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Proceedings



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**Prevention, Preparedness, Response and Restoration
- Perspectives for a Cleaner Environment**

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FOREWARD

A message from the Program Chairman

The 2003 International Oil Spill Conference was a huge success! Take a wonderfully picturesque setting, add to it very comfortable accommodations, a chocker-blocked full schedule, a mass of the most prominent and world renowned experts in the field of oil spill response, and you can't help but to come away with a world class conference.

The program, and the Conference for that matter, was completely outstanding because of the individual efforts of so many dedicated and enthusiastic individuals. The Program Committee had a very difficult task of paring down the over 500 abstracts to come up with a reasonable number of papers that could be presented. Honestly, many very worthwhile abstract topics were not accepted. Many factors decided which were successful applicants, such as those that coincided with the Conference theme. We tried to bring a balance to the program, presenting a largely equal number of the most up-to-date topics that were characterized by quality research and unique individual expression.

The theme for this year's Conference, "Prevention, Preparedness, Response, and Restoration – Perspectives for a Cleaner Environment" presented a wide view of focus. Special sessions lead the program with interesting and differing perspectives. These ideas created a basis for understanding the most significant global issues and set the stage for greater audience participation and interest in related topics presented during the remainder of the Conference.

The compendium of papers within these Proceedings represents the best of the papers that the 2003 International Oil Spill Conference had to offer. With all sincerity, I hope to see the great work contained here spark new ideas and research for presentation at the next Conference in Miami, FL.

Please make the 2005 International Oil Spill Conference an even greater success. I look forward to seeing you there!

David L. Lersch
Captain, U. S. Coast Guard
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OIL SPILL PREVENTION: A PROACTIVE APPROACH

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I. Introduction

The number one concern of the public when it comes to the health of the ocean is the risk of oil spills.¹ Unfortunately, focus on spills – by the public, the media, and many environmental organizations – occurs sporadically in response to major spill incidents. As a result, over the past three decades, the international community has taken what can best be described as a reactive approach to oil spills. Major initiatives to address spills, with a few notable exceptions, have focused largely on clean up and response measures. Prevention of spills, in its truest sense, has not been afforded the attention it deserves. Preventive measures, for purposes of this analysis, are defined as those initiatives intended to avoid the release of oil into the environment. Too often the word “prevention” is used loosely to include what really are mitigation and response efforts (e.g., pre-booming, dispersant use). While such efforts may minimize the “impact” of the spill, they do not prevent the spill from occurring. At the same time, salvage efforts are traditionally treated as response measures. While salvage capacity is an important part of response efforts, in the context of this paper the focus will be on the attribute of salvage as a preventive measure. In this light, our paper addresses prevention of spills – not mitigation of damage once a spill occurs. As such, consideration is limited only to those initiatives that are taken prior to the release of that first drop of oil.

The international marine, oil transportation system has grown dramatically since World War II. More than 1.7 billion tonnes of oil are transported annually by ship from producing and refining countries to the consuming countries of the world. As a result of the enormous increase in marine transportation of oil, the size of tank vessels has increased as well. The largest tank vessels have grown from approximately 25,000 deadweight tones (DWT) at the end of World War II to more than 550,000 DWT today. The world fleet of tank vessels grew from 160 million DWT in 1971 to about 267 million DWT in 1994 (Drewry Shipping Consultants, 1994).

At the same time, methodologies for assessing the environmental impacts of spills, including the contribution of photo-enhanced toxicity, have improved as well. A greater understanding of spill effects and damages has strengthened the resolve of many governments to focus efforts on prevention.

The premise of this paper is that every oil spill – regardless of its size or its source – is worthy of prevention efforts at some level. It cannot be emphasized enough that the size alone of an oil spill does not determine the degree of its resulting damage – either environmentally or economically. For example, while the grounding of the tanker, *Jessica* off the Galapagos Islands, resulted in a relatively small release of oil, ongoing studies at the Darwin Research Institute (DRI) indicate that this spill is having significant impacts on the endemic marine iguana. Clearly, a small spill in a World Heritage Site can have far reaching consequences. In addition, the impacts of repeated small operational spills in the confines of a port or along major traffic lanes demand greater attention. This point was validated for the first time in a quantitative fashion by the United States' National Academy of Sciences (NAS) recent study, which found that as regards accidental tank vessel spills the relationship between outflow (volume of oil spilled) and consequences (environmental damage) was not a linear one (NAS, 2002). This finding is quite significant in resolving the age-old debate about the efficacy of preventing a few large spills rather than a larger number of small spills. This analysis showed that a larger number of small spills, resulting in the same or even less outflow than a single large spill, is likely to produce more significant environmental damage and be more economically costly as well.

A spill of any size, regardless of its source, can have significant adverse environmental impacts, depending on seasonal timing, location, weather, and type of oil spilled.² For this reason, our use of spill statistics as a basis for establishing the scope and magnitude of the problem, and thereby where our prevention efforts should be placed, has limited efficacy. Such statistics provide only initial indicators of where the problem may lie. The fact remains that the environment does not discriminate between sources of oil. The damage occurs regardless of the source. All sources must be addressed at some level. In light of this limitation, we seek to identify those prevention measures, which are, or will be, most effective in averting the occurrence of spills from each source.

Our analysis begins with an historical overview of spill statistics and identification of the various sources of spills. Key strategies for preventing spills from each of the source categories are then described and analyzed for effectiveness. Finally, recommendations for future strategies are provided.

II. Sources of oil inputs

A. Overview. All international oil spill statistics must be viewed with a high degree of skepticism. Determining trends in oil spill occurrence and impact is extremely difficult given inadequacy and inconsistency of data gathered over time pertaining to spills.³ The spill statistics presented here are derived from a variety of sources.

Some of the data is compiled by an ad hoc committee of the United States' National Research Council (NRC) in a recently published report entitled, *Oil in the Sea III* (NAS, 2002; hereafter referred to in text as OIS.) The OIS utilizes effectively current data on spill inputs in North America, but does not provide substantial and convincing data on spills outside of North America, other than non-operational vessel-source, and pipeline spills. All spill statistics presented in this report are provided in terms of minimum and maximum "best estimates." Such estimates are only as valid as the legitimacy of their underlying assumptions. In some cases, those assumptions appear reasonable, but in other cases, they are highly questionable. These limitations will be addressed further in the discussion of specific sources.

OIS data on worldwide accidental vessel source and pipeline spills are supplemented with data maintained by Environmental Research Consulting (ERC). While ERC's database is the broadest and most comprehensive one available, and was used extensively in the OIS study, it is not without its own limitations.⁴ The ERC data is also being used in a similar study underway by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), scheduled to be published later this year.

What is sorely missing from this and all other databases is adequate information on the extent and degree of environmental damage resulting from spills. From an environmental perspective, it is not the size of the spill that is most significant, but rather, the damage resulting from the spill. Historically, that information is simply not available – partly because no attempt was made to gather such information (especially with regard to older spills), or, because the full impact of the spill has not been determined or it is not scientifically detectable. Research on the impacts of oil on the marine environment are ongoing, resulting in new insights into fates and effects. Most recently, scientists found that the toxicity of oil, as well as chemically dispersed oil on marine organisms may be largely underestimated because previous lab studies conducted under fluorescent lights failed to account for the effects of photo-enhanced toxicity (Barron 2002).⁵

"According to Boyce Thorne-Miller, senior scientist with SeaWeb, a marine conservation education initiative of The Pew Charitable Trusts,

"Although it's difficult to definitively establish cause and effect in a lot of these cases, these [PCBs and DDT] contaminants have been linked with mortality, malformation, reduced hatching success, developmental abnormalities and chromosome aberrations in fish eggs and larvae contaminated at the surface, and reproductive problems and reduced immune system in marine mammals."

Because heavy metals and organochlorines are bioaccumulative—that is, they build up in progressively greater concentrations as they are passed up the food chain. Top-line predators are particularly at risk..." (Mulvaney, 1998; p.1).

There continues to be much scientific debate about the impact of oil on the marine environment and marine organisms. Given the known damaging effects of oil, a precautionary approach demands substantial preventive measures.

Please note that unlike the NRC report, this study will be limited to an examination of anthropogenic sources of spills. Because we are interested in identifying measures for preventing spills, the contribution of so-called "natural seeps" to oil inputs to the environment will not be included or addressed.⁶ With a few exceptions, this analysis is limited to worldwide spill statistics, as reliable information on a regional breakdown is not readily available. It is with these limitations in mind that our examination will consider sources of spills in the following categories:

- Vessel spills -- accidental spills and operational discharges from all vessels);
- Oil and gas production (including accidental spills from offshore platforms, operational discharges from platforms, spills from marine and land-based pipelines and spills and discharges from land-based production facilities);
- Land-based point sources (spills and discharges from industrial facilities and municipal treatment plants); and
- Land-based non-point sources (coastal and urban runoff).

Our breakdown of the data provided in the OIS report is based upon the framework for regulation of the various pollutant sources. For example, there is a major distinction between vessel source and non-vessel source inputs. The shipping community is regulated internationally, while, non-vessel sources, in most parts of the world, are regulated solely through national or local legislation. One consequence of the OIS categorization of sources is the dilution of the true effect of the total contribution of various industry sectors. Our presentation of the data better enables an assessment of the impact of these various sectors, and thereby, better points the way to appropriate regulation. Available spill statistics are presented on number and volume of spills from each source category.

B. Comparison of all sources. Table 1 presents the OIS data for spills and discharges from anthropogenic sources on a worldwide basis. Estimates for total input from all sources ranges from 242,000 tonnes to 6.1 million tonnes per year. The "best estimate" is projected to be 600,000 tonnes per year according to this data. A breakdown of the data by our three defined source categories indicates that, by best estimates, vessel source spills far exceed the inputs from production and land-based sources combined, representing over 68% of total input. The next largest source is land-based sources (23%), with production representing the smallest input by volume (9%).

The pitfalls of using "soft" data to generate these estimates and the significant uncertainty associated with the assumptions applied in the OIS, is clearly demonstrated by considering the minimum and maximum estimates for total input as provided in the OIS data. Using minimum estimates, the general breakdown remains the same as regards vessels, which continue to present the large majority of input (85%). However, the minimum estimates show production following as the next largest category (11%) and land-based sources as the smallest category by volume (4%).

Application of the maximum estimates yields completely different results. In this case, land-based sources represent the largest input (82%), followed by vessel source (17%) and lastly, production (2%). This is a complete reversal of outcome based upon the use of varying assumptions for estimating input.

The breakdown of spill sources on a worldwide basis does not necessarily reflect that which exists on a regional basis. This

Table 1. Average, annual releases (1990 - 1999) of petroleum by source (in thousands of tonnes).

Source Category	NORTH AMERICA			WORLD WIDE		
	Best Estimate	Minimum	Maximum	Best Estimate	Minimum	Maximum
Vessels Total	12.32	7.36	22.8	413.1	207.5	1020.8
Tank vessels	5.3	4.0	6.4	100	93	130
Operational (cargo washing)	Na	Na	Na	36	18	72
Operational (100 GT)	0.10	0.03	0.30	270	90	810
Operational(<100GT)	0.12	0.03	3.0	Nd	Nd	nd
Non-tank vessels	1.2	1.1	1.4	7.1	6.5	8.8
Recreational vessels	5.6	2.2	9	Nd	Nd	nd
Production and Transportation Total	6.66	5.65	8.18	53.76	27.79	111.4
Platforms	0.16	0.15	0.18	0.86	0.29	1.4
Produced waters	2.7	2.1	3.7	36	19	58
Pipelines	1.9	1.7	2.1	12	6.1	37
Coastal Facilities	1.9	1.7	2.2	4.9	2.4	15
Runoff Total	54	2.6	1900	140	6.8	5000
TOTAL	72.98	15.61	1930.98	606.86	242.09	6132.2

Source: modified from NAS (2002); Table 2-2.

expected that inputs will differ widely from region to region, depending on the level of development and the nature of industrial activities conducted in those regions. By way of example, the OIS culls out data on oil inputs in North America. "Best estimates" in that region suggest that land-based sources contribute significantly more input (74%) than vessels (17%) or production (9%). The minimum estimates provided by the data reverse that finding to indicate vessels as the largest source (47%) followed by production (36%) and land-based sources (17%). Once again, the outcome of the analysis depends upon the assumptions made in the data estimates.

III. Vessel source spills and discharges

The data clearly demonstrate that both now, and historically, vessels have been responsible for a large majority of the oil entering the marine environment from anthropogenic sources broadly defined. Vessel source inputs can be divided into the following categories:

- tankers,
- barges,
- non-tankers,
- recreational vessels,
- fishing vessels, and
- passenger vessels.

Inputs from these sources fall into one of two categories -- accidental spills (e.g., groundings, collisions, and allisions) or operational discharges (e.g., oil discharged from tank cleaning, oil contained in discharged ballast water, oil from machinery spaces and discharged in bilge water). Recent evidence indicates widespread by-passing of oil/ water separators, in direct contravention of MARPOL operational discharge limitations. For this reason, we include both legal and illegal discharges of operational waste in the category of operational discharges. The

assumption that illegal discharges constitute a rare occurrence has been seriously undermined. The OIS "best estimate" for worldwide average annual inputs from vessel sources is 107,000 tonnes for accidental spills and 312,000 tonnes for operational discharges. Therefore, roughly 34% of vessel input comes from accidental spills, while 66% comes from operational discharges. This finding is important given the relative resources devoted to prevention of accidental spills and operational discharges.

Nonetheless, both accidental spills and operational discharges contribute significantly to the overall percentage of the volume of oil entering the world's oceans. Data compiled by Etkin (2001) indicate that in the decade from 1990–1999, accidental spills of oil totaled 104,996 tonnes/yr. Of this volume, 88,972 tonnes/yr were spilled from tankers, 2,606 tonnes/yr were spilled from barges, 5,592 tonnes/yr were spilled from non-tank vessels, 4,646 tonnes/yr were spilled from onshore pipelines, 2,747 tonnes/yr were spilled from onshore facilities, and 403 tonnes/yr were spilled as a result of offshore exploration and production activities. The relative percentage of these inputs is illustrated in Figure 1.

A. Tanker spills. It is safe to say that vessel source spills constitute a major portion of all oil inputs into the environment on a worldwide basis. In general, the statistics in Figure 2 show that between 1973 and 2000, the number of reported tanker spill incidents worldwide peaked in 1979 and then decreased slowly during the 1980s, remaining fairly constant through the 80s and 90s with a slight upward surge in 1990 (USCG, 2001). Volumes of oil spilled mirror a similar pattern, although it is noted that the occurrence of large or catastrophic spills greatly influence the volume of oil spilled in any given year. In other words, a single large spill in any given year will significantly affect the trend. It is not surprising that the late 1970s produced a larger number of spills, since vessel traffic increased dramatically during that time. When considering spill trends, the number of spills or volume of oil spilled must be considered relative to the volume of oil

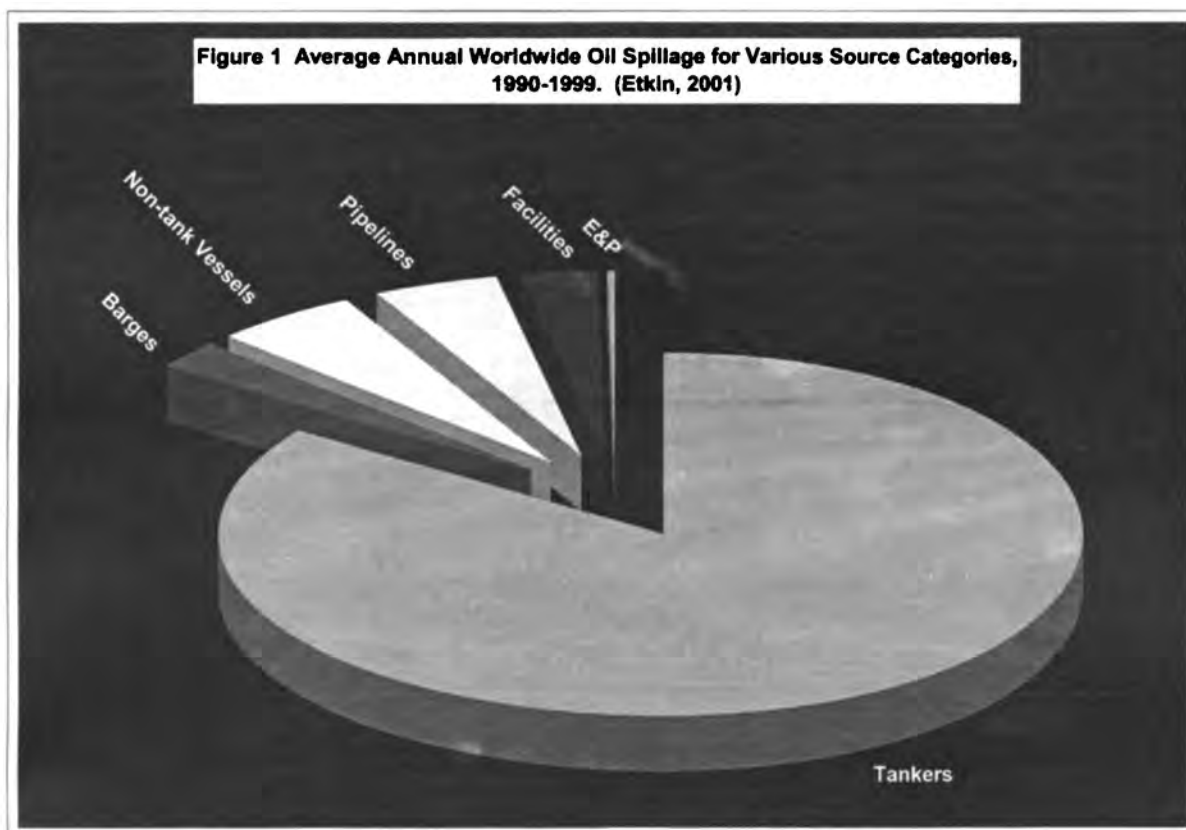


Figure 1. Average annual worldwide oil spillage for various source categories, 1990–1999.

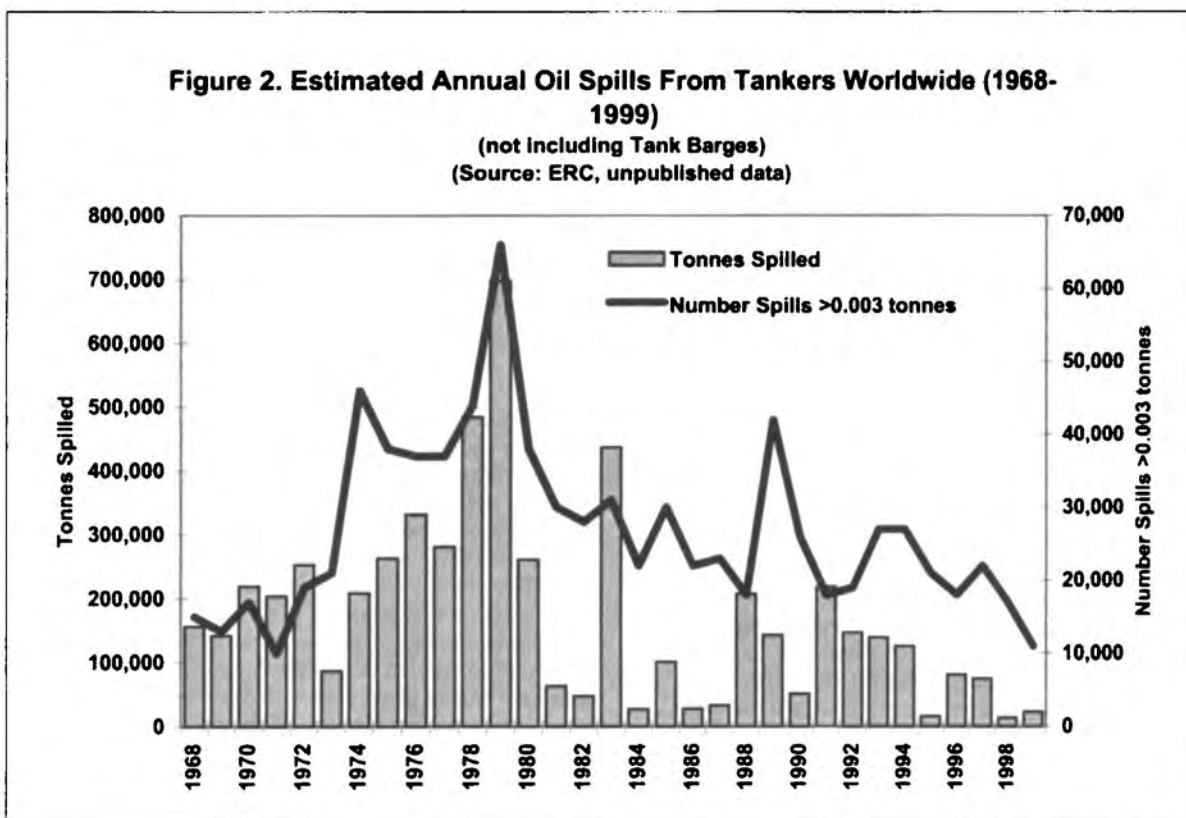


Figure 2. Estimated annual oil spills from tankers worldwide (1968–1999).

transported. Figure 3 indicates that since the middle of the 1980s, the number of accidental vessel spills into the marine environment (per million tonnes of produced oil) has remained in a consistent range (between 0.6 and 1), suggesting no dramatic improvement in prevention regarding the number of vessel spills during this time (USCG, 2001). This observation is especially significant given the NRC finding noted above concerning environmental damage and adverse economic impact from small spills relative to larger spills.

B. Tanker spills in US waters. Figure 1 indicates that tankers constitute a significant percentage of vessel source oil spills as

compared to non-tankers. Historically, tankers have accounted for over 50% of the total number of recorded vessel spills, as compared to barges and all other vessels. Since the passage of the U.S. Oil Pollution Act of 1990, a significant and consistent decrease in the total volume spilled has occurred for the U.S. as compared to the rest of the world. Figure 4 shows that between 1973 and 2000, the volume of oil spilled from vessels of all types remained somewhat erratic through the decades of the 70s and 80s. Then after 1991, there was a dramatic drop in the volume of oil spilled in US waters. At the same time, the number of spills in US waters dropped slightly between 1973 and 1986, steadily

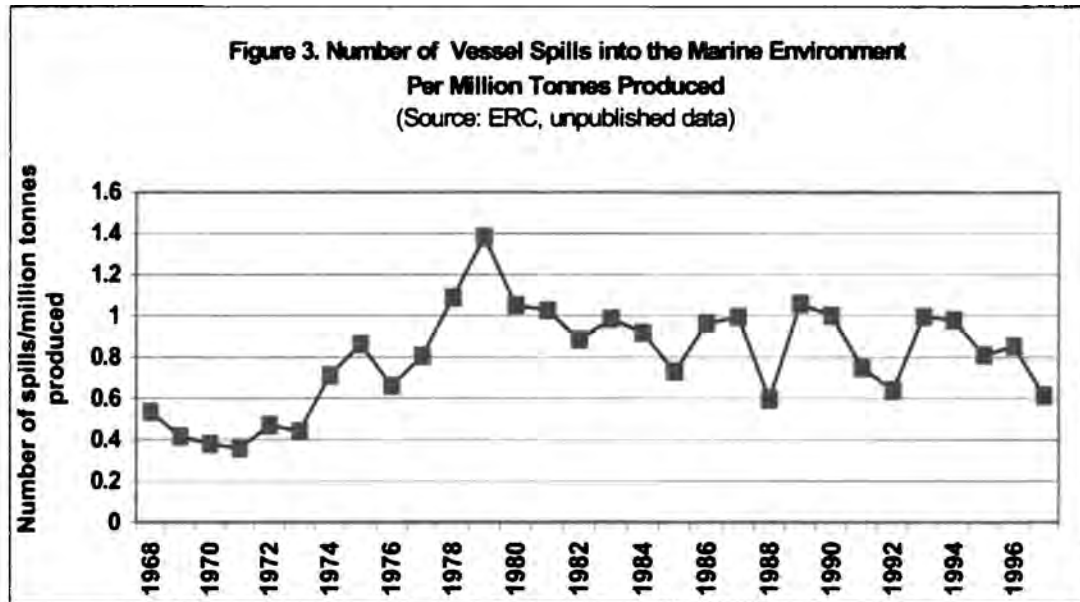


Figure 3. Number of vessel spills into the marine environment per million tonnes produced.

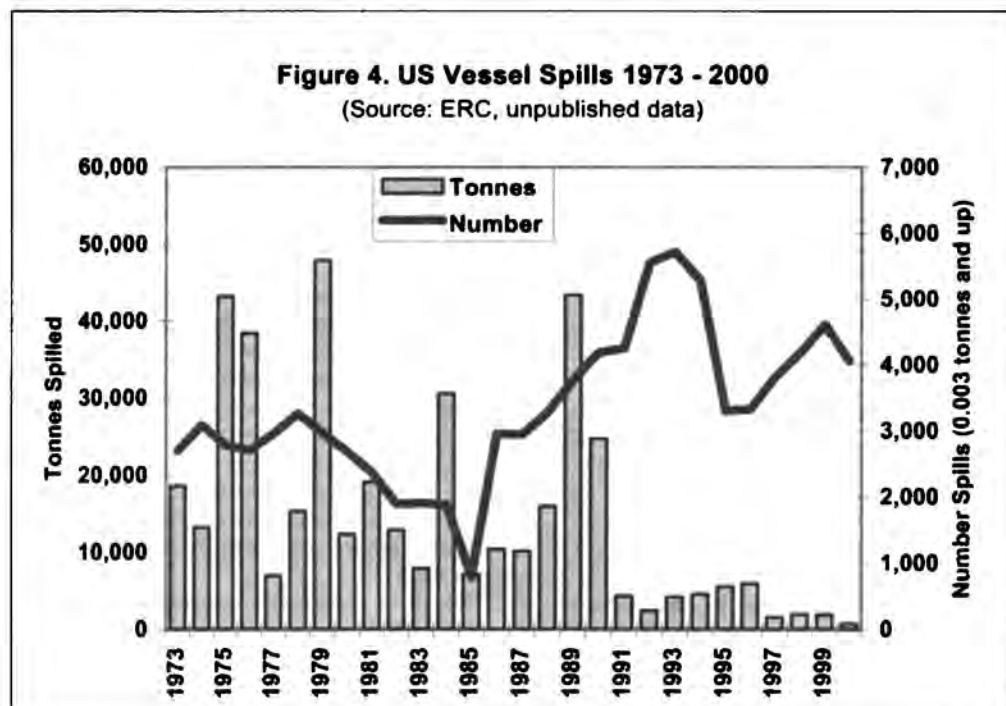


Figure 4. U.S. vessel spills 1973–2000.

increased through 1994, and then tapered off slightly towards the end of the decade. A key finding here is that, since the passage of OPA 90, there has been a consistent and dramatic drop in the volume of oil spilled in US waters. The rest of the world cannot reflect that same dramatic decrease.

The regional difference in spill trends over the last decade is an important finding that warrants further evaluation. How do we account for the dramatic and consistent drop in volume spilled in North America? Is it possible to attribute this trend to specific prevention measures? Are there lessons to be learned that might be applied to other regions of the world? These issues are further addressed below in Section VII on "Prevention Strategies for Vessel Source Spills."

C. Operational spills from tankers. As noted above, operational spills constitute a significant input according to OIS data. A closer look at the assumptions made with regard to operational spills suggests that the analysis greatly underestimates this source. The OIS found that, worldwide, operational discharges resulting from cargo washings constitute 36,000 tonnes per year. This value is down from previous estimates, based on the OIS Committee's assumption that, "[i]ncreased compliance with international regulations has reduced this amount significantly from past estimates" (NAS, 2002; page 46). Similarly, the OIS notes that, "operational discharges from cargo washing are illegal in North American waters," and, relying on 100% compliance with such regulations, estimates that no operational discharges of cargo washing are made in North American waters (NAS, 2002; page 46).

Such reliance on adherence to international or national regulations, without any hard evidence is entirely misplaced. To the contrary, recent examples of non-compliance in North American waters render invalid the assumptions applied in the OIS. Several passenger cruise lines have been fined for illegal discharges over the past few years.⁷ Illegal discharges are not limited to the cruise industry. The chief engineer of an automobile transport ship, *Cygnus*, pleaded guilty on July 25, 2002, to making false waste oil disposal statements in the ship's record book. It was found that he had fraudulently recorded in the ship's oil record book that waste oil was being incinerated in the ship's incinerator when, instead, it was being discharged into the Pacific Ocean via a secret bypass hose. This, too, is not an isolated incident. A similar violation was found during a US Coast Guard investigation in February of 2002 by the freighter, *MV Soho*, transporting seafood to Asia.⁸

Further, a series of reported incidents suggest that certain shippers may be intentionally modifying their oil/water separators to discharge illegal quantities of oil into the sea. (Rosen 2002). Reports of fleet-wide modifications of oil/water separators, such as in the Evergreen Shipping Lines, have lead to ongoing grand jury investigations.

A major initiative to address operational discharges has been undertaken in Canada to protect wildlife off the coast of Newfoundland. The Prevention of Oiled Wildlife Project (POW) made two major findings. First, it is estimated that between 60,000 and 100,000 birds are killed annually on the South Coast of Newfoundland "as a result of "illegal ship-source oil pollution." (POW Steering Committee, 2001; pages iv and 2). Second, "[t]his chronic ship-source pollution in unsheltered waters is not occasioned by necessity; it is the result of illegal acts of convenience prompted by economic considerations." (POW Steering Committee, 2001; page iii).

Illegal discharges of oil are well-documented in European waters as well, where surveillance is more rigorous than in most other regions of the world. Aerial surveillance of oil spills is

conducted over the North Sea, Baltic Sea and the Mediterranean ("special areas" under MARPOL). Information on the number of oil slicks from illegal discharges observed over the past decade indicate that over 800 such spills were detected in 1998 and over 1100 in 1997. This suggests that non-compliance runs rampant in this heavily-monitored area, and calls into question the OIS assumptions. It appears that they are not valid, in North America, Europe, or worldwide. Therefore, it is likely that the maximum estimates of such sources presented by OIS more closely characterize the degree of the problem associated with illegal discharges. The OIS recognizes that operational discharges represent a serious problem. Given the highly questionable validity of their assumptions, we believe that the problem is much greater than the OIS suggests.

It should be noted that a key ingredient of compliance with operational discharge requirements is the availability of reception facilities to receive the vessel's oily waste. Those nation states that are parties to MARPOL Annex I have pledged to provide sufficient reception facilities for vessels calling on their ports. The shipping industry has been highly critical of many port states, which do not maintain adequate reception facilities. Intertanko (International Tanker Owners Association) has repeatedly raised the issue of inadequate shoreside reception facilities within IMO as a major weak point in the MARPOL regime is the lack of adequate shoreside reception facilities for shipboard waste. The problem is one of availability as well as a lack of consistency in the pricing mechanisms specified by the reception facilities that are available. It is argued that the waste reception fees are prohibitively high (Intertanko, 1998).

IMO has developed draft guidelines for the provision, improvement and ongoing management of waste reception facilities, and the European Commission has issued a draft Directive on Reception Facilities for Ship-generated Wastes and Cargo Residues. The proposed Directive places an obligation on EU governments to provide adequate port reception facilities and recommends a fee system that provides an incentive for ship wastes to be discharged to such facilities. Intertanko has cited the EC initiative as a model for governments worldwide to plug this major gap.

While the absence of adequate reception facilities does not necessarily justify illegal discharges of oily waste, it certainly acts as a disincentive to compliance. An independent analysis of the adequacy of reception facilities on a worldwide basis would be useful to help identify current and future needs and to explore ways in which to facilitate their use so as to discourage illegal discharges.

D. Non-tank vessel accidental spills. The OIS estimates that accidental spills from non-tank vessels (100 gross tones (GT) and above) input an average of 7,100 tonnes of oil per year worldwide into the marine environment. Many of the large non-tank vessels, including freighters, container ships, and bulk cargo carriers, carry as much oil as bunker fuel as some of the smaller tank vessels. As such they pose a significant risk should those fuel tanks be breached. A number of such spills have occurred in recent years (*New Carissa* (1999), *Kure* (1997)), raising serious questions about the less stringent standards to which these vessels are held.

Non-tank vessels also contribute at least 270,000 tonnes in operational discharges. Machinery space bilge oil, fuel oil sludges, and oily ballast constitute the primary sources of operational discharges from non-tank vessels. The OIS points to the regulation of discharges through the International Convention for Prevention of Pollution from Ships (MARPOL) for significantly reducing operational discharges of oil, and quotes a

compliance rate of 80 to 99 percent (by class). The OIS concludes that:

"Estimated operational discharges from vessels contribute very significant inputs. More than 99 percent of the estimated volume of operational discharge is related to non-compliance, because existing regulations restrict operational discharges of oil or limit them to not more than 15 ppm. The extent of non-compliance is difficult to assess, and therefore these estimates have a high level of uncertainty." (NAS, 2002: page 106)

We strongly agree with the OIS recommendation that a systematic assessment of the extent of noncompliance with discharge regulation provisions of MARPOL is needed. In addition, we agree with OIS that, "If the estimates of noncompliance assumed in this report are essentially correct, more rigorous monitoring and enforcement policies should be developed and implemented." (NAS, 2002; page 106)

E. Recreational vessels. Recreational boats generate large quantities of operational oil discharges from the operation of two-stroke engines in outboard motor boats and personal watercraft (PWC). Discharges of oil are created by the simultaneous operation of the lubrication and combustion systems, resulting in discharges of the unburned lubricating oil being discharged with the exhaust. As much as 25% of fuel and lubricating oil used by a two-stroke engine is discharged unburned directly into the water or atmosphere (EHSO, 2002). The large numbers of recreational watercraft worldwide indicate a significant contribution by this source. This raises particular concerns because most of these vessels operate in inland or coastal areas, which are already stressed by many other sources of oil and other pollutants. The OIS data on inputs from recreational vessels is limited to inputs into North American waters because "worldwide populations of recreational vessels were not available." (NAS, 2002; page 33). The OIS best estimates that between 2,200 and 9,000 tonnes of oil is discharged into the environment from recreational vessels operating in North American waters alone. Extrapolating from that value, it is safe to assume that on a worldwide basis, discharges from recreational vessels would far exceed the OIS estimates.

Clearly, the significance of operational discharges to the overall pollutant load has been seriously ignored. Both the large volume and number of such discharges, and the real possibility of further limiting them, demands greater attention from the international community.

IV. Prevention strategies for vessel source inputs

Over the course of the past three decades the international shipping industry has undergone significant transformation from virtual self-regulation to increasingly prescriptive rules and regulations from international, national and state governments. Major spill events have served as a catalyst for heightened oversight and regulation.

History has consistently supported acceptance of "freedom of the high seas" as a basic tenet governing the operation of vessels. This has served the shipping industry well over time, as it has largely shielded this industry, unlike other transportation sectors, from significant government involvement or intervention -- both internationally and domestically. The International Maritime Organization (IMO) was established under the auspices of the United Nations to provide a forum for promoting shipping through uniform standards. While purporting to represent

governmental interests, especially in its early days, the then "IMCO" (International Maritime Consultative Organization) was significantly influenced by the industry it was intended to regulate. Its characterization as a "consultative organization" was reflected in its efforts to avoid strict regulation in favor of voluntary schemes and less intrusive measures to enhance the industry. Given this premise, it is not surprising that the first response to the problem of oil spills by the international community was not to regulate shipping for prevention of spills, but rather, to limit the liability of ship owners, by providing a mechanism to pay for cleanup and damages that would not create a financial burden on the industry.

The international conventions that address the prevention of oil pollution from ships can be divided generally into three categories -- those that address issues of liability and compensation; and those that address prevention of intentional discharge and accidental spills of oil from ships. We turn first to the conventions addressing issues of liability and compensation, as these conventions constitute the first attempt by the international community to address the problem of oil spills.

A. Liability and compensation under international law. The *Torrey Canyon* spill of 1967 provided the impetus for the international community to address liability and compensation for accidental spills of oil for the first time. In November 1969, IMO adopted the International Convention on Civil Liability for Oil Pollution Damage (CLC). The purpose of the CLC was to ensure compensation for victims of oil spills by adopting uniform standards for establishing liability and compensation. Under the CLC, a ship owner is "strictly" liable for damages caused by the spill. This means that, regardless of fault, a ship owner must compensate the victims. When more than one ship is involved in a spill, owners are held "jointly and severally" liable. In 1971, the International Oil Pollution Compensation Fund (IOPC Fund) was established to provide compensation for damages from spills, which are not fully compensated under the CLC. Cargo owners finance the IOPC Fund, so that while a ship owner bears primary responsibility under the CLC, in cases where claims exceed a ship owner's liability, the cargo owners assume responsibility through the Fund.

Both the CLC and Fund Conventions are gradually being superseded by revised versions of the Conventions, known as the 1992 Protocols, which entered into force in 1996. Increasing costs of spill cleanup and damages has necessitated an increase in both shipowner liability limits and Fund claim limits. In the meantime, there are two regulatory regimes in place -- the original CLC and Fund Conventions and the 1992 Protocols. The existence of two regimes has caused some problems in consideration of claims by parties to differing conventions. For example, in relation to the 1997 *Nakhodka* spill off the coast of Japan, claims were made by Japan, which had ratified the 1992 Protocols, but the flag state of the vessel, Russia, was still party only to the 1969 CLC and 1971 Fund Conventions. It was agreed to limit a ship owner's liability to the 1969 CLC and the 1971 Fund Conventions, so that a ship owner's liability was set at \$2.2 million under the 1969 CLC. The 1971 Fund paid out \$80.9 million. While the 1992 Protocol was not applied, the 1992 Fund provided \$103.9 million to supplement the 1969 CLC and 1971 Fund Conventions.

In addition to the substantial increases in liability limits under the 1992 Protocols, of particular significance is clarification of the definition of "pollution damage." The original definition of pollution damage did not define "environmental" damage. The 1992 Protocols, however, specifically clarify that environmental damage (other than loss of profit from environmental impairment) is limited to costs incurred for "reasonable measures

of reinstatement actually undertaken or to be undertaken.” In practice, this definition has been narrowly interpreted and applied, so as to constitute virtually no measurable expansion of the 1971 definition. For example, the fund will accept only claims for environmental damage where an individual brings the claim for a proven quantifiable economic loss. Assessment of damages based on theoretical models has been consistently rejected. In other words, under both the 1971 and the 1992 Funds, claims for environmental damage will be accepted only if a claimant can prove quantifiable economic loss in monetary terms. Compensation for “reinstatement” of the marine environment is limited to costs of measures undertaken or to be undertaken, and only those costs of “reasonable measures” are accepted.

This very narrow and rather subjective definition, of environmental damages, is an unfortunate historical vestige of the effort to protect the industry – in this case, at the expense of the environment – and does not fully embrace the “polluter pays” principle because it seriously restricts those damages for which the polluter is responsible. On the basis of this definition, the Fund has denied claims on two occasions by the Russian government⁹ and on two occasions by the Italian government.¹⁰ By maintaining this rather narrow definition of environmental damage, the international community affirmed its rejection of the broader definition of environmental damages which exists in U.S. law.

As discussed below, the departure of U.S. law from this very narrow approach to environmental damages may be partly responsible for improving performance of the fleet trading in the U.S., and thereby warrants reconsideration by the international community.

B. International conventions addressing oil pollution. The international community’s first consideration of oil pollution was reflected in the International Convention for the Prevention of Pollution of the Sea (OILPOL 1954).¹¹ The purpose of this Convention was to reduce intentional “operational” discharges of oil from routine ballasting and tank cleaning operations. It did not address the problem of accidental spills.

Several Conventions adopted in more recent years address directly or indirectly the problem of accidental oil spills from ships. The International Convention on Load Lines of 1966 (ICLL), the International Convention on Safety of Life at Sea 1974 and its 1978 Protocol (SOLAS) and the International Convention for the Prevention of Pollution From Ships (MARPOL) all address some aspect of the problem. The ICLL establishes the deepest draft to which a ship may be loaded to prevent sinking and improve safety of the crew. SOLAS addresses the safety of the crew and cargo, through requirements for ship subdivision and stability, safety equipment, fire protection, and navigation. A number of these provisions contribute to spill prevention.

The convention that most directly addresses the issue of accidental pollution from ships is MARPOL 73/78. While the original focus of MARPOL was intentional “operational” discharges of oil, over time, concern for accidental spills has been translated into amendments specifically intended to prevent such accidental incidents.

The 1973 convention, addressing only the issue of operational pollution, required ballast to be carried only in clean or segregated ballast tanks thereby avoiding the pollution that can occur when ballast water containing remnants of oil is discharged from cargo tanks or when tanks are cleaned. The Convention was amended in 1978 to require that segregated ballast tanks be located so as to provide protection against collisions and groundings (protectively located segregated ballast (PLSBT)).

This was the first attempt to directly address the issue of accidental pollution. This 1978 amendment was the result of a major compromise between industry and governmental representatives at IMO. Discussions on the issue of prevention included – even at that time – recommendations from the United States to institute a double hull mandate. Industry representatives who objected to government intervention in how their ships would be designed and operated successfully opposed this proposal. Instead, industry lobbyists succeeded in obtaining government support for the less protective PL/SBT standard.

In order to be “protectively located” the segregated ballast tanks must be arranged so that the side shell and the bottom shell area of the tanks are from 30 to 45 percent of the total side and bottom area of the entire hull.¹² In other words, instead of protecting the entire cargo area with a double hull, only 30-45 percent of the cargo area would be protected from collisions or groundings. This established a kind of “Russian roulette” for tanker accidents. A ship owner might be lucky when its ship collided and went aground if the ship penetrated only an SBT, but there was a greater than 50% chance that a cargo tank, unprotected by SBT would be breached, resulting in substantial loss of oil.

The 1978 amendments to MARPOL came at a time when the number and severity of accidental oil spills was rapidly rising. It was clear that the increase in tanker traffic, coupled with the increasing size of tankers and the volume of cargo carried onboard, meant that the risks of spills was substantial. Unfortunately, the response to the threat – adoption of “protectively located segregated ballast” (PL/SBT) – was not sufficient to produce an acceptable reduction of the risk. Regulations for protective location of ballast tanks requires that only 30-45 percent of the vessel’s entire hull (both side and bottom) be protected. In effect, adequate protection from PL/SBT is a gamble, at best, with unacceptably favorable odds.

In the 1980s a modest decline in the number and severity of spills is evident in the statistics. However, during this time, better understanding by the scientific community of the destruction of natural resources and the expanding claims for economic loss, sustained ongoing concerns about the adequacy of preventive measures. However, it was not until the *Exxon Valdez* incident that the international community was forced to take significant steps to further improve upon prevention.

The *Exxon Valdez* incident in March of 1989 roused deep concern within the United States about the environmental and economic consequences of oil spills. The Congress acted quickly to adopt the Oil Pollution Act of 1990. A key provision of that new law was a requirement that ships entering U.S. ports be fitted with a double hull. This requirement was to be phased in over time. As a result, the U.S. set out to convince the international community to adopt a similar requirement. The United States was successful in doing so, and MARPOL was once again amended. Specifically, Regulation 13F of MARPOL was amended to provide that tankers contracted on or after July 6, 1993, of 600 deadweight ton (DWT) capacity or more be equipped with double hulls. Those between 600 and 5,000 DWT are to be fitted with double hulls and double sides, and the capacity of each cargo tank is restricted. Every oil tanker of more than 5,000 DWT is required to have a double hull (double bottom and double sides), a mid-deck with double sides, or an alternative arrangement specifically approved by IMO that provides protection equivalent to the double-hull design.

Regulation 13G of MARPOL addresses existing single hull ships. It provides that tankers (20,000+ DWT) and oil product carriers (30,000+ DWT) be retrofitted with double hulls or their

equivalent according to an established schedule. They must also be subject to operational measures providing added protection, or be retired 25-30 years after delivery.

The United States "reserved its position" on 13F and 13G, not accepting the differences between those provisions and U.S. law. OPA90 restricts single hull tanker activity at U.S. ports according to a schedule based on vessel age. MARPOL requires all new vessels have a double hull or an approved alternative design, and allows existing vessels to trade for a period of time longer than under OPA provided they meet other requirements related to SBT or hydrostatic balanced loading (HBL).

Given the phase-out schedule for single-hull vessels, it is clear that the reasons for reduction in spills from tankers, since 1990, cannot be attributed to the implementation of the double hull requirement. The real benefits of that requirement are yet to be realized.

The authors would suggest that the way in which the economic risks of transporting oil at sea are addressed has a profound effect on prevention of spills. The threat of unlimited liability in many U.S. states, and broader definitions of environmental damage in the context of liability, discourage substandard ships from operating in U.S. waters. The threat of severe economic consequences, along with more rigorous inspection regimes has served to improve industry's spill prevention efforts in its North American operations. An unfortunate consequence of this development is the concentration of substandard ships in other parts of the world.

C. Overview of preventive measures to address vessel source inputs. As noted at the outset, the international community's response to the risk of oil spills has been demonstrated largely in terms of efforts to improve spill response capability. However, there are several measures that have been adopted over the past decade, which purport to address prevention. These are as follows:

- Double-hull requirements;
- Vessel management requirements (e.g., International Safety Management (ISM) Code);
- Vessel crew licensing certification and training requirements (e.g., development of Standards of Training, Certification and Watchkeeping (STCW)); and
- Port state control inspections.

Each of these measures will be addressed with regard to its demonstrated effectiveness in prevention of oil spills.

Double hull and other design measures. The US NRC prepared an in-depth evaluation of the effectiveness of the double hull provision in Double-Hull Tanker Legislation: An Assessment of the Oil Pollution Act of 1990, Committee on Oil Pollution Act of 1990 (Section 4115) Implementation Review, National Research Council. Not until the year 2020 is the entire world fleet scheduled to be converted to double hulls. Given that the double hull mandate has yet to be fully implemented, the NRC Committee could not attribute reductions in volume of oil spilled in U.S. waters to the double hull requirements.

Nevertheless, double hulls are consistently found to be effective in the prevention and mitigation of spills. The US Coast Guard's Programmatic Regulatory Assessment (PRA) "found that double hull requirements will reduce the number of spills for tankers and barges by 13% and 16% respectively, and the volume of oil spilled by 21% and 22% respectively in the future" (USCG, 2001; page 4-7). Double hulls were found to be even more effective in an analysis of vessels in US waterways, which demonstrated that, "for collisions, groundings and allisions there is an order of magnitude reduction in spill volume that can be

attributed to the double hull/double bottom designs." (USCG, 2001; page 4-5)¹³ While there is general agreement that double hulls play an important role in the prevention of oil spills, there is some debate on the cost effectiveness of this measure, with a number of experts submitting that it is a costly measure in relation to its effectiveness. This assessment can be largely attributed to the failure of most cost-benefit analyses to fully account for the true value of environmental benefits associated with the prevention of spills. For example, the US Coast Guard routinely uses the "volume of oil not spilled" as the only measure on the benefits side of the equation. This simplistic approach does not reflect the true benefits of spill prevention. It has been repeatedly demonstrated that, "the relationship between damages and volume spilled is a complex nonlinear function which varies by case and conditions" (ASA, 1999). A valid assessment requires the application of complex models for:

1. quantifying the injury to natural resources in terms of lost or disrupted services;
2. identification of restoration actions and assignment of cost value to those actions; and
3. calculation of damages associated with injuries based on lost use values (compensable values) (ASA 1999).

Avoidance of those compensable values and restoration costs constitutes a significant portion of the benefit of prevention.

Prevention of oil spills begins with ship design requirements. The effectiveness of those requirements will, in many circumstances, determine the capability of the vessels to withstand exposure to various risks. Design measures to improve the strength and stability of a vessel are obvious candidates for consideration. In addition, failure of steering, power or propulsion needs to be addressed. The following design requirements have not been fully explored and should be incorporated in international standards to further prevention efforts:

- Requirements for redundancy, alarm, and automatic changeover for steering gear in event of single failure;
- Increased powering requirement;
- Requirement for emergency or redundant propulsion;
- Improved longitudinal bending moments;
- Restricted use of high tensile steel to internal structures; and
- Requirement for inherent positive stability throughout cargo and ballast handling.

ISM Code. Beyond the actual design of a ship, the extent to which spills might be prevented depends in large part on the standards set and maintained by those responsible for managing ship operations. The International Safety Management (ISM) Code was adopted to provide an international standard for the safe management and operation of ships. The ISM Code applies to all passenger vessels, oil tankers, chemical tankers, gas carriers, bulk carriers and high speed craft of 500 gross tons or more on an international. The Code became effective in July of 1998. To be in compliance, the operator of the vessel must possess a Document of Compliance and the ship must possess a Safety Management Certificate. Both documents are issued by the ships' flag state administration.

The ISM Code requires a documented management system designed to provide for the prevention of accidents involving ships and personnel, casualties and damage to the marine environment. The implementation of the ISM Code is intended to ensure a company has safety and environmental pollution risks under control and can guarantee a consistent and acceptable level of service.

The key elements of a successful management system are:

- Policy and objectives. Senior management must define the company policy and objectives with respect to safety, protection of the environment and service. The intentions must be conveyed to personnel ashore and afloat, understood and implemented.
- Trained Personnel. Management personnel should:
 - know their responsibility and authority;
 - understand their role in the organization;
 - know whom they report to and for what; and
 - have the skills and knowledge to do their jobs, including necessary resources.
- Plans, procedures and instructions. The company must ensure all situations, operations, activities and work tasks related to both safety, environmental protection and service quality are planned, controlled and verified in accordance with regulatory and company requirements.
- The company must implement policies and procedures to ensure all activities which may adversely affect safety, the environment or services are identified and measures are taken to prevent the hazardous condition, control it or minimize its effects. In particular, management must implement an effective system for corrective and preventive action to avoid the recurrence of incidents, accidents or non-conformities.
- Management Review. The company must periodically evaluate the efficiency, suitability and effectiveness of their Safety Management System.

The ISM approach to safety complements existing quality assurance systems, such as the ISO 9000 series and the ISO 14001 environmental certification schemes, which have been a critical part of quality shipping over the years. The jury is still out on the efficacy of the ISM Code. The structure of the Code has the real potential to be little more than a paper exercise. Its effectiveness relies heavily on the commitment of ship managers to diligently carry out its implementation. To date, there has been no systematic evaluation of the level of such commitment by which to judge its effectiveness.

STCW. The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978, as amended, sets qualification standards for masters, officers and watch personnel on seagoing merchant ships. The Convention was amended in 1995, largely in response to major spills of the *M/V Braer* (1993), the *M/V Aegean Sea* (1992) the *S/S Scandanavian Star* (1990).

The main objective of STCW is to establish standards of competence, for the performance of tasks by each individual subject to the Convention, and to conduct assessments to determine individual competency. Other important provisions include minimum rest periods for watchkeeping personnel, as well as requiring basic safety training and vessel familiarity for all mariners. The intent is to reduce the risk of human error by providing proper training for mariners, along with the implementation of improved management practices.

The most significant amendments to 1995 were as follows:

- enhancement of port state control;
- communication of information to IMO to allow for mutual oversight and consistency in application of standards;
- quality standards systems (QSS), oversight of training, assessment, and certification procedures;
- placement of responsibility on parties, including those issuing licenses, and flag states employing foreign

nationals, to ensure seafarers meet objective standards of competence; and

- rest period requirements for watchkeeping personnel.

The amended STCW took effect in February 2002. It is too soon to assess its effectiveness as a preventive measure or to evaluate its cost effectiveness. Success is dependent on the commitment of individual companies – the willingness to embrace and implement its provisions. As such, the character of the STCW process can range from a mere paper exercise to implementation of a highly effective program, depending on the effort behind it. As such, the character of the STCW process can range from a mere paper exercise to implementation of a highly effective program, depending on the effort behind it. The widespread forging of STCW documents and certifications has been alleged by some.¹⁴ Under the convention, each IMO signatory country compiles its own maritime training data, certifies that its programs comply with all STCW requirements, and submits its findings to the IMO. Countries meeting the standards are included on the IMO's "white list" of compliant countries from which ship operators are to recruit officers and crews. Some industry representatives have questioned the validity of the standards applied for awarding "white list" status by IMO, calling into question the effectiveness of the current structure for implementing STCW.

Port state control. Historically, the primary responsibility for ensuring that ships comply with international regulations has rested with the flag state that issues the necessary certifications attesting to such compliance. Unfortunately, certain flag States, for various reasons, fail to fulfill their obligations to ensure ships' compliance with internationally agreed standards. As a result, some ships operate in a substandard condition, threatening crew safety and posing serious risks to the marine environment.

Efforts within the international community to make flag states more accountable have met with little success. The establishment of the Flag State Implementation Subcommittee of the IMO's Marine Environment Protection Committee has resulted in little more than agreement by flag states to a so-called "self-assessment" process. Absent any serious consequences for failure to meet their obligations, irresponsible flag states have little incentive to dramatically improve the performance of those obligations.

Port states, whose interests are subject to the vagaries of substandard ships, have become increasingly impatient with the failure of flag states to meet their obligations. These circumstances have motivated port states to undertake efforts within IMO under Resolution 632 to increase supervision and broaden the scope of authority of port states for inspection and detention of vessels. Perhaps more importantly, a number of regional Memoranda of Understanding have developed over the years to improve port state control in particular areas of the world.

Regional Port State Control was initiated in 1982 when fourteen European countries agreed to co-ordinate their port State inspection effort under a voluntary agreement known as the Paris Memorandum of Understanding on Port State Control (Paris MOU). Current membership includes 13 EU countries plus Canada, Croatia, Iceland, Poland, Norway and the Russian Federation. The European Commission, although not a signatory to the Paris MOU, is also a member of the Committee. Under the agreement each country undertakes to inspect 25% of individual foreign flagged ships visiting their ports, to pool inspection information and harmonize procedures. The coordinated effort results in inspection coverage of 90% to 100% of individual ships visiting the region. Inspection reports are recorded on a central

database, available for search and daily updating by MOU member countries.

The Paris MOU has served as a model for the development of regional port state control regimes. Today there are seven such agreements as follows:

- Acuerdo Viña del Mar for Latin America
- Mediterranean MOU
- Caribbean MOU
- Abuja MOU for West and Central Africa
- Indian Ocean MOU and the Black Sea MOU
- Tokyo MOU for the Asia Pacific Rim¹⁵

The success of port state regimes in eliminating substandard ships and thereby improving upon oil spill prevention, has not been qualitatively documented. Such an analysis would be useful in determining the relative benefits of past initiatives that have been taken as lessons learned for further improvements to port state control. One effort that deserves further expansion is the data sharing between parties to the established port state MOUs. Sharing between these regions would greatly facilitate effective tracking and regulation of substandard vessels.

A Port State Control initiative was undertaken in the US in 1994 which included an effort to board potentially substandard vessels at sea buoys, rather than wait for them to enter port. Vessels are screened prior to their arrival to determine their level of risk. Each vessel is categorized according to compliance with international safety conventions, previous track records and those of sister ships in the same ownership or management, and the rating of its flag and classification society. These categories determine at what point a ship will be boarded and the level of inspection to be applied.¹⁶ This program, coupled with more stringent liability and financial responsibility requirements,¹⁷ has been widely regarded as a major basis for the reduction of substandard ships in U.S. waters. As noted by the NRC, there has been no analysis of the quality of the vessels entering U.S. ports. However, strong anecdotal evidence, along with the evidence provided in spill trends, supports that view. On this basis, it may be useful for other port state regimes to consider incorporation of similar screening and categorization processes.

Port states can also encourage quality shipping with economic incentives for exemplary performance. The European Green Award has been identifying and rewarding quality vessels for many years. This program audits vessel operations, and Green Award vessels receive reduced port fees, discounts on chandlery services, towing, line handling, and other port services. Broadening the use of economic incentives to improve the quality of the world fleet deserves more serious consideration. Inclusion of such a program in conjunction with regional, port state control programs needs to be encouraged.

Thus far, we have examined prevention efforts that are currently underway to prevent oil spills from ships. These include both overt measures such as design requirements, as well as less direct measures for improvement to the overall quality of ships (both structurally and operationally) as intended by implementation of STCW, ISM, and heightened port state control efforts.

Two other opportunities exist for improving spill prevention that have not been effectively addressed by the international community. Flag states and the salvage industry hold these opportunities.

Flag state accountability. Historically, flag states have had primary responsibility for ensuring safety at sea for their flagged vessels with regard to construction, maintenance and seaworthiness, as well as crew training and sufficiency. Flag

states must continuously monitor and survey their vessels with regard to structural integrity, equipment and crew. These obligations are generally achieved through the issuance of vessel safety certificates indicating compliance with applicable international conventions. Port states rely to some degree on these certificates to validate the integrity and seaworthiness of the vessels calling on their ports.

As noted above, some flag States, for various reasons, fail to fulfill their obligations to ensure ships' compliance with internationally agreed standards. As a result, some ships operate in a substandard condition, threatening crew safety and posing serious risks to the marine environment. As noted by one observer, "The hard reality is that there is little identifiability and almost no accountability where it is needed most - in relation to the owners of sub-standard ships."¹⁸ These ships are often referred to as "flags of convenience" or "ships of shame."

The structure of the industry, giving primary responsibility to flag states, but not then holding them accountable, can be largely imputed for many of the serious problems facing the industry. While flag states are permitted to contract out their surveying responsibilities to classification societies or non-exclusive marine surveyors, there is a potentially unhealthy relationship between the classification societies, the registers for which they survey and the shipowner. Generally, the shipowner indirectly pays the bill of the surveyor who must assess the seaworthiness of the vessel. At the same time, the flag state has a vested interest in providing certification, so as to continue the economic benefits of maintaining the vessel on its registry. Legally, the class society is only accountable to the flag state, and the flag state is accountable to no one. In the case of an incident, the shipowner is responsible for damages, but those are often covered by insurance. It is the system that needs change for there is little incentive for rigorous compliance.

International efforts to improve upon Flag State responsibility have largely failed. So long as the current system continues in its current form, this is not likely to change. A dramatic change in the way in which ships are registered is needed to overcome this deficiency. The flag states that hold the power and benefit economically from the current system are unlikely to yield easily to a new structure. The political reality suggests that such a change is not likely to be achieved in the near future.

Tug escorts. One relatively simple measure that dramatically improves prevention performance is the use of tug escorts in heavily trafficked or navigationally challenging regions. According to the two year \$2 million Prince William Sound Risk Assessment (PWSSC 1997), improvements to the tug escort system has reduced the risk of a spill in that region by 70%. Early on, it was demonstrated that the probability of collisions are reduced by 57% and the probability of groundings are reduced by 75% if tug support is available.

D. Salvage as a preventive measure. The International Salvage Union reports that in 2000, ISU salvors performed 310 salvage services, following fires, collisions, groundings, structural failures and other marine accidents. These ships were laden with 591,202 tonnes of oils, hazardous chemicals and bunkers, of which 419,000 tonnes of oil were recovered from tanker casualties, representing the equivalent to around 11 spills the size of the Exxon Valdez. In addition, salvage operations in 2000 also resulted in the recovery of nearly 10,000 tonnes of hazardous chemicals, around 83,000 tonnes of bunkers and more than 79,000 tonnes of other pollutants - including slops, dirty ballast and non-hydrocarbons.

The year 2000 was not exceptional. The ISU further reports that in the period 1994-2000, ISU salvors assisted 1,355

casualties with a potential to cause pollution, recovering 8.9 million tonnes of oils and chemicals. This included 7.7 million tonnes of crude oil, 494,385 tonnes of hazardous chemicals 436,787 tonnes of bunkers.

Once a spill has occurred, the recovery rate, even under the best of circumstances is 10 – 15 percent (OTA, 1990) thus underlining the importance of salvage readiness and capability to keep the oil in the vessel. The usefulness of salvage as a key preventive measure in the deterrence of oil spills has been greatly underestimated by the international community. Typically, salvage is considered in the context of “response” to spill casualties. Salvage efforts are undertaken once the spill has occurred. Little attention has been paid to improving prevention of spills by enhancing salvage capability during that window of opportunity that often exists between the time a vessel becomes disabled and a spill occurs. This oversight represents a major gap in spill prevention initiatives, which, if effectively addressed, could significantly reduce accidental spills.

Examples of instances where effective salvage response resulted in spill prevention include:

- A Chinese salvage team response in 1999 to the tanker *Dan Chi*, laden with 38,830 tonnes of crude oil, reporting a broken propeller shaft during a voyage from South Korea to Shanghai. The tanker was brought to safety by salvage tugs.
- The 74,500 DWT bulk carrier *Captain Diamantis* ran into engine trouble 1,200 miles from Cape Town. A large salvage tug performed a rescue tow.
- The ro-ro/cable layer *Elektron* grounded on the island of St. Kilda in October 2000. Lloyd's Open Forum (LOF)/Special Compensation P & I Clause (SCOPIC) salvage was performed, ending in the vessel's redelivery in Oslo. Some 45 tonnes of diesel and lube oils was pumped to a storage facility ashore.
- The vessel *Kita*, grounded at St. Mary's, in the Scilly Isles, in 1997. Salvors removed bunkers from the wreck.
- Salvors responded during 1997 to a serious pollution threat in Japanese waters. This arose from the capsized fore section of the tanker *Nakhodka*. The stern section of the *Nakhodka* sank in deep water (2,500 m) but the forepart drifted and grounded on the Japanese west coast. Salvors removed the remaining oil from the fore section.

In this context, salvage readiness means the ability to undertake virtually “immediate” action. It is well known that a casualty's condition can deteriorate rapidly without salvage intervention. Instant response is essential. This means mobilizing and deploying experienced salvage personnel and specialized equipment - pumps, generators, firefighting systems, anti-pollution boom and other vital items rapidly and efficiently.

Historically, salvors have been compensated for their salvage services on a “no cure no pay” basis, receiving a proportion of the “salved value” of the ship, its bunkers and cargo. Under this scheme the salvage reward was entirely dependent upon the recovery of property. In the past, if there was no recovery, there was no payment, whatever the expense of the operation. With the adoption of the International Salvage Convention of 1989 (the Salvage Convention), the “no cure, no pay” approach to salvage was supplemented by a concern for spill prevention. Article 14 of the Salvage Convention, introduced a new incentive scheme, known as “Special Compensation”. Under this scheme, when the salvor has prevented or minimised damage to the environment,

but the value of the salved property is insufficient to provide a just reward, the shipowner must, nevertheless, compensate the salvor for its efforts to prevent or reduce pollution. “Special compensation” rewards are limited under the Salvage Convention to salvage services in “coastal waters and areas adjacent thereto.” The scope of this compensation, however, extends to any vessel or its cargo, which threatened damage to the environment, and the potential increment of the reward was established at a maximum of 100 per cent of expenses.

The provisions of Article 14 were reflected in the preferred salvage agreement contained in Lloyd's Open Forum (LOF) 90 and subsequently, LOF95 and LOF2000.¹⁹ This “special compensation” provision has proven difficult to implement for lack of clarity on of these difficulties, an alternative system for assessing Special Compensation remuneration, known as SCOPIC (Special Compensation P & I Clause), was developed jointly by salvors, P & I Clubs, underwriters and other parties. Under SCOPIC, there is no geographic limitation or linkage to the existence of a pollution threat. SCOPIC allows salvors to contract out of the special compensation provisions of LOF and apply the new scheme at any time, regardless of the circumstances. Also included in SCOPIC is a provision to discourage salvors from invoking the SCOPIC compensation provisions where the traditional ‘no cure no pay’ award would exceed the remuneration payable under SCOPIC.

SCOPIC took effect in August 1999. An updated edition, SCOPIC 2000, was introduced in September 2000. It is too soon to assess SCOPIC as a viable solution to the problem of providing effective incentives for salvage as a preventive measure. The salvage industry appears to be generally open to SCOPIC, but maintains a “wait and see” stance as to its ultimate acceptability, pending more experience with its use.

The economic viability of the salvage industry has been challenged over the past few decades as improvements to ship safety have reduced the overall number of major casualties.²⁰ As a result, the salvage industry is also faced with a decline in the numbers of trained and experienced personnel available to undertake complex salvage operations.

It has been noted that although major accidents are now fewer in number, shipping casualties continue to occur as a result of collision, fire, grounding, structural failure and mechanical breakdown. Recent total losses include the *Erika*, *Ievoli Sun*, *Jessica* and *Kristal*. Environmental consequences, as in the case of the *Erika*, can be devastating.

In recognition of the need for continued and enhanced preventive salvage capability, and the economic difficulty of providing such capability under the traditional structure of the salvage compensation regimes, some governments have contracted with the salvage industry to provide “pollution defense” services. In this context, many governments have retained salvage readiness in the form of “standby” salvage arrangements. These retainers have the advantage of providing a guaranteed level of protection for busy waters - such as the English Channel and Dover Strait. Similar arrangements exist in France, Spain, Germany, Italy, the Netherlands and South Africa.

In contrast, the United States relies upon a “tug of opportunity” system to respond to maritime emergencies. This system has been publicly criticized for its unreliability and failure to ensure adequate salvage readiness and capability, since it largely leaves to chance the availability of effective salvage in any given instance.²¹

The US Coast Guard has recently initiated the development of salvage regulations (USCG-1998-3417/33CFR 155). While the proposed rule attempts to address parts of the problem, it does not go far enough. The key elements of a successful salvage policy are:

- A regulatory framework that will result in prompt, effective response;
- Necessary equipment and technological capability;
- Trained and experienced personnel;
- Standard contracting options for salvage and wreck removal to eliminate delay;
- Preplanning among owners, underwriters, and regulatory agencies before the actual event;
- Effective system of communication and cooperation among all interested parties, including salvors, shipowners, cargo owners and coastal states; and
- Legal regime of fair compensation to salvors for performance of pollution prevention efforts.

The proposed rule attempts to address, at least in part, some of these components. It does not, however, fully address any of them. The elements related to equipment and capability, training of experienced personnel, contracting options, effective communication and fair compensation, remain largely untouched.

Need for dedicated salvage. Ocean Advocates has been a long time proponent of a dedicated, standing salvage fleet. In contrast, the Coast Guard has chosen to rely largely on a "tug of opportunity" system that leaves largely to chance the capacity and readiness to respond to any given vessel casualty. The proposed rule provides a system of regulatory requirements to improve commercial salvage capacity, in much the same way it has done with the oil spill removal organization (OSRO) requirements. One benefit of this approach is that it places responsibility for response capability (cost and response readiness) on the potential polluter, in accordance with the "polluter pays" principle. However, the potential disadvantage is that it creates little more than a "paper tiger," providing minimal salvage capability and readiness. Local consortiums or cooperatives may be formed to create an aura of readiness and capacity that is not a true reflection of reality, given the financial drive to keep personnel/equipment overhead costs as low as possible. This situation is further exacerbated by the absence of licensing or certification requirements or some other way to objectively evaluate the competency of a "response organization." Given the strong commercial pressures increased profitability, there is little incentive for most vessel owners/operators to minimally satisfy the regulatory requirements. For these reasons, a dedicated salvage fleet (whether provided under government contract to private entities or provided via government owned and operated vessels or some combination of the two) is more likely to satisfy the need for strong salvage capacity and readiness.

Ocean Advocates has been a major proponent of the long-term effort to establish a rescue tug in Neah Bay. Numerous studies have identified a gap in the region's ability to prevent and clean up oil spills along the Olympic Coast between Grays Harbor and Port Angeles. A multi-mission response tug stationed in Neah Bay year round has proven to be the best way to fill that gap in coverage. The State and federal governments have funded a rescue tug at the entrance to the Strait over the past 5 winters to be available to respond to shipping accidents. During that time the tug has been called out 20 times (<http://www.ecy.wa.gov/biblio/0208001.html>). Funding has been provided for yet one more winters' operation, but longer-term

funding is needed to secure the services of the rescue tug for this region of expanding maritime trade.

Local and tribal governments have expressed keen interest in protecting their constituency's livelihoods and quality of life from the long-term impacts of a major oil spill. While Ocean Advocates has been a leading NGO voice for oil spill prevention in the NW as well as at the IMO for many years, a growing number of environmental organizations have recently expressed an interest in having meaningful input on the way in which maritime safety is managed.

Unfortunately, the Coast Guard has traditionally looked primarily to the regulated community for both technical input as well as future employment. The lack of balance in the numerous "expert panels" convened by the Coast Guard over the years and the refusal to even allow local government representatives to attend the recent PAWSA for the San Juan Islands makes the "revolving door" with the maritime industry appear far too pervasive in the actions of past Captains of the Port.

Therefore, if there is to be meaningful dialogue in the future, there needs to be balance brought to such forums as the Harbor Safety Committee and future expert panels. Representatives from a Puget Sound RCAC would ideally serve that role. Furthermore, there needs to be a cooling off period of at least a year from the time a Captain of the Port or other high ranking MSO can go to work for the community they previously regulated. Captains Moore, Softye, Hutchins, Felton, Maurey, and Rousseau have demonstrated there is quite a trend in the Pacific Northwest that erodes the credibility of the decisions made by current office holders.

The case of the *New Carissa* demonstrated the problem quite dramatically. In February 1999, the 640-foot Panamanian-flagged *New Carissa*, with 400,000 gallons of fuel oil, ran aground off the coast of Oregon in the vicinity of Coos Bay. Eventually the ship was driven further towards shore and broke apart, spilling approximately 70,000 gallons of fuel. Despite initial delays and failures, the 440-foot bow section was ultimately dragged off the beach and towed to sea where it was sunk in international waters. The vessel's stern sections remain firmly on the beach.

As stated by the Federal On Scene Coordinator for the *New Carissa* incident:

"We need a salvage plan more capable than that demonstrated during the initial stages of the *New Carissa* casualty. It was my belief on 4 February 1999 and it remains my belief today, that adequate and timely salvage capability would have significantly mitigated this 'crisis on the coast.' There are currently only two salvage vessels on the Pacific coast capable of re-floating a large grounded ship, and neither was readily available to respond in this case."²²

The lack of adequate salvage was particularly costly in the case of the *New Carissa*. The costs of the incident exceed \$60 million, not counting the U.S. Navy's contribution, and half the ship is still grounded on Oregon's coast. The cost of stationing a single rescue tug in the vicinity of the *New Carissa* incident would be approximately \$3M per year.

One notable exception to the "tug of opportunity" system in the U.S. is the stationing of a dedicated rescue tug in Neah Bay for the protection of sensitive environmental resources from the risks posed by busy vessel traffic in that region. Over the past 4 winters the tug has been called out 18 times to respond to maritime incidents.²³ The urgent need to address salvage in the US was recently expressed by the NRC's Marine Board:

"Within the maritime community, as well as government agencies, it is recognized that the nation's domestic salvage capacity is inadequate to meet basic and emergency needs. This inadequacy jeopardizes environmental, transportation and homeland security objectives. There is a need for a cohesive, federal national salvage policy and a designated lead government agency to implement that policy. The Marine Board has published two reports on this critical issue, in 1982 and 1984, along with specific recommendations that detail this need and the justification for it."²⁴

Wreck removal. The usefulness of salvage in preventing oil pollution is not limited to vessels that are currently afloat. Salvage, as a means of pollution defense, may also involve the removal of bunkers and polluting cargoes from vessels, which have been, declared total losses. These include both present and past "ship wrecks." Today, there is a growing appreciation of the risk of persistent pollution from wrecks, which continue to deteriorate over time.²⁵ The International Salvage Union describes the problem as follows (ISU 2002):

Many elderly vessels are now partially or totally buried in mud and sand. A high proportion of the wrecks are in poor condition; special techniques are required to clear away the deposited material, in order to expose the structure and allow expert inspection prior to an attempt to recover pollutants and/or clear the wreck.

There are many thousands of wrecks of this type along the North American seaboard, in West European waters and in heavily trafficked areas elsewhere in the world. Many of these ships were lost as a result of military action during two world wars. There is growing demand for salvage assistance, to deal with long-term pollution problems.

The ISU estimates that during the 10-year period 1991-2000, ISU salvors performed 343 wreck removal operations. The number of such cases in 2000 totaled 37. The wrecks included a variety of vessel types. Examples of governmental action, to address the risks posed by shipwrecks, include:

- the accomplishment of the Norwegians with the removal of oil from the war wrecks *Blucher* and *Norvard*, both situated on the bottom of Oslo Fjord;
- the work of the U.S. Coast Guard in the case of the barge *Cleveco* located in Lake Erie and removal of oil from the tanker *Jacob Luckenbach*, located off the coast of California at San Francisco;
- the work of the Finns in the case of the passenger/vehicle ferry *Estonia*, resting on the bottom of the Baltic Sea;
- the effort of the Canadians with the barge *Irving Whale* located off Prince Edward Island in the Gulf of Saint Lawrence;
- the work of the Dutch in the case of the wreck of the *Spyros Armenakis*, submerged in the Westerschelde;
- the recent work of the French with the tankers *Erika* and *Ievoli Sun*, both situated off the French coast;
- and the work of the U.S. Navy to remove oil from the U.S.S. *Mississinewa*, at Ulithi Atoll, Micronesia.²⁶

Negotiations are underway within IMO to adopt an International Convention on Wreck Removal. A key issue to be addressed by the new convention is the need for an international framework to address pollution threats posed by wrecks. It is well accepted that as the condition of a vessel deteriorates, there is an increasing risk of pollution from corroding cargo and/or fuel tanks. It is hopeful that this new convention, when adopted, will

pave the way for recovery of those wrecks posing significant environmental risk.

Cost effectiveness. The ISU's Annual Statistical Survey for the past 23 years, including nearly 4,300 salvage operations, indicates that the aggregate value of the property salvaged (ships, cargoes and bunkers) was US\$ 24.9 billion. The cost of these recoveries was determined to be just over five per cent of the total salvaged values. By any standards, this represents a highly cost effective measure. We suggest that even relatively significant increases in the cost of salvage would result in a cost-effective return in terms of pollution prevention. However, no qualitative analysis is available to verify this supposition.

The key elements of an effective salvage capability include:

- A regulatory framework that will result in prompt, effective response;
- Necessary equipment and technological capability;
- Trained and experienced personnel;
- Standard contracting options for salvage and wreck removal to eliminate delay;
- Preplanning among owners, underwriters, and regulatory agencies before the actual event;
- Effective system of communication and cooperation among all interested parties, including salvors, ship owners, cargo owners and coastal states; and
- Legal regime of fair compensation to salvors for performance of pollution prevention efforts.

In sum, further improvements to salvage readiness and capability on a worldwide basis could significantly improve the oil spill prevention performance of the shipping industry. Further efforts are needed within IMO, as well as regionally and nationally to address this issue.

E. Establishment of "safe havens" or "ports of refuge." A key ingredient for effective "preventive salvage" is the availability of "safe havens" for vessels in distress, where salvage and/or repair efforts can be safely undertaken in a more controlled environment. The enormity of this problem was recently demonstrated in the case of the *Castor*. This ship, laden with gasoline, developed a deck crack. The responding salvors were forced to tow the casualty over 2,000 miles around the Western Mediterranean as they sought shelter to perform a ship-to-ship cargo transfer. Government after government refused their requests for shelter.

IMO has responded to the *Castor* incident by agreeing to develop guidelines for coastal states for identifying places of refuge, including ports, sheltered waters and safe anchorages. In addition, guidelines will be prepared for the evaluation of risks posed by casualties and for advice to Masters in emergency situations - including actions to be taken by the crew, salvage operations and including the involvement of coastal states.

This IMO initiative has been characterized as:

"the first step towards the production of a global register of designated places of refuge available to salvors dealing with marine casualties. This goal may take some time to achieve. In the meantime, the production of guidelines is a major leap forward, especially in the area of risk assessment. The salvor and the governmental agency will have a risk assessment template to work with."²⁷

The IMO's success in ultimately establishing an agreed upon regime for identifying and utilizing "safe havens" is critical to enhancing salvage effectiveness.

F. Prevention of operational discharges. As described above, operational discharges are not well documented, but have been shown to pose serious problems in some parts of the world. The

Canadian Prevention of Oiled Wildlife (POW) Project has identified a number of measures to be undertaken to resolve the problem off the coast of Newfoundland. Some of these measures could be appropriately implemented elsewhere. Specifically, monitoring, education and awareness, surveillance, and enforcement have been identified as areas warranting additional energy. In this context, their recommendations included the following key components:

- Continuation of beach bird surveys to assess the severity of the problem;
- Campaign to inform judicial authorities of the need for penalties sufficiently severe to provide effective deterrence;
- Expand aerial surveillance program, with concentrated efforts during the winter months;
- Implementation of the Automatic Identification Systems (AIS) and supporting shore based infrastructure and extension of AIS to the entire EEZ;
- Exploration of satellite imaging and other technology to assist in identification of illegal discharges;
- Enhancement and refinement of oil fingerprinting processes and techniques; and
- Development of an effective sampling device that can be deployed remotely to assist in enforcement efforts.

Similar initiatives have been employed in the North Sea in conjunction with OSPAR and individual governments.

These recommendations provide a basis for a broader discussion of how to address this difficult and, possibly, growing problem. There is a need to generate a better understanding of the extent of the problem. However, that should not deter individual nation states, regional organizations, or the IMO to work jointly to address this widespread concern.

G. Industry initiatives. Many voluntary industry initiatives have been undertaken to reduce the number of spills. The use of internal environmental auditing programs, for example, has proven to be quite effective in improving performance of vessels, as well as production facilities, refineries, and transfer facilities.²⁸ Such an audit ensures that all regulatory requirements, corporate policies and “best practices” are implemented to prevent spills. A combination of facility compliance audits, and audits of overall management systems can be expected to yield the best results.

Those companies, which have undertaken these and similar initiatives, are to be commended for their actions. Such initiatives can be costly, and may place a company at a competitive disadvantage (at least in the short term). Those companies, which do undertake such initiatives, recognize the long term gains that may be achieved. They view the benefits of prevention as outweighing the economic hardships resulting from the institution of a voluntary measure. Unfortunately, such voluntary schemes are not likely to be pursued by those companies, which could most benefit by them. Owners and operators of substandard ships are not likely to invest in voluntary efforts to improve performance beyond that which is required by regulation. For these organizations, regulatory mandates are necessary.

H. Addressing the human element. Human error is a major contributing factor in most oil spill incidents. Inadequate training, poor judgment, or a negligent attitude, constitute the basis for the actions or inactions leading up to a casualty. Greater efforts are needed to attract well educated, trained personnel to serve as seafarers.

Perhaps even more important however, is the inclusion of prevention as a key element in the corporate mission and individual job performance. In the first instance, the concept of

prevention must be embraced by corporate management at the uppermost levels. It is there that the goals and expectations of the company are formulated and passed down the chain of command to all other levels of the company. Recognition of the importance of prevention to the employer, will necessarily inspire those in the field to perform with prevention as a priority.

The difficulty faced by corporate managers who wish to implement preventive measures is the inherent conflict between the cost of undertaking a program of prevention and fiscal responsibility to the shareholders of the company. There is often a cost associated with such programs that may not coincide with the short term economic goals of the shareholders. Overcoming this hurdle requires a broader initiative to educate on the long term benefits of a prevention program.

I. Responsibility of the charter. The current structure of the maritime transport of petroleum provides little incentive to encourage quality shipping. One part of the problem is the absence of Charterer responsibility in the event of a spill. Charterers are given little incentive to choose the more expensive, quality shippers for transport of their products. In this day of “spot” chartering, the least expensive shipper is likely to gain the most business. Quality shippers find themselves at a decided disadvantage in the current market. Most of the major oil companies have relinquished all or most of their fleets (and liability for spills, as well). Some companies have “vetting” systems to ensure that certain standards are met by the shipping providers, but, too often, the choice between shippers becomes an economic one.

This points to the need to consider shared liability between shipper and charterer to ensure that the highest quality shipping will be employed for the transport of hazardous materials such as oil.

V. Spills and discharges from production sources

According to the OIS, offshore oil and gas exploration and production inputs account for between 27,000 and 111,000 tonnes of oil input per year worldwide. The OIS best estimate is 54,000 tonnes. This represents about 9% of the total annual inputs. Included in these production sources are offshore oil exploration and production platforms, marine pipelines that transport the oil from the platforms to the shore, and floating production, storage and offloading systems (FPSOs).

ERC data presented in Figure 5 show a threefold increase in pipeline spills worldwide between the decade of the 80s and the decade of the 90s. A one third reduction in spill volume is recorded for exploration and production activities during that same period of time. Figure 6 presents USCG data on annual worldwide oil spillage from E&P facilities for the past three decades. The last decade, with the exception of 1990, showed consistently low spill volumes, but variability in the number of spills over 1 gallon, ranging up to 1,000 spills.

On a worldwide basis, the amount of petroleum entering the marine environment during the pre-1980 period from oil and gas production activities was estimated at 40,000–70,000 tonnes annually, according to NAS (1985). During the period of 1990–1999, USCG estimates that amount to be approximately 403 tonnes annually. This represents a significant reduction in inputs from this source.

Sources of spills associated with exploration and production include accidental spills caused by well blowouts, vessel/platform collisions and allisions, operational discharges of oil in the “produced water” from production operation.

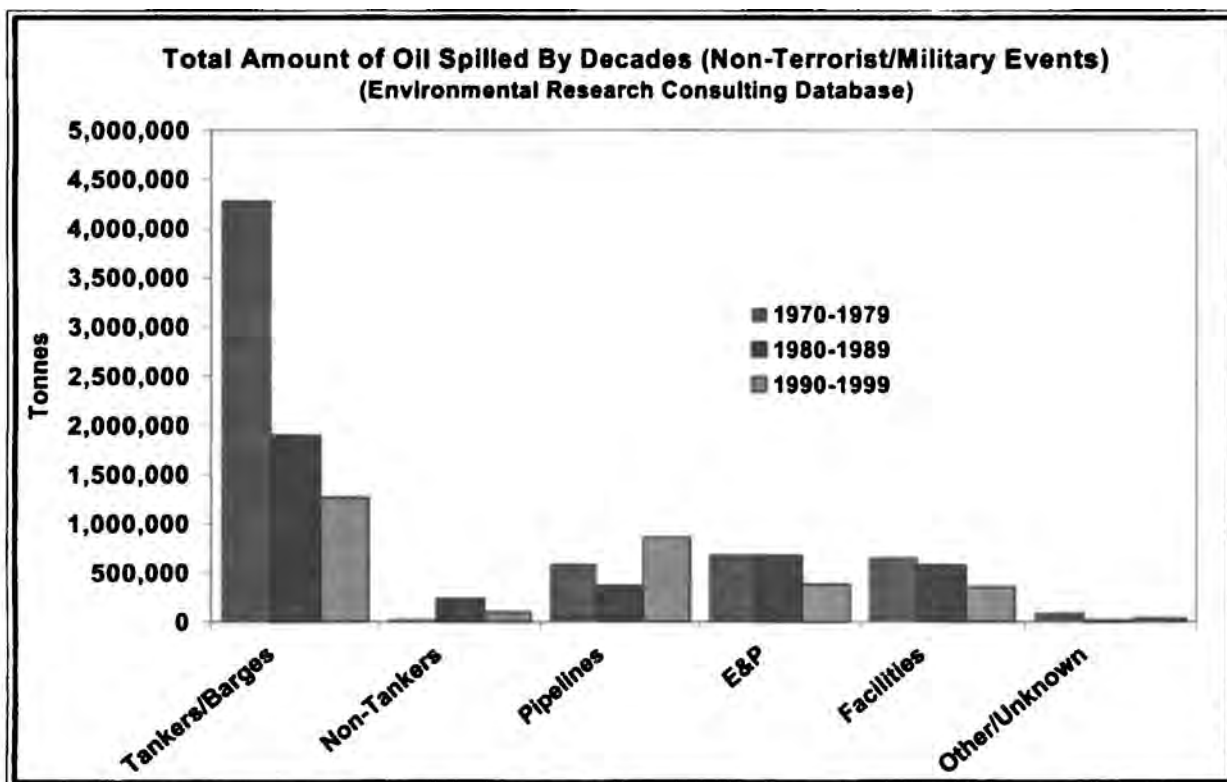


Figure 5. Total amount of oil spilled by decades (USCG 2001).

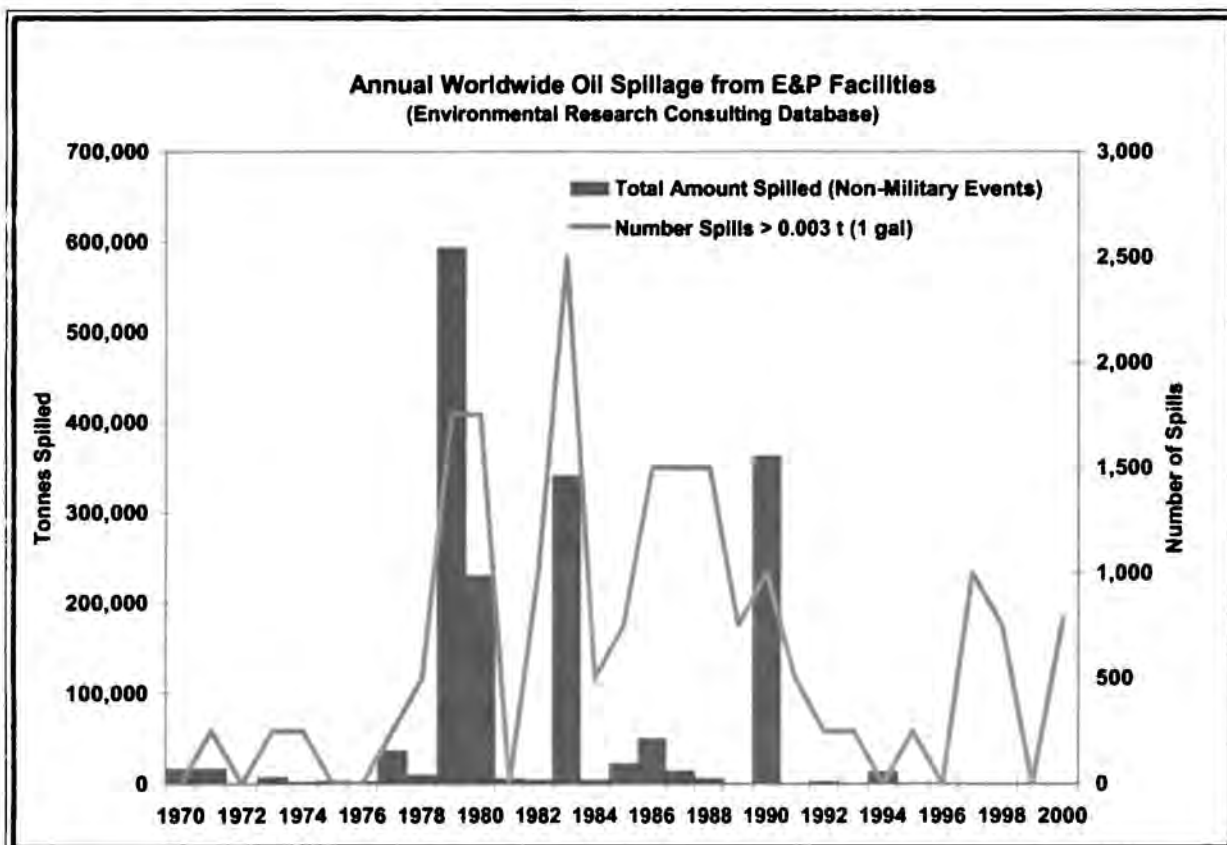


Figure 6. Annual worldwide oil spillage from E&P facilities (USCG 2001).

be attributed to vessel/pipeline allisions and collisions as well as pipeline leaks caused by corrosion. The increase in pipeline spills over the past decade may be attributed in part to aging pipelines worldwide.

VI. Prevention strategies for production sources

USCG (2001) has observed that the volume of oil entering the marine environment from offshore oil- and gas-related accidental spills is only a fraction of that entering from operational inputs from that same source. It does appear that, at least with regard to operational inputs, that further reductions can be achieved. Such reductions would require further tightening of national water discharge and air emissions standards. Offshore oil and gas production activities are regulated by national governments and regional agreements rather than through the international community. Therefore, it will be largely up to individual nation states to take action individually or jointly with neighboring countries to address these issues.

National governments should undertake to explore technology options for zero-discharge of oil from exploration and production activities. At minimum, further restrictions on water and air emissions should be instituted. Absent further government regulation and oversight, it is incumbent upon industry to explore options for zero-discharge and further promotion of spill prevention from this source.

Floating production, storage, and offloading systems (FPSOs). FPSOs are essentially large oil production and storage vessels that extract oil from the seafloor, store it onboard, and then periodically lighter their contents to other vessels for transport to shore.²⁹ Worldwide there have been in operation or are currently in operation: 204 Floating Production, Storage, and Offloading Systems (FPSO); 107 Floating Storage and Offloading Systems (FSO);³⁰ and 93 Floating Production Systems (FPS). These systems have had a total throughput of nearly 702 million barrels. As oil exploration and production operations move further offshore, there is an expected future increase in use of FPSOs as a substitute to permanent production facilities.

An evaluation of the spill record of these facilities, conducted by ERC, reveals that worldwide, there have been 204 oil spills associated with these systems, for a total of 197,131 gal spilled. All but two spills were from FPSOs. One incident is responsible for over 83% of the total volume of oil spilled – 163,800 gallons of crude oil spilled from the FPSO Captain in the North Sea, off Scotland, UK, on 24 August 1997 (USCG 2001). One FPSO in the Timor Sea of Australia has reported 140 incidents, the largest of which involved 632,646 gallons of oil. Eight FPSOs have been involved in more than one spill incident, three have been involved in ten or more spills. These statistics call into question the adequacy of regulation of these facilities. This issue was raised several years ago within the IMO by NGOs concerned about the legal status of FPSOs as production facilities rather than vessels, given the nature of their activities and their ability to navigate international and coastal waters. That issue has yet to be resolved. In the meantime, it is largely up to individual nation states or regional organizations to address this issue.

Pipelines. As noted above, there has been a significant increase in inputs from pipelines over the past decade. The OIS estimate of worldwide inputs from pipelines of 12,000 tonnes per year is “uncertain” and we submit, greatly underestimates this source. The figure was derived from the volume of oil spilled per mile of pipeline per year in North American waters. We submit that the spill rate from pipelines in North American waters may

differ dramatically from that which exists in other parts of the world and is not a valid parameter for worldwide application. This, coupled with the lack of adequate data for the number of miles of pipelines in waters outside of North America, renders the worldwide figures virtually meaningless.³¹

CONCAWE identifies five main categories of pipeline spills. The percentages provided here relate to onshore spills, so will not be indicative of the relative percentage of spills from each source from marine pipelines.

Causes of pipeline spills 1971-1995 (CONCAWE database) include:

- Third party activity 33%
- Corrosion 30%
- Mechanical failure 25%
- Operation failure 7%, and
- Natural hazard 4%.

One notable pipeline spill occurred on January 1, 1990 when an underline pipe connecting Exxon's Bayway Refinery and a nearby terminal ruptured and released over 500,000 gallons of refined oil into the Arthur Kill, a water body separating New Jersey and New York. The spill affected several miles of shoreline and killed hundreds of birds in the area. The settlement totaled a \$15 million cost to the company over a five-year period. Payments included \$10 million for "environmental initiatives" including the purchase of new wetlands, \$4.8 million in restitution to the governments of New York and New Jersey and a \$0.2 million criminal fine.

A report issued by the NRC's Marine Board found that the most widespread risks associated with pipelines in US waters were oil spills resulting from pipelines damaged by vessels and their gear (NRC, 1994b). However, at that time it was not possible to precisely quantify the data available. It was determined that the risk was manageable using existing technology and by improving implementation of then-existing regulations. It was suggested that “better cooperation among operators and regulators in gathering safety data, assessing risks, and planning and implementing risk management programs” was needed to promote spill prevention.

In some parts of the world, aging pipelines provide a serious risk of spills. For example, between 70 mm and 140 mm barrels of oil are spilled in Russia every year from aging and poorly maintained pipelines. This volume is a significant percentage of the approximately 2.1 billion barrels the country produces, according to government and environmentalist estimates cited in a Greenpeace report.

A notable effort is currently being made in the US to reduce pipeline-related spills. The US Office of Pipeline Safety (OPS) is implementing an industry-wide Integrity Management Program to validate and improve pipeline integrity in high-density population areas, waters where there is a substantial likelihood of commercial navigation, and areas unusually sensitive to environmental damage. In addition, oil pipeline companies must submit federal response plans (FRPs) similar to those required by oil transfer facilities, and participate in both tabletop, full-scale, area exercises that involve equipment and personnel deployment.

Clearly, the elements of a successful program for prevention of spills from pipelines include:

- Continuous efforts to improve design, materials and engineering of pipelines;
- Enhanced and increased leak detection efforts;
- Targeted efforts at third-party interference deterrence;
- Liability for non-compliance or negligence; and
- Rigorous enforcement efforts.

Since pipelines are not regulated internationally, these and other prevention initiatives for this source must be initiated by national governments or voluntarily by industry.

VII. Land-based source spills

Land based facilities may be divided into point source and non-point source categories. Point sources include non-exploration and production related facilities (e.g., manufacturing, industrial, utility). Non-point sources include those which cannot be easily identified (e.g., runoff).

Land based facilities. The OIS estimates that worldwide spills from point-source facilities that are not from vessels or oil and gas exploration and production (including crude oil pipelines) facilities amounts to between 2,400 and 15,000 tonnes per year. The OIS best estimate for this source is 4,900 tonnes per year and is based on data compiled by ERC. This source includes industrial and manufacturing facilities as well as sewage and utility plants.

- USCG compiled data on annual spill volume and spill numbers for accidental discharges from onshore facilities for 1985-1999. Figure 7 shows that the annual spill volumes vary significantly over time and are greatly affected by large discharges in any individual year. Figure 8 further shows that there was an increase in the number of spills from 1985-1991 and a decrease in the number of spills from 1991-1999. The increase from 1985-1991 is attributed by some to "increased awareness of spill reporting requirements," while the decrease in the number of spills from 1991-1999 is attributed to better compliance and prevention measures (USCG 2001). These explanations are merely conjecture, and are not based upon hard evidence. It is unlikely that better reporting and compliance were prevalent on a worldwide basis.
- In the US alone, for FY2002, with 697,966 active underground storage tanks (USTs) in operation, the

number of confirmed releases was 427,307 (EPA 2002). That constitutes 61%. The number of cleanups completed was 284,602 (67%). Spills and overfills result mainly from bad filling practices. Also, unprotected steel tanks and piping can corrode and release product through holes caused by corrosion of the metal tank or piping. Clearly, in addition to ensuring that the tanks are properly designed, built and maintained to avoid leaks caused by corrosion, rigorous operating procedures must be employed to prevent spills and overfills.

It has been noted by the U.S. Environmental Protection Agency (EPA), that many releases at UST sites come from spills made during delivery. Spills usually result from human error and can be avoided if everyone involved in the fuel delivery follows industry standard practices for tank filling, using catchment basins to contain small spills.

Overfills usually result in much larger volumes of oil spilled. Overfilling results when oil is released at the fill pipe and through loose fittings on the top of the tank or a loose vent pipe. Overfill problems can be avoided by ensuring adequate volume of the receptacle tank before delivery and carefully monitoring the entire delivery process.

Primarily, national and local authorities manage control of spills from these sources. No international regulation applies. Spill prevention measures may vary widely from facility to facility based upon the nature of its primary activity. It is safe to say, however, that a number of key elements similar to those referred to above are needed for a successful prevention program. These include:

- Efforts to improve design, materials and equipment with prevention as a goal;
- Monitoring and maintenance of equipment to ensure optimum performance;
- Well trained personnel and company incentives to promote prevention;
- Management leadership for prevention program; and
- Meaningful fines for non-compliance/negligence.

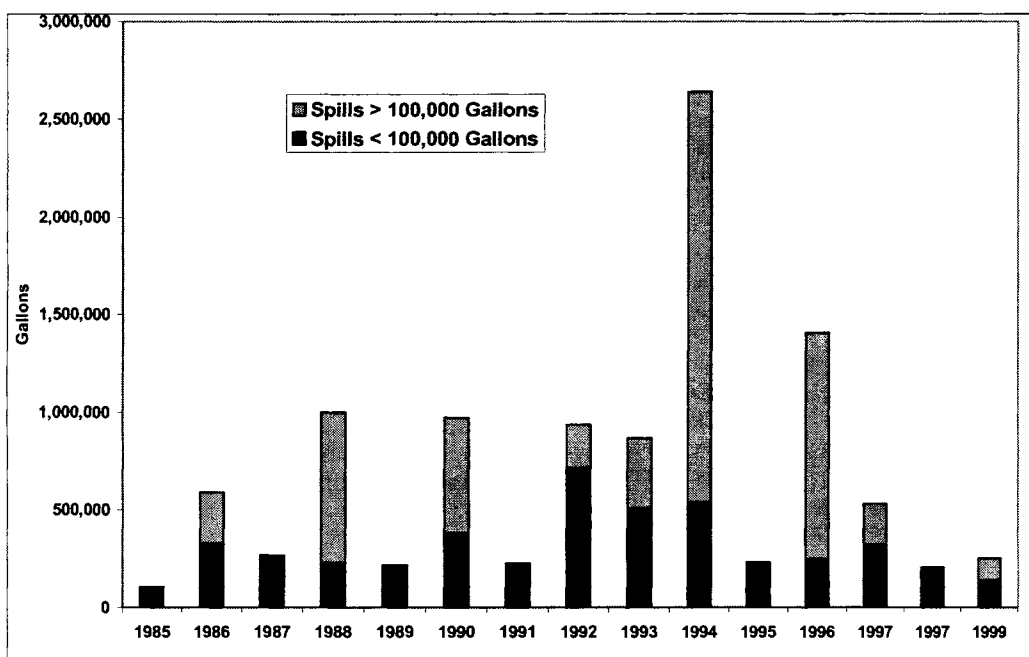


Figure 7. Volume of oil spilled from onshore facilities (excluding pipelines) in U.S. waters, 1985-1999. (USCG 2001)

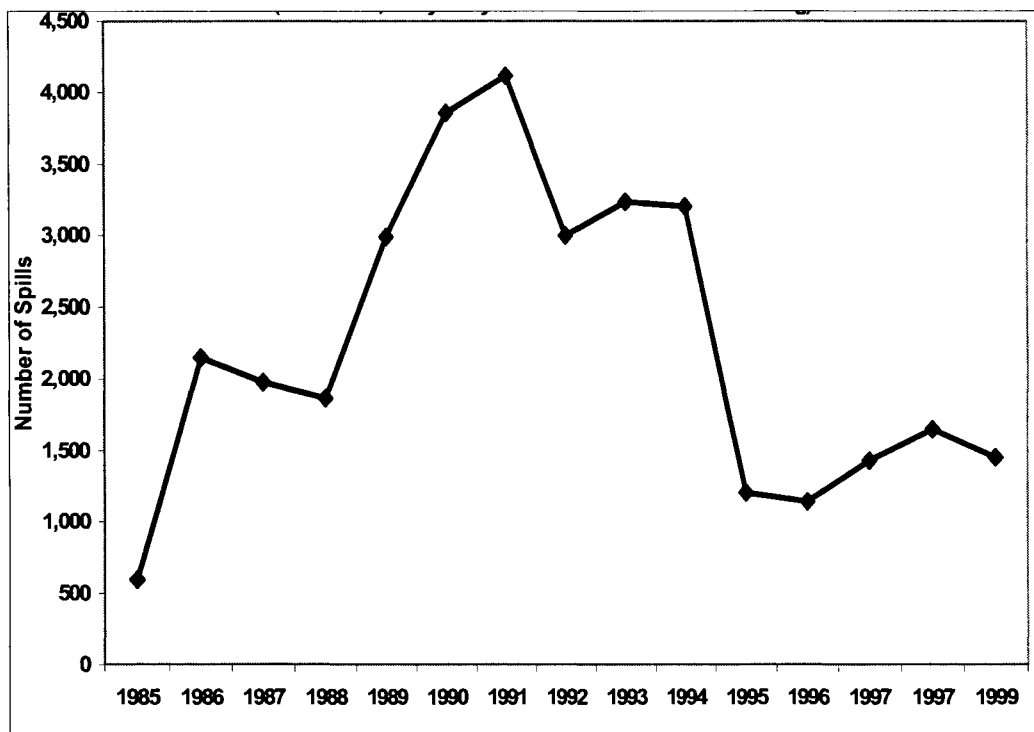


Figure 8. Annual number of facility (excluding pipelines) spills (1 gal and over) in U.S. Waters, 1985-1999. Source: USCG 2001.

Non-point sources. The spill sources described thus far have been point sources, which are location specific and generally can be addressed by prevention and/or response initiatives. Two significant non-point-source contributors of oil to the marine environment are urban and coastal runoff, and atmospheric input (atmospheric deposition and air-sea exchange).

The OIS estimates worldwide oil input from non-point, land-based sources to be between 161,000 and 6,132,000 tonnes of oil annually. The OIS best estimate is 606,000 tonnes. Other analysts have stated (USCG, 2001; page 2-8):

Hydrocarbon runoff from urban and coastal areas is a significant contribution in comparison with the various point-source contributions outlined above. However, the individual point sources contributing to this input are difficult to identify and even more difficult to mitigate as regulatory measures and pollution prevention programs addressing coastal and urban runoff are just now being implemented.

The OIS notes that the range of uncertainty in the estimated loadings of oil to the sea from land-based sources is four orders of magnitude. Once again, absent more solid statistical data, it is difficult to find meaning in these numbers.

The international community first addressed land-based source pollution in a comprehensive way in 1974 with the adoption of the International Convention for the Prevention of Marine Pollution from Land-Based Sources. More recently, with the adoption of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities and the Washington Declaration, regional cooperation has been seen as the framework to ensure national implementation in addressing land-based pollution.

Efforts are underway to address the problem of land-based sources of marine pollution through a number of regional

agreements. These agreements have been adopted under the auspices of the United Nations Environment Program and include the following:

- Convention on the Protection of the Black Sea against Pollution, Bucharest, 1992;
- Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, Cartagena de Indias, 1983;
- Convention for the Protection, Management, and Development of the Marine and Coastal Environment of the Eastern African Region, Nairobi, 1985;
- Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution, Kuwait, 1978;
- Convention for the Protection and Development of the Marine Environment and Coastal Region of the Mediterranean Sea (Barcelona Convention), Barcelona, 1976;
- Regional Convention for the Conservation of the Red Sea and the Gulf of Aden Environment, Jeddah, 1982;
- Convention for the Protection of the Natural Resources and Environment of the South Pacific Region, Noumea, 1986;
- Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific, Lima, 1981; and
- Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region, Abidjan, 1981.

Specific protocols addressing land-based sources have been adopted for the Mediterranean (1980, amended in 1996), the South-East Pacific (1983), the Kuwait region (1990), the Black Sea (1992), and the Wider Caribbean (1999).

Protocols adopted for the Mediterranean and the Wider Caribbean have broadened their scope of application to the hydrologic basin and have expanded upon the sources of pollution to be regulated under the protocols. These protocols contain obligations relating to the establishment of national plans, programs, and specific measures for addressing land-based pollution, as well as other regional or subregional cooperative initiatives.

The OSPAR and Helsinki conventions contain provisions relating to land-based sources of pollution as well. OSPAR provides a model for regional cooperation on this issue. The parties to OSPAR address specific sources of land-based pollution in a large number of directives and agreements designed to assist member countries in implementing sound environmental policy. The OSPAR Strategy with regard to Hazardous Substances includes petroleum products in its List of Chemicals for Priority Action.

Non-point source pollution constitutes perhaps the most insidious and certainly the most difficult spill source to address. It involves widespread and diverse pollutant sources, which are not easily identified or controlled.

VIII. Air emissions

In addition to the spill sources we have discussed thus far, oil enters the environment from air emissions from oil and gas exploration and production activities (production, transport and refining) and vessel operations (loading, crude oil washing and in transit) in the form of volatile organic carbons (VOCs). A portion of these VOCs eventually enters the marine environment. The OIS estimates that over 53,000 tonnes of petroleum is released annually as a result of atmospheric deposition. Of this volume, only 1,300 tonnes is attributed to oil exploration and production activities.

As noted by the OIS, the impact of VOCs on the marine environment are not well documented. However, the release of VOCs is expected to have an adverse impact on local air quality. In addition, it has been suggested that the release of VOCs into the atmosphere may contribute to global warming.

The international community should explore design standards, equipment alterations or operational measures to eliminate or minimize VOC emissions from tankers. Likewise, the oil industry should carry out similar efforts in relation to their production facilities.

IX. Findings and recommendations

The following findings and recommendations are those of the author, culled from the data and discussions presented herein. This paper is intended to stimulate debate and further examination of the issues. It is hoped that these and other recommendations will be actively pursued by governments and industry in an effort to improve spill prevention efforts. The recommendations appear in bold lettering.

General. Historically, government entities, both national and international, have taken a reactive approach to addressing oil spills and have focused resources on improving response capability.

1. Prevention of oil spills necessarily requires a "proactive" approach, which anticipates the risks and initiates action to eliminate or minimize those risks. The international community, regional regimes and national governments should be

proactive in addressing oil spill prevention, by instituting preventive measures in the absence of a major incident.

In recent years the volume of oil spilled from tankers on a worldwide basis has decreased slightly. Much of this decline can be attributed to a more dramatic decrease in volume of oil spilled by tankers in U.S. waters. Based upon current understanding of the fate and effect of oil in the marine environment, and recognition that even a relatively small spill can have devastating environmental impacts, the volume of oil spilled by all sources continues to be unacceptable from an environmental perspective.

2. Decision-making bodies, internationally, regionally and nationally, as appropriate, should institute measures for prevention of oil spills from all sources.

Vessel source spills. Although the data indicate a general reduction in the volume and number of spills from vessel sources over time, since the mid - 1980s the number of accidental vessel spills into the marine environment per million tonnes of produced oil has remained in a consistent range (between .6 and 1) suggesting no dramatic reduction in number of spills relative to the level of activity.

Vessel spills are significant, both in terms of volume of oil spilled and number of spills.

Double hulls have proven to be highly effective in oil spill prevention.

3. Efforts to improve ship design and construction with prevention as a goal should continue. Initiatives to encourage or require further modifications in ship design, including redundancy of propulsion and/or steerage should be actively explored.

4. Bunker spills from non-tank vessels are a growing concern. Application of tank-vessel prevention measures (e.g. double hull) should be considered for these vessels. Dramatic reductions in the spill volume and number of spills in the United States is attributed in large part to:

- Higher liability limits and the potential for unlimited liability in some states;
- Broader definition of damages, including a broad definition of natural resource damages and third party damages; and
- Rigorous port state control program, including a screening process prior to entry into ports.

6. The international community should adopt an unlimited liability standard for oil spills in accordance with the polluter pays principle and to reflect the real costs of marine transport of petroleum.

7. The international community should include within the scope of liability, the full range of costs associated with spills, including the cost of natural resource damages and third party claims.

8. The international community should consider including a broader definition of environmental damage under current liability and compensation regimes.

9. Regional and national port state controls should institute a screening process to identify potentially substandard ships for targeted inspection. Operational discharges from vessels are a major source of oil spills which has not been adequately addressed. Non-compliance with current international regulations on discharges and illegal discharges are not well documented. In those areas where surveillance is greatest, violations are regularly reported.

10. International, regional and national efforts should be made to increase surveillance for illegal spills and to detect violations of vessel discharge standards.