total cost. For example, penalties for the 1994 *An Ping* spill in Washington State amounted to more than 30 percent of the known costs of the spill, over six times the NRDA settlement. Criminal and civil fines for the Exxon Bayway spill amounted to $15 million (Golobs, 1991). In some cases, spillers may also be subject to city and

[7] The 1994 jury award of $5 billion in punitive damages is currently under appeal. Interest on the settlement is accumulating at $800,000 per day.

county penalties. ARCO paid $500,000 in penalties to local governments following the Santa Clara River spill (Environmental Reporter, 1997).

Other costs

We focused our data collection on the response and NRDA costs following an incident, but RPs may face many other costs including vessel loss, costs for salvage, temporary and permanent repairs, loss/contamination of cargo, loss of earnings of the vessel, repair of other vessels/objects (e.g., collisions with vessels, bridges, and piers), and crew overtime. We were unable to determine the value of these types of claims and losses for specific cases, but we provide some evidence of the damage done. In at least three of the cases examined, the *Mega Borg, Morris J. Berman* and the *Tenyo Maru*, the vessels were a total loss. For the *Exxon Valdez*, the value of lost cargo totaled $3.8 million (ARI, 1993),[8] repairs cost an estimated $30 million (Golobs, 1990), and the vessel was out of service for nearly a year.

Depending on the circumstances of the spill, significant port closures and navigational restrictions may be imposed over the course of the cleanup, subjecting the RPs to additional claims from Port Authorities, other shippers, and dependent businesses. Each day of delay may cost a large vessel owner $10,000-$20,000 in operating and capital costs. A short closure may affect hundreds of vessels in a busy port.

Finally, we found that RPs are often required to upgrade facilities and spill prevention efforts as a condition of many settlements. These can result in significant costs. For example, Texaco agreed to spend $800,000 in facility improvements following the *Anacortes* spill (ARI, 1993), and Exxon agreed to spend $50 million in general safety improvements as part of the *Exxon Valdez* settlement (Etkin, 1994).

CASE HISTORIES

We selected six incidents to discuss the costs of spills in detail, including the *Apex Houston, Mega Borg*, *Exxon Valdez*, *Fortuna Reefer*, *American Trader*, and *Glacier Bay*. These cases represent unique or significant data outliers and demonstrate the effect of spill context on cost composition and magnitude.

T/B *Apex Houston*

In early February 1986, oiled birds began coming ashore along the central California coast. Subsequently, the oilings were linked to the tank barge *Apex Houston*, which lost a hatch cover, while enroute from San Francisco to Los Angeles in late January. An estimated 25,000 gallons (94,600 liters) of San Jaoquin Valley crude oil were lost, affecting the central California coast including the Gulf of the Farallones and the present day Monterey Bay National Marine Sanctuary (it was not a sanctuary at the time of the spill). The spill killed an estimated 9,000 marine birds with significant impacts to several common murre colonies.

The offshore nature of the release, the relatively small volume, combined with the high bird mortality make the *Apex Houston* case somewhat anomalous. NRDA composed 95 percent of the known costs of the incident. Federal and State response costs and penalties were 0.5 percent and 3.8 percent of the known costs, respectively. While more complete response data would reduce the NRDA cost share, the response costs were likely quite low. Given the release scenario, significant third party claims are also unlikely.

[8] Lost cargo costs in other cases were calculated based on the amount of oil spilled and the market value of the oil.

Mega Borg

The tanker *Mega Borg* exploded June 8, 1990 during lightering procedures approximately 60 nautical miles south-southeast of Galveston. The explosion and subsequent fire resulted in the release and/or loss of 5.1 million gallons of crude oil. Roughly 50 percent of the oil burned in the fire and another 25 percent evaporated. Responders used skimmers and booms and applied dispersants to recover and control the remaining oil. Trustees investigated impacts to marine mammals, sea turtles, and shrimp in the area of the spill; no injuries were reported. The oil spill never came on-shore, so there were no recreational losses due to oiled beaches and near-shore environments.

The *Mega Borg* incident contrasts with the *Apex Houston* case: response costs comprised the majority of costs and NRDA costs were minimal. State and Federal response costs totaled $4,110,930 or 61.3 percent of the known cost of the incident. NRDA costs were only 5 percent of the total known costs and were limited to the costs of pre-assessment studies; at the completion of the studies the trustees determined that the magnitude of the impacts did not warrant a claim for damages. The off-shore nature of the spill and limited fauna in the area of the spill minimized natural resource impacts in this case. The other large cost category for the incident was lost cargo, which was 33.6 percent of the cost of the spill.

T/V *Exxon Valdez*

The *Exxon Valdez* incident in Prince William Sound, Alaska, perhaps the most studied case, contains the fullest set of information on the costs of an oil spill. Estimates of RP response costs

and third party costs are available due mostly to the extensive litigation surrounding the incident. Some costs, especially the third party claims, are still under appeal.

Total costs exceeded $9 billion. Natural resource damage and assessment costs comprised 10 percent of the known costs. Response costs totaled approximately $2.8 billion (Etkin, 1994, ARI, 1993), or approximately 30 percent of the total known costs. Third party claims have exceeded $5.3 billion (OSIR, 1996), or nearly 60 percent of known costs. Exxon was not the only responsible party. Alyeska, the Valdez terminal operator, settled $98 million in third party claims (Etkin, 1994). Other cost categories, while a small percentage of the overall cost, were significant. For example, as part of the Federal and State settlement, Exxon was required to spend $50 million in safety improvements, $40 million to help establish the Marine Spill Response Corporation, and $100 million in criminal restitution (Etkin, 1994). Other costs included $25 million in Federal penalties, $30 million in repair costs, and almost $4 million in lost cargo (NTSB, 1990).

Despite the amount of information available on the *Exxon Valdez*, there are still some missing numbers. For example, Exxon incurred significant costs conducting their own damage assessment studies. In addition, *Exxon Valdez* repairs took almost a year and thus the tanker lost income during that period. Finally, we assume that Exxon incurred significant legal costs in their defense of the public and private claims.

Fortuna Reefer

In some cases, the grounding of a vessel may cause significant injuries to natural resources, even if no oil is released. The *Fortuna Reefer*, a 325-foot freighter, ran aground on a fringing reef that surrounds Mona Island, Puerto Rico in July of 1997. At the time of the grounding, the

vessel was carrying approximately 133,000 gallons of fuel oil, but no significant spillage of oil resulted from the incident. However, the grounding scar caused by the vessel, combined with the sweeping action of the heavy steel cables used in pulling the ship off the reef resulted in crushing and dislodging of approximately 6.8 acres of old growth stands of elkhorn coral. The trustees calculated the costs of restoration of the coral reef and negotiated a NRDA settlement of $1.25 million, which included $200,000 in assessment costs. Public response and salvage costs were approximately $390,000. Response and assessment costs incurred directly by the RP, and vessel repair costs, are not public.

American Trader

Few oil spill cases ever come to trial. We include the *American Trade*r incident as a case history because of the precedent setting 1997 jury award associated with the recreational losses resulting from the spill. In early February 1990, The *American Trader* ran aground on one of its anchors while approaching the Golden West Refining Company's moorings near Huntington Beach, California. The grounding resulted in the release of approximately 400,000 gallons of North Slope crude. Over 15 miles of recreational beaches were oiled and closed, and over 1,000 birds were killed.

Total known costs for the American Trader incident exceed $58 million dollars. Response costs were approximately $14 million, NRDA costs were approximately $23.0 million, and penalties of $5.3 million.[9] The NRDA costs include a 1997 jury verdict of $12.7 million for lost beach and boating use. The jury verdict is currently under appeal. The share of NRDA costs was

[9] The other significant cost category is third party claims. While $12 million dollars in claims have been settled, other suits are still pending.

higher than average in this case and somewhat anomalous because the spill oiled and forced the closure of several popular beaches in Southern California for weeks at a time.

T/V *Glacier Bay*

On July 2, 1987, the Tank Vessel *Glacier Bay* ran aground near Kenai, in Cook Inlet, Alaska, spilling approximately 207,000 gallons of North Slope crude. The *Glacier Bay* incident is unusual in our data set as the only incident without a NRDA. However, as mentioned earlier, damage assessments are conducted for only a few of the population of spills. We included the *Glacier Bay* incident because the U.S. Minerals Management Service conducted a detailed analysis of the costs of the incident as part of its Outer Continental Shelf leasing program (Burden et al., 1990).

The *Glacier Bay* spill occurred during the start of the commercial salmon season in Cook Inlet, with the largest salmon return in history moving up the inlet. Total ex-vessel value[10] of the fishery was approximately $95 million (Burden et al., 1990). Closures of commercial, sport, and subsistence fisheries in Cook Inlet resulted in significant third party claims. Private claims, largely by commercial fishermen, totaled $61 million (OSUSLR, 1995), accounting for 95 percent of the known costs for the incident. In contrast, we found only $3 million in response costs (Burden et al., 1990). Cost to repair the vessel and lost cargo was approximately $90,000 (Burden et al., 1990).

These incidents and others in our data set demonstrate the variability of cost shares for particular cost categories across spill incidents. The variability is due in part to the incomplete nature of the data, but also to the incident specific conditions of each spill.

[10] Ex-vessel value is the value of the catch to the fishermen.

First, the timing of an incident determines cost shares. Cost comparisons for incidents that occurred before and after OPA 90 are inappropriate because of the extended liability limits and third party claims provisions under OPA (Stolls, 1995). Damage assessment procedures have evolved over time as well. For example, natural resource damages for the 1985 *ARCO Anchorage* spill in Port Angeles Harbor, Washington, were calculated at approximately $33,000, despite the mortality of approximately 4,000 waterbirds, 5,700 kg of hardshell clams, and other injuries to natural resources (Kittle, 1987). The assessment costs were $285,000. Because of the high assessment costs, in part, the Washington State Legislature called for the development of a compensation table to calculate natural resource damages (Geselbracht and Logan, 1993). A similar spill evaluated using the Washington State table would result in much higher damages.

The location of a spill has significant implications for a number of cost categories, including response, NRDA, and third party claims. Spills that impact remote areas, such as the *Nestucca* incident, will typically result in greater response and assessment costs simply because of logistics. Offshore versus inshore cleanup is also a major factor. Harper et al. (1995) found shoreline cleanup to be 2.5 to 4 times more costly than offshore recovery. Spills that remain offshore are likely to have low third party costs unless the incident impacts an important fishing area. In most cases, offshore spills will also have lower NRDA costs. For example, the *Mega Borg* had very low percentage of NRDA costs; only 5 percent or $275,000. This amount represents the costs of preliminary assessment studies. The prompt response of the salvage and clean-up operations, the type of oil, the location and timing of the spill, and the oceanographic and weather conditions combined to minimize the effects of the spill. Favorable ocean currents kept the remaining oil away from sensitive coastal habitats. Therefore, the Trustees did not pursue any claims for natural resource damages.

The sensitivity of the affected environment is obviously a significant factor in the cost of spills. For example, the *Apex Houston* spill occurred in an area of high aggregations of sea birds, resulting in high bird mortality relative to the volume of oil lost. Spills in environmentally sensitive areas are also likely to be more costly to cleanup. For example, manual labor may be used instead of heavy equipment, to minimize collateral injury from the response.

DISCUSSION

Our analysis reaffirms the obvious to anyone who has been to a spill: spills are costly events, and depending on the size and location of the spill, RPs may face millions of dollars in costs and claims. We recognize that our analysis is preliminary, and inclusion of more case histories and more complete data on those case histories would be valuable. While incomplete, our data raise a number of issues.

The significance of NRDA as a cost component of oil spills has been misstated by industry critics of damage assessment, perhaps due to their failure to consider all the costs of a spill. For individual cases, NRDA costs can be a major component of the total cost of spills, but in our data they averaged about 26 percent of the known cost of an incident. The perception that response costs are only the “tip of the iceberg” when compared to NRDA costs is false, and the reverse is probably more accurate. Even in our data set which overstates the significance of NRDA (29 out of 30 incidents have NRDA costs, while we have estimates of RP response costs for only about half of the cases), we found response costs were, on average, over one and one-half times NRDA costs.

The inability to account for all the costs of spills also has implications in other regulatory programs. Costs per unit oil spilled are often used in regulatory settings, and the lack of

complete data may have serious implications, since lack of complete cost data generally means understating the cost of oil spills. For example, the decision whether to increase budgets for spill prevention or to increase public investments in response and salvage capabilities often hinge on the "costs" of oil spills that would be avoided if such investments were made. The establishment of adequate liability limits also depends on complete cost data. Lack of complete data on the total costs of spills might result in inadequate liability limits (Lively-Diebold et al., 1995), or failure to make appropriate investments in prevention and preparedness.

For example, in a study of the costs and benefits of double-hulled tankers, Brown and Savage (1996) argued that double hulls are not worth the investment, but based their analysis on incomplete cost data. The authors did not include State and Federal response costs, categories that can represent a substantial share of total cost. Other cost categories appear understated. In their worst case estimate of the cost of spills, (i.e., most favorable to double hulls) they assume a unit spill cost of $228.50 per gallon ($865 per liter) in 1990 dollars. We selected Brown and Savage's analysis to illustrate how cost per unit spilled data are often used. While a re-evaluation of their analysis is well beyond the scope of this paper, we found that even with our incomplete data, five of our thirty case histories exceeded their worst-case estimate.[11]

Average cost per unit may be appropriate to evaluate the expected costs of spills and, thus, predict the effects of regulating oil shipping. However, we caution the reader from making inferences about the cost of spills based on an average cost. All spills are different, and the same quantity of oil spilled in two different locations, or under different environmental conditions, can have different impacts. In our sample, the total cost of spills varies from $1/gallon (*Mega Borg*)

[11] Note that of the five incidents, three (*Apex Houston*, Exxon Bayway, and Unocal Tank Farm) would not have been prevented by double-hull requirements, and the benefits for the other incidents, *Exxon Valdez* and *Nestucca* are questionable.

to $923/gallon (*Nestucca*). NRDA costs vary from $0/gallon (*Glacier Bay*) to $234/gallon (*Apex Houston*).

Our evaluation of the cost of spills has thus far focused on the task of compiling case information with the goal of determining the relative importance of response and natural resource damage assessment costs. Secondarily, we have looked at some of the factors that affect costs. The data raise several difficult public policy questions and areas for future inquiry. We leave the reader with the following questions to ponder: 1) Should there be a relationship between response and damage assessment costs?; 2) Would the public and environment be better off by reallocating efforts and funds between response and restoration?; 3) Are these dollars well spent and are we getting our monies worth?; and 4) Should we even make a distinction between response and restoration, or should they be viewed as a continuum, with cleanup as the first step in restoration?

CONCLUSIONS

The cost of oil spills is of interest to industry and regulators alike; cost data are difficult to collect and we welcome additional data. We recognize that NRDA costs can be significant but dispute the assertion that NRDA costs comprise the major cost of a spill and threaten industry viability. First, fewer than 1 percent of all oil spills contain natural resource damage assessments. Second, for the incidents with damage assessments in our sample, NRDA claims averaged about 26 percent of the overall cost of spill, a figure that is biased upward due to the understatement of other cost categories. Our analysis suggests, contrary to industry opinion, NRDA claims represent only a small proportion of total liability. In the largest incident by

volume and cost, the *Exxon Valdez*, the NRDA share is 10 percent, suggesting that if the financial viability of the industry is at risk, NRDA costs are not driving that risk.

BIOGRAPHY

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REFERENCES

Advanced Resources International, Inc., *Economic Impacts of Oil Spill: Spill Unit Costs for Tankers, Pipelines, Refineries, and Offshore Facilities*, Prepared for the U.S. Department of Energy, Office of Domestic and International Energy Policy, 104pp + appendices, 1993.

Brown, R., and I. Savage, "The Economics of Double-Hulled Tankers," *Maritime Policy and Management*, Vol. 23(2) pp. 167-175, 1996.

Burden, P., Isaacs, J., Richardson, J., Braund, S., Witten, E., and L. Moorehead, *Economic Impacts of the S.S. Glacier Bay Oil Spill*, Minerals Management Service Report MMS 90-0081-TR 146, 1990.

Canadian Coast Guard (CCG) Western Region, *Nestucca Oil Spill Report,* 99 pp., 1989.

Desvouges, W.H., Dunford, R.W., Mathews, K.E. and H. Banzhaf, "NRDA Case Study: The Arthur Kill Oil Spill." *Proceedings of the 1993 International Oil Spill Conference,* pp. 355-61, 1993.

Environmental Reporter, "Company to Pay $7.1 Million in Damages," Vol. 27, No. 39, pg. 2043, 1997.

Environmental Reporter, "Record $75 Million Criminal Penalty Levied for 1994 Incident in Waters off Puerto Rico," Vol. 27, No. 22, pg. 1235, 1996.

Etkin, D.S., The Financial Cost of Oil Spills, Cutter Information Corporation, Arlington, MA, 254 pp., 1994.

Fawn, D., and D. Barber. *The Mega Borg Incident*, Texas Water Commission Report LP 91-05, 1991.

Geselbracht, L, and D. Logan, Washington's Marine Oil Spill Compensation Schedule for Simplified Resource Damage Assessments, *Proceedings of the 1993 International Oil Spill Conference*, pp. 705-709, 1993.

Golobs Oil Pollution Bulletin, Vol II, No. 13, "3.9 Million Gallons Lost in *Mega Borg* Explosion and Fire," World Information Systems, Cambridge, MA, 1990.

Golobs Oil Pollution Bulletin, Vol. II, No. 16, "Renamed *Exxon Valdez* Completes Repairs, Prepares for Sea Trials," World Information Systems, Cambridge, MA, 1990.

Harper, J., Godon, A., and A.A. Allen, "Costs Associated with the Cleanup of Marine Oil Spills," *Proceedings of the 1995 International Oil Spill Converence*, pp. 27-30. 1995.

Helton, D., Penn, T., and R. Hicks, "The Cost of Oil Spills: Putting Response and Natural Resource Damage Costs in Perspective," Proceedings of the 20th Annual Arctic and Marine Oilspill Program (AMOP). Technical Seminar, pages 981-994.

Hobbie, R. H., "Statement of the American Institute of Marine Underwriters and the Water Quality Insurance Syndicate before the United States Senate Committee on Environment and Public Works," March 27, 1996.

Kittle, L.J., "Marine Resource Damage Assessment Report for the *ARCO Anchorage* Oil Spill, December 21, 1985," Washington State Department of Ecology Report 87-4, 97 pp. + appendices, 1987.

Kramer, W.M., American Institute of Marine Underwriters (AIMU), Comment # 19 on NOAA's Advanced Notice of Proposed Rule Making, 1995.

Lively-Diebold, B., Ameer, P., Yoshioka, G., and J. Anand, "Liability Incentives for Reducing the Cost of Oil Spills," *Proceedings of the 1995 International Oil Spill Conference*, pp. 249-254, 1993.

Mercer management, OPA 90: Regulatory Impact Analysis Review- Spill Unit Values, Interim Report, 109 pp., 1992.

Miller, M, "Statement of Mr. Mark Miller, President of National Response Corporation, on Improved Prevention and Response to Oil Spills in Light of the Recent *North Cape* Spill," before the United States Senate Committee on Environment and Public Works, March 27, 1996.

National Academy of Sciences, *Tanker Spills; Prevention by Design*, National Academy Press, Washington, D.C., 1991.

National Pollution Funds Center (NPFC), *The USCG National Pollution Funds Center FY95 Annual Report*, 35 pp., 1996.

National Transportation Safety Board (NTSB), "Marine Accident Report: Grounding of the U.S. Tankship *Exxon Valdez* on Bligh Reef, Prince William Sound Near Valdez, Alaska, March 24, 1989," PB90-916405, 1990.

Oil Spill Intelligence Report (OSIR) 2/1/96, Cutter Information Corp., Arlington, MA, 1996.

Oil Spill US Law Reporter (OSUSLR), March, 1995, Cutter Information Corp., Arlington, MA, 1995.

Stolls, A.M., Vessel Liability and Financial Responsibility in the U.S. Coastal States", *Proceedings of the 1995 International Oil Spill Converence*, pp. 255-260, 1995.

Washington State Department of Ecology (WA DOE), *Central Programs: Spill Operations, Spill Operations and Planning*, 1991 Annual Report, Appendix 4, 1991.

Washington State Department of Ecology (WA DOE), *Nestucca Oil Spill On-Scene Coordinator's Report*, 1989.

Table 1. Oil Spill Case Histories

Incident Name	*Type*	*Date*	*Location*	*Product*	*Amount (gallons)*
Amazon Venture	Tanker	12/4/86	Savannah River, GA	#6 Fuel	500,000
American Trader	Tanker	2/7/90	Huntington Beach, CA	Crude Oil	398,000
An Ping	Freighter	1/10/94	Longview, WA	#6 fuel	26,000
Apex Houston	Barge	1/28/86	Gulf of the Farallones, CA	Crude Oil	25,000
Apex Towing/Shinoussa	Barge	7/28/90	Galveston Bay, TX	Catalytic Stock	694,000
Arco Pipeline	Pipeline	1/17/94	Santa Clara River	Crude Oil	190,000
Arco Anchorage	Tanker	12/21/85	Port Angeles, WA	Crude Oil	239,000
Berry Petroleum	Pipeline	12/23/94	McGrath Lake, CA	Crude Oil	87,000
BT Nautilus	Tanker	6/7/90	Kill Van Kull, NY	#6 Fuel	252,800
Burlington Asphalt	Facility	1/1/94	Rancocas Creek, NJ	#2 Fuel	10,000
Colonial Pipeline	Pipeline	3/28/93	Sugarland Run, VA	Diesel Fuel	407,000
Exxon Bayway	Pipeline	1/2/90	Arthur Kill, NY	#2 Fuel	567,000
Exxon Valdez	Tanker	3/24/89	Prince William Sound, AK	Crude Oil	11,000,000
Fortuna Reefer	Cargo Vessel	7/23/97	Mona Island, PR		
Glacier Bay	Tanker	7/2/87	Cook Inlet, AK	Crude Oil	207,000
Greenhill	Well	9/29/92	Timbalier Bay, LA	Crude Oil	122,000
Jahre Spray	Tanker	7/22/95	Delaware River	Crude Oil	56,000
Jupiter	Tanker	9/16/90	Bay City, MI	gasoline	840,000
Mega Borg	Tanker	6/8/90	Gulf of Mexico	Crude Oil	5,100,000
Mobiloil	Tanker	3/19/84	Columbia River, OR	#6 Fuel	170,000
Morris J. Berman	Barge	1/7/94	San Juan, PR	#6 Fuel	800,000
Nestucca	Barge	12/22/88	Grays Harbor, WA	#6 Fuel	23,100
Nosac Forest	Cargo Vessel	4/21/93	Tacoma, WA	IFO 380	6,260
Presidente Rivera	Tanker	6/24/89	Delaware River	#6 Fuel	307,000
Quinnipiac River	Facility	10/15/95	North Haven, CT	#4 Fuel	5,000
RTC-380	Barge	12/21/92	Groton, CN	#2 Fuel	27,000
Tenyo Maru	Fishing Vessel	7/22/91	Neah Bay, WA	#6 and #2 fuel oils	173,000
Texaco Anacortes	Facility	2/22/91	Anacortes, WA	Crude Oil	210,000
Unocal Tank Farm	Pipeline	8/3/92	Avila Beach, CA	Crude Oil	21,000
World Prodigy	Tanker	6/23/89	Narragansett Bay, RI	#2 Fuel	288,666

Table 2. Cost breakdowns: Costs are valued in 1997 dollars; unknown costs are indicated by a question mark

Incident Name	*PRP Response*	*Public Response*	*NRDA*	*3rd party*	*Penalties*	*Other*	*Total Known Costs*
Amazon Venture	41.8%	3.2%	49.6%	?	?	5.3%	$3,849,679
American Trader	20.6%	3.4%	39.5%	20.6%	9.1%	6.8%	$71,536,431
An Ping	?	61.2%	5.1%	?	31.6%	2.1%	$492,877
Apex Houston	?	0.5%	94.9%	?	3.8%	0.1%	$9,880,307
Apex Towing/Shinoussa	?	39.2%	26.9%	?	?	34.0%	$7,355,975
Arco Pipeline	?	3.9%	32.8%	54.7%	6.0%	2.6%	$23,759,517
Arco Anchorage	94.8%	2.1%	2.3%	?	0.2%	0.6%	$20,463,216
Berry Petroleum	?	38.6%	33.8%	1.3%	25.5%	0.8%	$4,351,687
BT Nautilus	82.4%	0.7%	16.5%	?	?	0.4%	$29,787,835
Burlington Asphalt	?	80.8%	17.9%	?	?	1.3%	$304,522
Colonial Pipeline	50.4%	2.0%	8.4%	33.6%	5.0%	0.5%	$33,033,904
Exxon Bayway	30.9%	?	17.1%	?	8.6%	43.3%	$71,427,585
Exxon Valdez	27.3%	1.5%	9.7%	57.8%	0.3%	3.5%	$11,859,836,448
Fortuna Reefer	?	23.8%	76.2%	?	?	?	$1,640,000
Glacier Bay	1.0%	3.6%	0.0%	95.3%	?	0.1%	$90,482,442
Greenhill	?	24.7%	73.6%	?	?	1.6%	$3,101,243
Jahre Spray	?	34.0%	47.0%	9.8%	2.6%	6.6%	$319,535
Jupiter	?	3.4%	10.4%	81.3%	?	4.9%	$7,555,393
Mega Borg	?	61.3%	5.0%	?	?	33.6%	$6,706,201
Mobiloil	35.9%	0.5%	2.6%	?	0.5%	60.6%	$12,910,203
Morris J. Berman	5.9%	48.3%	?	1.3%	44.3%	0.2%	$183,186,201
Nestucca	23.5%	23.4%	20.5%	4.2%	?	28.4%	$28,916,857
Nosac Forest	?	13.4%	49.4%	?	36.3%	0.9%	$275,735
Presidente Rivera	?	47.1%	41.0%	3.2%	6.5%	2.2%	$8,017,890
Quinnipiac River	?	94.3%	5.4%	?	?	0.3%	$736,047
RTC-380	?	41.0%	56.7%	?	?	2.4%	$466,399
Tenyo Maru	16.2%	36.1%	37.1%	0.1%	10.1%	0.4%	$17,473,459
Texaco Anacortes	79.8%	1.5%	5.0%	?	5.0%	8.7%	$11,809,453
Unocal Tank Farm	88.6%	1.8%	9.5%	?	?	0.1%	$16,782,110
World Prodigy	39.0%	22.0%	9.0%	14.6%	13.9%	1.4%	$9,285,247